Plan B 4.0 - Supporting Data for Chapters 4 and 5 - U.S. Energy Profile

Table 5-2. U.S. Electricity Generating Capacity in 2008 and Plan B Goals for 2020
Average Capacity Factors for Selected Electric Power Sources in the United States
U.S. Cumulative Installed Wind Electricity-Generating Capacity, 1980-2008
GRAPH: U.S. Cumulative Installed Wind Electricity-Generating Capacity, 1980-2008
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GRAPH: U.S. Annual Solar Photovoltaics Production, 1976-2008
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GRAPH: U.S. Annual Biodiesel Production, 2000-2009
U.S. Natural Gas Consumption, 1965-2008
GRAPH: U.S. Natural Gas Consumption, 1965-2008
U.S. Oil Consumption, 1965-2008
GRAPH: U.S. Oil Consumption, 1965-2008

A full listing of data for the entire book is on-line at:
http://www.earthpolicy.org/index.php?/books/pb4/pb4_data

This is part of a supporting dataset for Lester R. Brown, **Plan B 4.0: Mobilizing to Save Civilization** (New York: W.W. Norton & Company, 2009). For more information and a free download of the book, see Earth Policy Institute on-line at www.earthpolicy.org.

Table 5-2. U.S. Electricity Generating Capacity in 2008 and Plan B Goals for 2020

Source	Installed Capacity 2008	Installed Capacity 2020	Electricity Generation 2008	Electricity Generation 2020
	Electrical Gigawatts		Petajoules	
Fossil Fuels and Nuclear				
Coal	337	0	7,180	0
Oil	62	0	163	0
Natural Gas	459	140	3,199	900
Nuclear	106	106	2,900	2,900
Total	965	246	13,442	3,800
Renewables				
Wind	25	710	288	8,060
Rooftop Solar Electric Systems	1	190	5	1,260
Solar Electric Power Plants	0	30	1	220
Solar Thermal Power Plants	0	120	3	910
Geothermal	3	70	85	1,980
Biomass	11	40	246	960
Hydropower	78	100	1,086	1,320
Total	119	1,260	1,714	14,710

Note: Columns may not add to totals due to rounding.

Source: **Fossil Fuels and Nuclear: 2008: Installed Capacity** from U.S. Department of Energy (DOE), Energy Information Administration (EIA), "Existing Capacity by Energy Source, 2007," and "Planned Nameplate Capacity Additions from New Generators, by Energy Source, 2008 through 2012," Tables 2.2 and 2.4 in *Electric Power Annual* (Washington, DC: January 2009), p. 25, and from Erik Shuster, *Tracking New Coal-Fired Power Plants* (Pittsburgh, PA: DOE, National Energy Technology Laboratory, January 2009); **Electricity Generation** calculated from DOE, EIA, "Electricity Net Generation: Total (All Sectors), Selected Years, 1949-2008," Table 8.2a in *Annual Energy Review 2008* (Washington, DC: June 2009), p. 230; **2020: Installed Capacity and Electricity Generation** calculated by backing out all coal- and oil-fired electricity generation, 70 percent of gas-powered electricity generation in 2006, and holding nuclear power generation at 2006 levels. **Renewables: 2008: Installed Capacity: Wind** from American Wind Energy Association, *American Wind Energy Association Annual Wind Energy Report - Year Ending 2008* (Washington, DC: 2009), p. 4; **Rooftop Solar Electric Systems** and **Solar Electric Power Plants** estimated from European Photovoltaic Industry Association, *Global Market Outlook for Photovoltaics Until 2013* (Brussels: April 2009), p. 7 (total installed PV in the United States in 2008 estimated at 1,173 MW with 80 percent in rooftop electric systems and 20 percent in power plants); **Solar Thermal Power Plants** from DOE, National Renewable Energy Laboratory (NREL), "U.S. Parabolic Trough Power Plant Data," at www.nrel.gov/csp/troughnet/power_plant_data.html, updated 25 July 2008; **Geothermal** estimated from Kara Slack, *U.S Geothermal Power Production and Development Update* (Washington, DC: Geothermal Energy Association, August 2008), p. 2 and Kara Slack, *U.S Geothermal Power Production and Development Update* (Washington, DC: Geothermal Energy Association, March 2009), p. 3; **Biomass** estimated by assuming that 2008 installed capacity is the same as 2007 from DOE, EIA, *Electric Power Annual 2007* (Washington, DC: 2009), p. 24 (biomass includes wood

and wood-derived fuels as well as biogenic municipal solid waste, landfill gas, sludge waste, agricultural byproducts); **Hydropower** estimated by assuming that 2008 installed capacity is the same as 2007 from DOE, EIA, *Electric Power Annual 2007* (Washington, DC: 2009), p. 22 (hydropower excludes pumped storage); **Electricity Generation** calculated by converting installed capacity into actual generation using capacity factors from DOE, NREL, *Power Technologies Energy Data Book* (Golden, CO: August 2006), p. 201; **2020: Installed Capacity and Electricity Generation: Wind** assumes a growth rate of 32 percent from 2008 to 2020; **Rooftop Solar Electric Systems** calculated based on covering 23 percent of suitable rooftop area with PV and assuming 18 percent spacing and system (inverter) losses and an average power capacity of 12 watts per square foot; rooftop area from Maya Chaudhari, Lisa Frantzis, Tom Hoff, *PV Grid Connected Market Potential under a Cost Breakthrough Scenario* (Washington, DC: Navigant Consulting, September 2004); J. Paidipati, L. Frantzis, H. Sawyer, A. Kurrasch, *Rooftop Photovoltaics Market Penetration Scenarios* (Golden, CO: DOE, NREL, February 2008); **Solar Electric Power Plants** assumes a growth rate of 51 percent from 2008 to 2020 (assumes an 8 percent inverter loss); **Solar Thermal Power Plants** assumes a growth rate of 60 percent from 2008 to 2020; **Geothermal** assumes a growth rate of 30 percent from 2008 to 2020; **Biomass** includes forest and urban wood waste, as well as perennial crops such as switchgrass and fast-growing trees, estimated from DOE and U.S. Department of Agriculture, *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply* (Washington, DC: April 2005); average energy for biomass is 13 million Btus per ton from DOE, NREL, *Power Technologies Energy Data Book* (Golden, CO: 2005); average power plant heat rate of 9,000 Btu/kWh from DOE, EIA, *Assumptions to the Annual Energy Outlook 2005 with Projections to 2025* (Washington, DC: 2005); **Hydropower** assumes an additional 20,000 MW of capacity from new small hydropower, capacity gains at existing dams, new conventional hydropower at currently existing non-powered dams, ocean wave and hydrokinetic technologies from Electric Power Research Institute, *Assessment of Waterpower Potential and Development Needs* (Palo Alto, CA: 2007), p. vii.

