

World on the Edge - Energy Data - Overview

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A full listing of data