This is part of a supporting dataset for Lester R. Brown, **Plan B 4.0: Mobilizing to Save Civilization** (New York: W.W. Norton & Company, 2009). For more information and a free download of the book, see Earth Policy Institute on-line at www.earthpolicy.org.

Average Capacity Factors for Selected Electric Power Sources in the United States

Source	Capacity Factor
	Percent
Fossil Fuels and Nuclear	
Coal	72.2
Oil	18.9
Natural Gas	37.3
Nuclear	89.8
Renewables	
Wind	36.0
Solar Photovoltaics	22.5
Solar Thermal	24.4
Geothermal	90.0
Biomass	80.0
Hydropower	44.2

Note: Capacity factor is the ratio of actual electricity generated during a period of time (usually one year) to the electricity that could have been generated over that same period with continuous operation at full power. Capacity factors given here represent averages for a range of recent years.

Source: Fossil fuels and Nuclear from "Average Capacity Factors by Energy Source, 1996 through 2007," Table A.6 in DOE, Energy Information Administration, *Electric Power Annual 2007* (Washington, DC: January 2009); Renewables from U.S. Department of Energy (DOE), National Renewable Energy Laboratory, *Power Technologies Energy Data Book* (Golden, CO: August 2006), p. 201.

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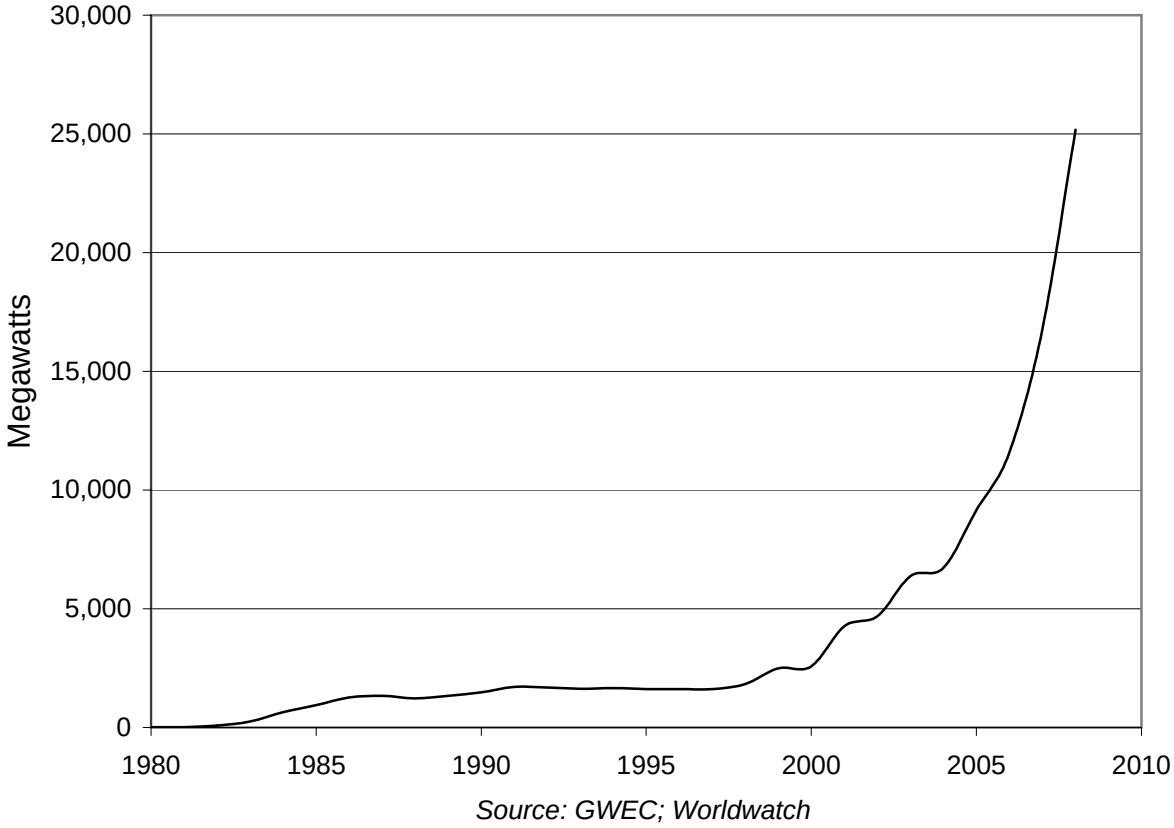
U.S. Cumulative Installed Wind Electricity-Generating Capacity, 1980-2008

Year	Cumulative Installed Capacity	Net Annual Addition*
	Megawatts	
1980	8	
1981	18	10
1982	84	66
1983	254	170
1984	653	399
1985	945	292
1986	1,265	320
1987	1,333	68
1988	1,231	-102
1989	1,332	101
1990	1,484	152
1991	1,709	225
1992	1,680	-29
1993	1,635	-45
1994	1,663	28
1995	1,612	-51
1996	1,614	2
1997	1,611	-3
1998	1,837	226
1999	2,490	653
2000	2,578	88
2001	4,275	1,697
2002	4,685	410
2003	6,372	1,687
2004	6,725	353
2005	9,149	2,424
2006	11,575	2,426
2007	16,824	5,249
2008	25,170	8,346

* Note: Net annual addition equals new installations minus retirements.

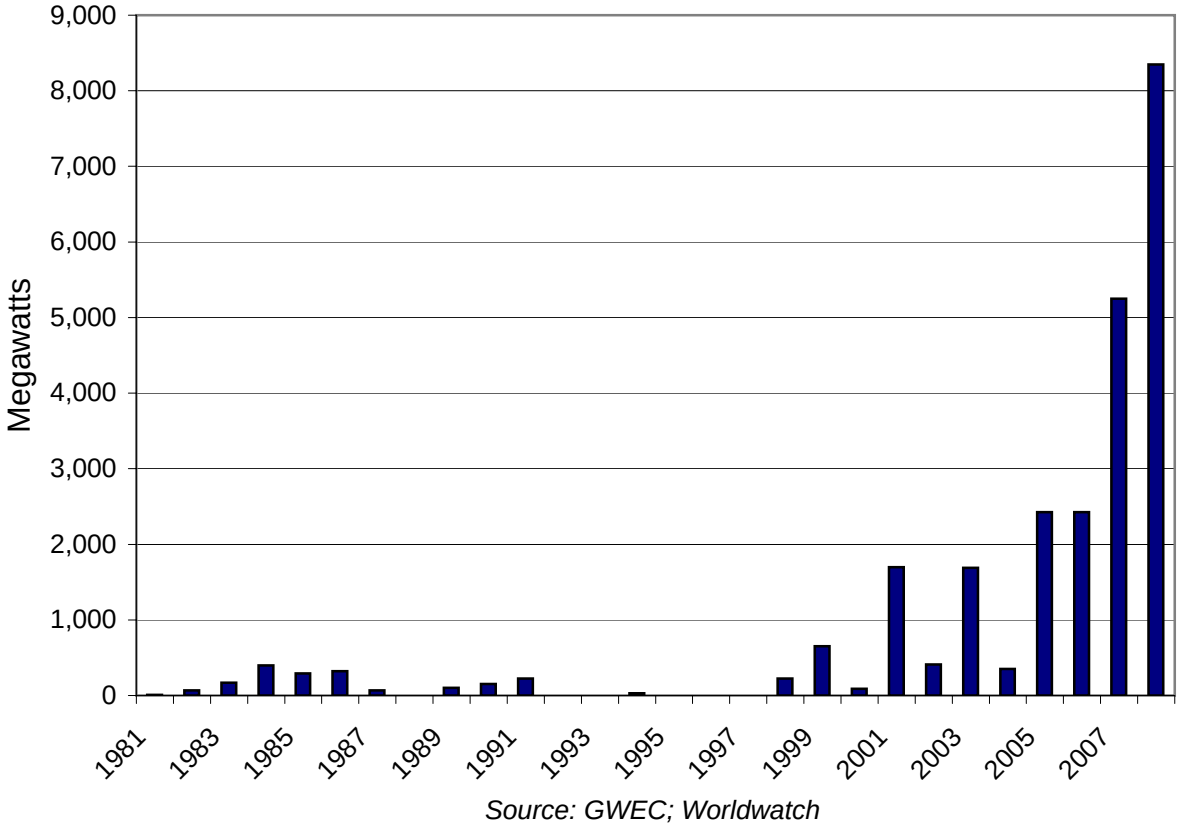
Source: Compiled by Earth Policy Institute using 1980-1999 data from Worldwatch Institute, *Signposts 2001* , CD-ROM (Washington, DC: 2001); 2000-2008 data from Global Wind Energy Council (GWEC), *Global Wind 2008 Report* (Brussels: 2009), p. 57.

U.S. Cumulative Installed Wind Electricity-Generating Capacity, 1980-2008



Source: GWEC; Worldwatch

U.S. Net Annual Installed Wind Electricity-Generating Capacity Additions, 1981-2008



Source: GWEC; Worldwatch

U.S. Solar Photovoltaics Production, 1976-2008

Year	Annual Production	Cumulative Production
	Megawatts	
1976	0.3	0.3
1977	0.4	0.7
1978	0.8	1.6
1979	1.2	2.8
1980	2.5	5.3
1981	3.5	8.8
1982	5.2	14.0
1983	8.2	22.2
1984	8.0	30.2
1985	7.7	37.9
1986	7.1	45.0
1987	8.7	53.7
1988	11.1	64.8
1989	14.1	78.9
1990	14.8	93.7
1991	17.1	110.8
1992	18.1	128.9
1993	22.4	151.4
1994	25.6	177.0
1995	34.8	211.8
1996	38.9	250.6
1997	51.0	301.6
1998	53.7	355.3
1999	60.8	416.1
2000	75.0	491.1
2001	100.3	591.4
2002	120.6	712.0
2003	103.0	815.0
2004	138.7	953.7
2005	153.1	1,106.8
2006	177.6	1,284.4
2007	270.6	1,555.0
2008	412.0	1,967.0

Source: Compiled by Earth Policy Institute with 1976-1993 from Hillary Flynn, Content Manager at Prometheus Institute for Sustainable Development, Cambridge, MA, email to Joseph Florence, Earth Policy Institute, 21 March 2006; 1994-2000 data from Worldwatch Institute, *Signposts 2004* , CD-ROM (Washington, DC: 2005); 2001-2008 from Prometheus Institute and Greentech Media, "25th Annual Data Collection Results: PV Production Explodes in 2008," *PVNews* , vol. 28, no. 4 (April 2009), pp. 15-18.

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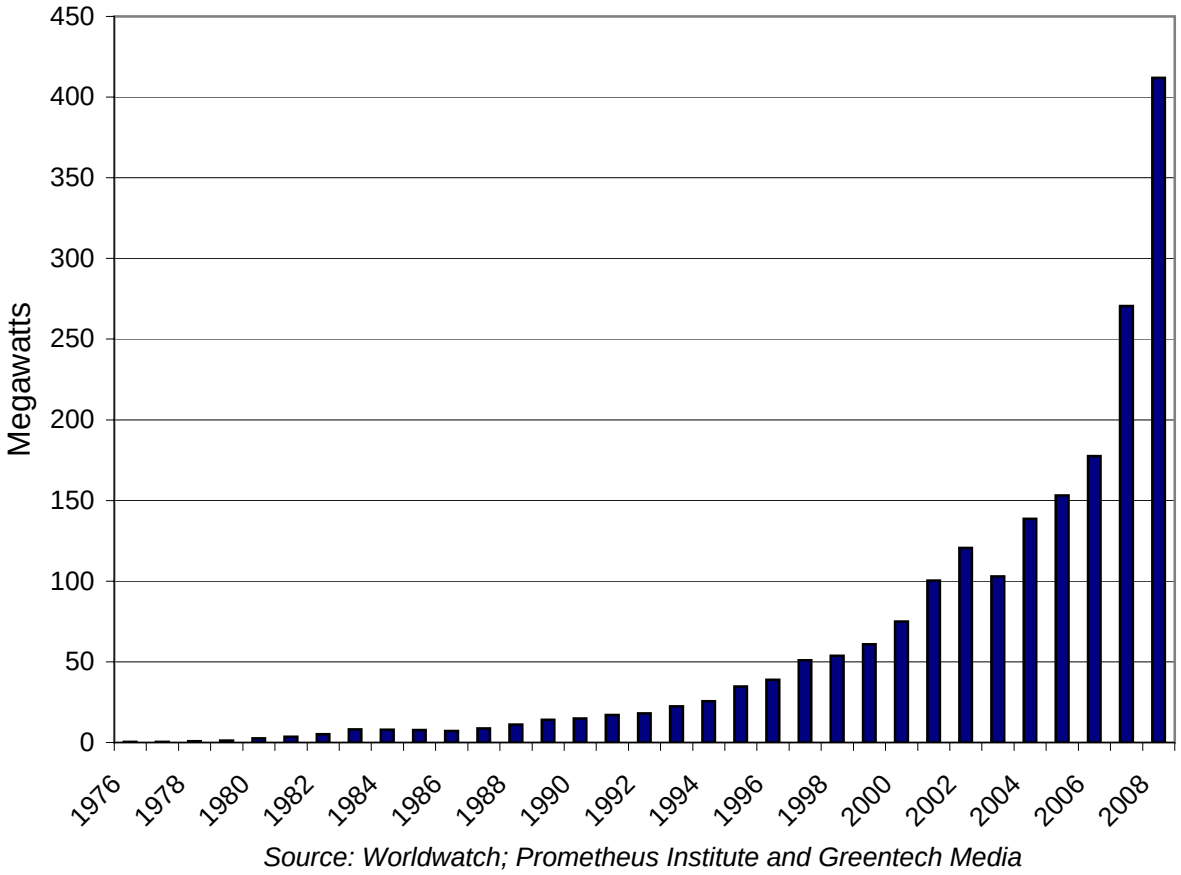
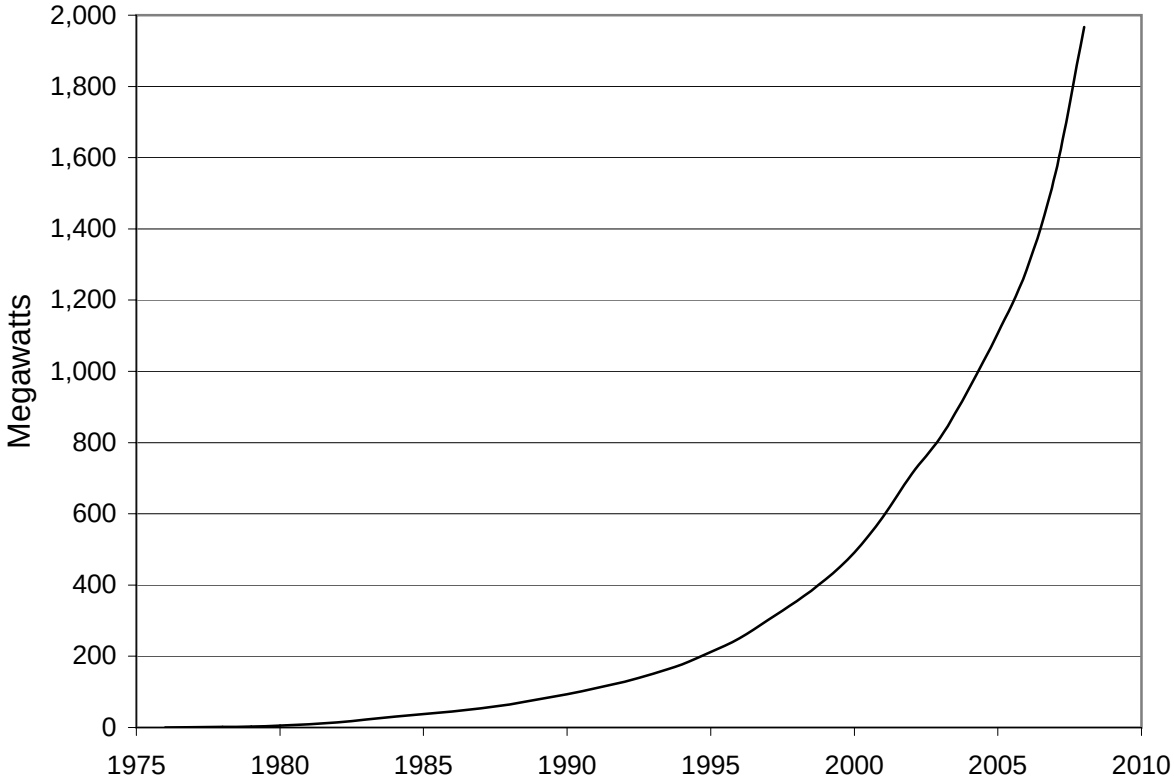
U.S. Annual Solar Photovoltaics Production, 1976-2008



Source: Worldwatch; Prometheus Institute and Greentech Media

U.S. Cumulative Solar Photovoltaics Production,
1976-2008



Source: Worldwatch; Prometheus Institute and Greentech Media

U.S. Cumulative Installed Geothermal Electricity-Generating Capacity, 1990-2009

Year	Cumulative Installed Capacity
	Megawatts
1990	2,775
1995	2,817
2000	2,228
2005	2,564
2009 *	3,040

* Note: Installed capacity as of March 2009.

Source: Compiled by Earth Policy Institute with 1990 and 1995 from International Geothermal Association, "Installed Generating Capacity," at http://iga.igg.cnr.it/geoworld/geoworld.php?sub=elgen, updated 3 July 2009; 2000 and 2005 from Ruggero Bertani, "World Geothermal Generation in 2007," *GHC Bulletin*, September 2007, p. 9; 2009 from Kara Slack, *U.S. Geothermal Power Production and Development Update* (Washington, DC: Geothermal Energy Association, March 2009), p. 3.

Confirmed U.S. Geothermal Projects Under Development as of March 2009

State	Number of Projects	Expected Capacity	
		Low Range	High Range
		Megawatts	
Alaska	5	60.0	100.0
Arizona	1	2.0	20.0
California	27	1,038.6	1,327.6
Colorado	1	10.0	10.0
Florida	1	0.2	1.0
Hawaii [1]	2	8.0	8.0
Idaho	5	238.0	326.0
Nevada	58	1,692.4	3,172.4
New Mexico	1	10.0	10.0
Oregon	12	292.4	318.4
Utah	7	194.0	194.0
Washington [2]	1	n.a.	n.a.
Total	121	3,545.6	5,487.4

Notes: [1] Expected capacity only reported for one of the two projects (8 megawatts); [2] Expected capacity not reported.

Source: Kara Slack, *U.S. Geothermal Power Production and Development Update* (Washington, DC: Geothermal Energy Association, March 2009), p. 9.

U.S. Hydroelectric Consumption, 1965-2008

Year	Consumption
	Billion Kilowatt-hours
1965	199
1966	200
1967	227
1968	228
1969	256
1970	253
1971	272
1972	279
1973	278
1974	307
1975	306
1976	290
1977	226
1978	286
1979	286
1980	282
1981	267
1982	316
1983	339
1984	328
1985	287
1986	297
1987	255
1988	228
1989	275
1990	296
1991	292
1992	256
1993	283
1994	263
1995	314
1996	351
1997	360
1998	327
1999	323
2000	278
2001	219
2002	267
2003	279
2004	271
2005	273
2006	292
2007	250
2008	251

Source: BP, *Statistical Review of World Energy June 2009* (London: 2009).

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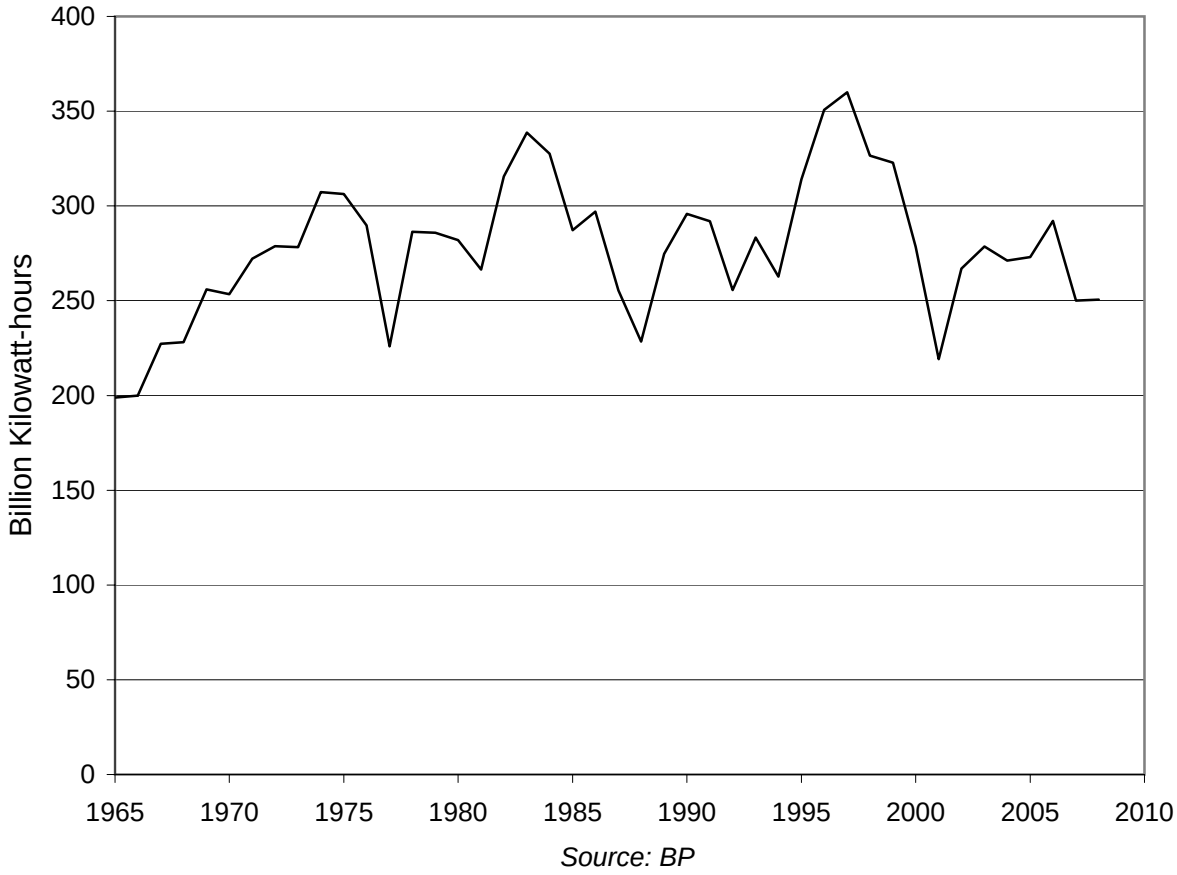
U.S. Hydroelectric Consumption, 1965-2008



Source: BP

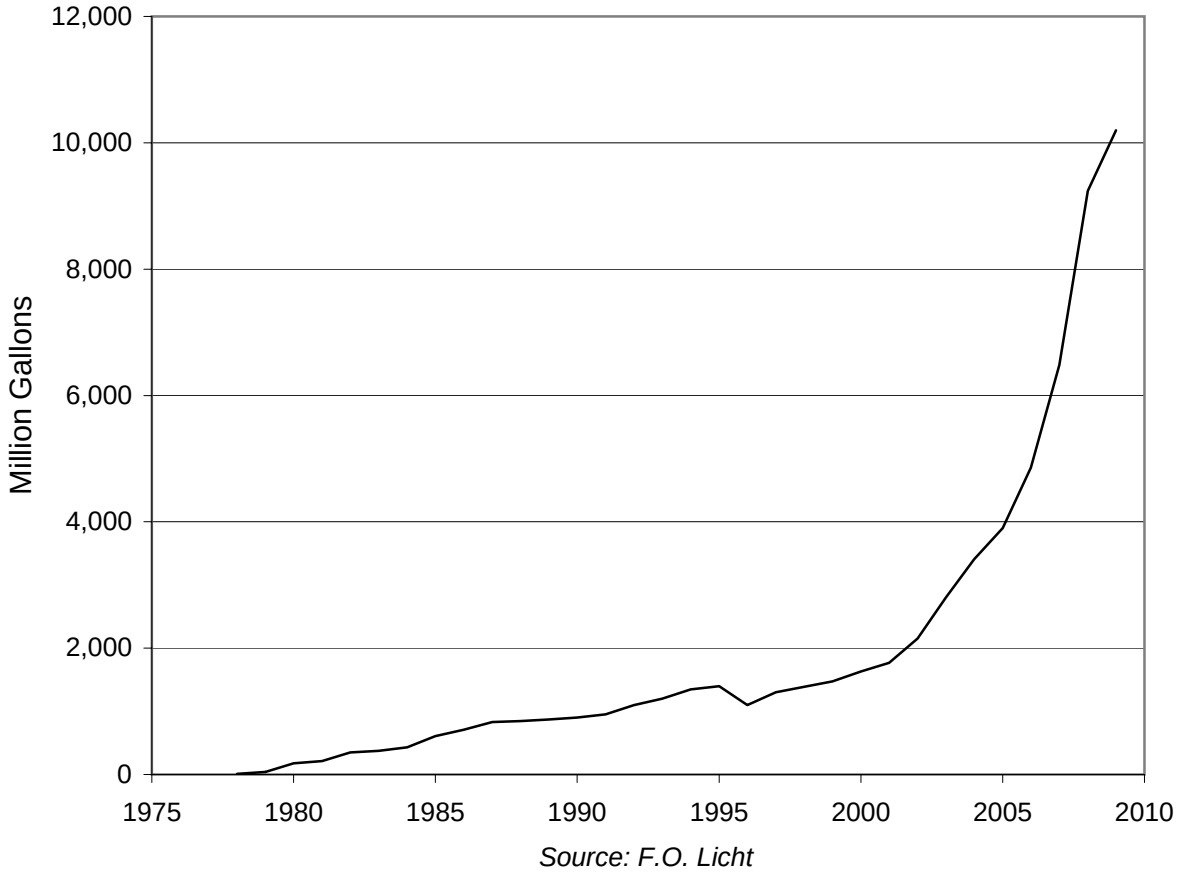
U.S. Annual Fuel Ethanol Production, 1978-2009

Year	Annual Production
	Million Gallons
1978	10
1979	40
1980	175
1981	215
1982	350
1983	375
1984	430
1985	610
1986	710
1987	830
1988	845
1989	870
1990	900
1991	950
1992	1,100
1993	1,200
1994	1,350
1995	1,400
1996	1,100
1997	1,300
1998	1,387
1999	1,472
2000	1,630
2001	1,766
2002	2,153
2003	2,805
2004	3,409
2005	3,898
2006	4,856
2007	6,486
2008	9,238
2009 *	10,197

* Projection.

Source: Source: Compiled by Earth Policy Institute with data for 1978-1998 from F.O. Licht, *World Ethanol and Biofuels Report*, vol. 6, no. 4 (23 October 2007), p. 63; 1999-2009 from F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 18 (26 May 2009), p. 365.

U.S. Annual Fuel Ethanol Production, 1978-2009



Source: F.O. Licht

U.S. Annual Biodiesel Production, 2000-2009

Year	Production
	Million Gallons
2000	2
2001	5
2002	15
2003	20
2004	37
2005	118
2006	246
2007	512
2008	711
2009 *	450

* Projection.

Source: Compiled by Earth Policy Institute with 2000-2004 data from F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 2 (23 September 2008), p. 29; 2005-2009 data from F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 14, (26 March 2009), p. 288.

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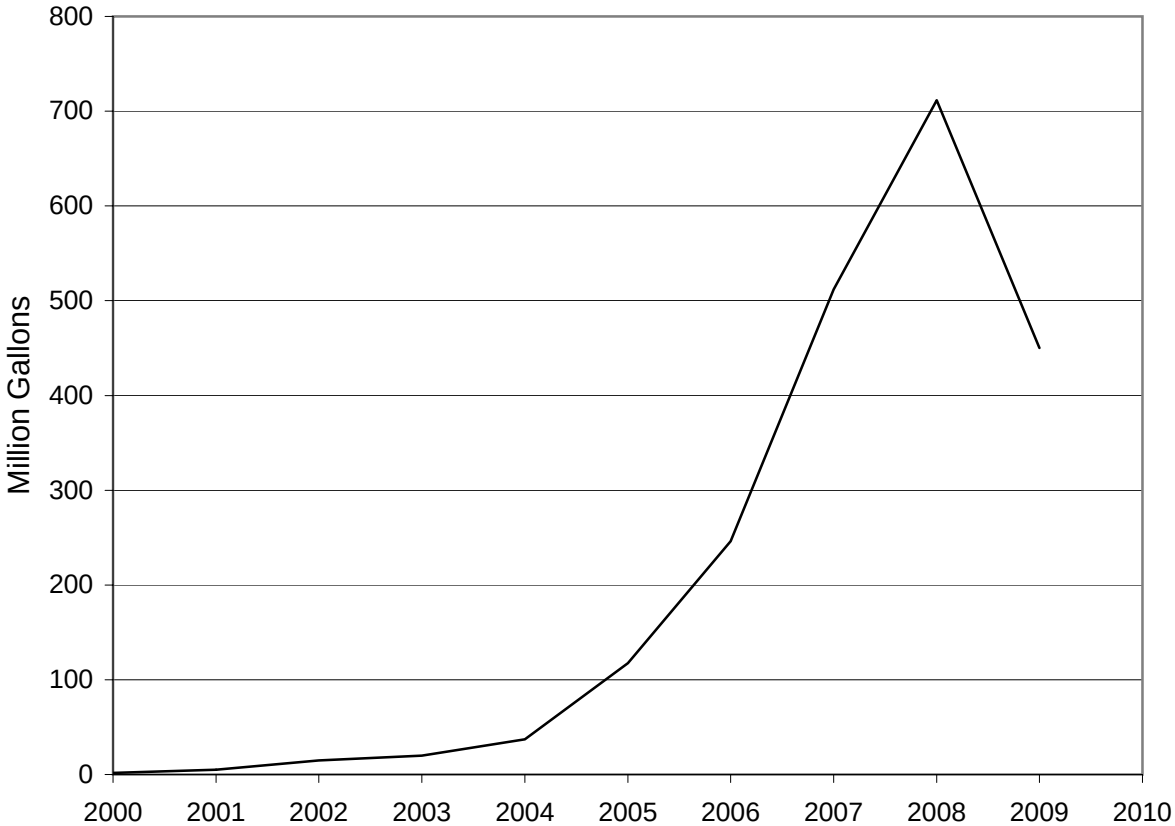
U.S. Annual Biodiesel Production, 2000-2009



Source: F.O. Licht

U.S. Natural Gas Consumption, 1965-2008

Year	Consumption
	Million Tons Oil Equivalent
1965	397
1966	428
1967	452
1968	484
1969	521
1970	549
1971	566
1972	572
1973	567
1974	548
1975	503
1976	513
1977	502
1978	504
1979	521
1980	510
1981	498
1982	463
1983	434
1984	464
1985	446
1986	418
1987	445
1988	465
1989	494
1990	494
1991	505
1992	522
1993	535
1994	548
1995	571
1996	582
1997	585
1998	575
1999	577
2000	600
2001	574
2002	594
2003	577
2004	578
2005	569
2006	560
2007	595
2008	601

Source: BP, *Statistical Review of World Energy June 2009* (London: 2009).

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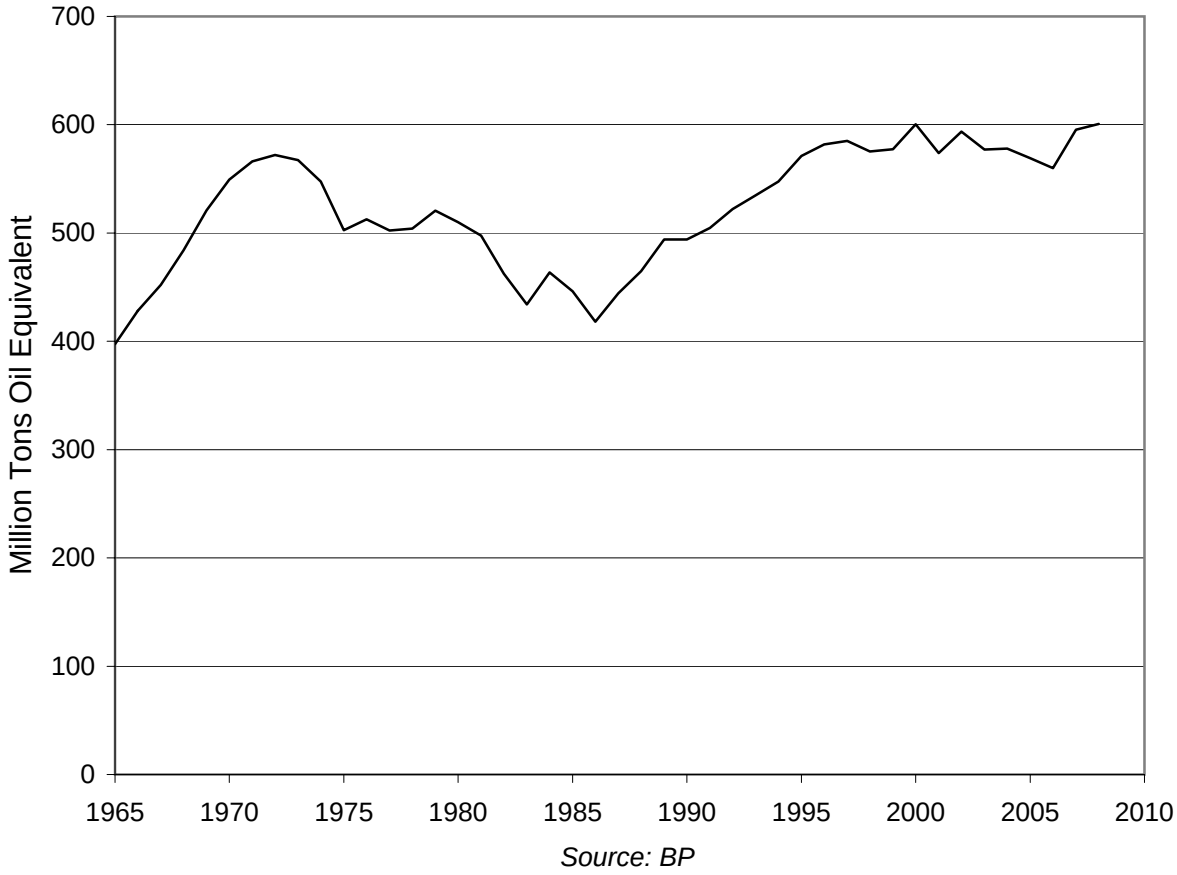
U.S. Natural Gas Consumption, 1965-2008



Source: BP

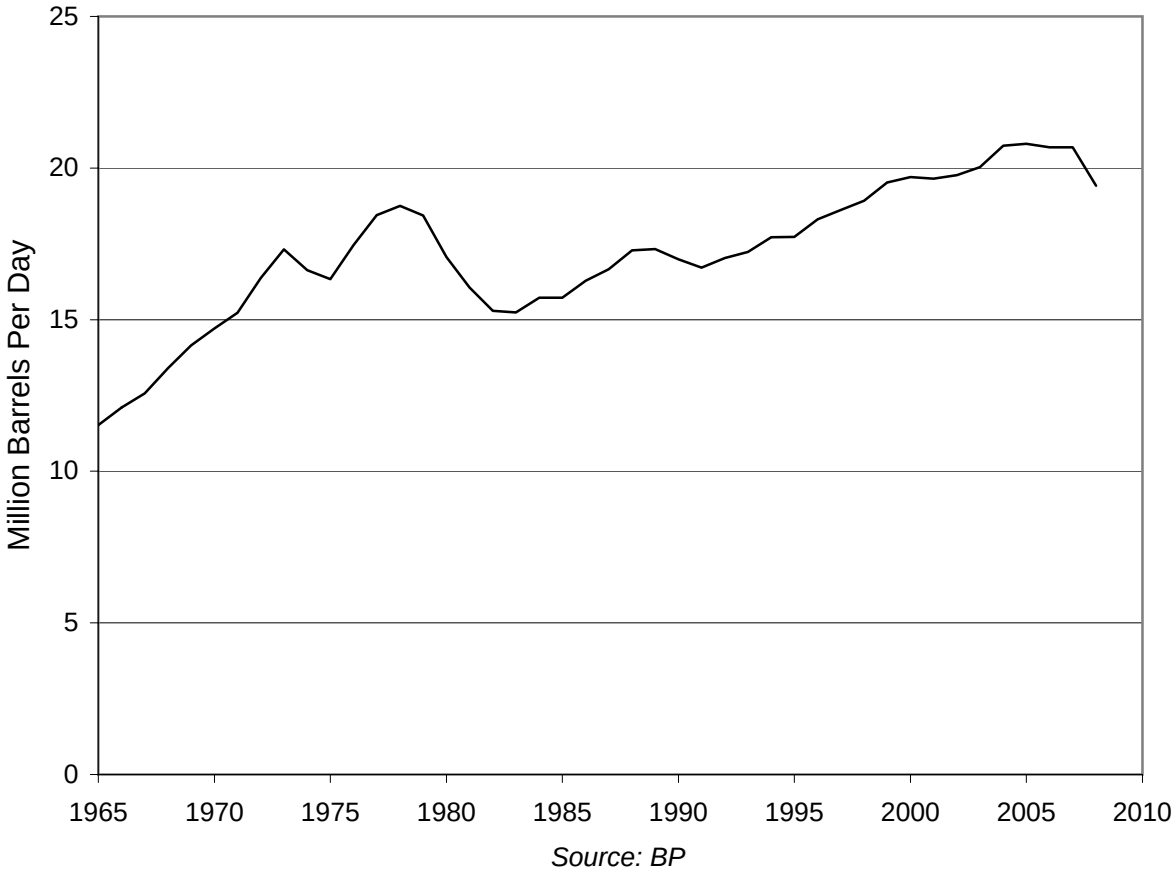
U.S. Oil Consumption, 1965-2008

Year	Consumption*
	Million Barrels per Day
1965	11.5
1966	12.1
1967	12.6
1968	13.4
1969	14.2
1970	14.7
1971	15.2
1972	16.4
1973	17.3
1974	16.6
1975	16.3
1976	17.5
1977	18.4
1978	18.8
1979	18.4
1980	17.1
1981	16.1
1982	15.3
1983	15.2
1984	15.7
1985	15.7
1986	16.3
1987	16.7
1988	17.3
1989	17.3
1990	17.0
1991	16.7
1992	17.0
1993	17.2
1994	17.7
1995	17.7
1996	18.3
1997	18.6
1998	18.9
1999	19.5
2000	19.7
2001	19.6
2002	19.8
2003	20.0
2004	20.7
2005	20.8
2006	20.7
2007	20.7
2008	19.4

* Includes ethanol and biodiesel.

Source: BP, *Statistical Review of World Energy June 2009* (London: 2009).

U.S. Oil Consumption, 1965-2008



Source: BP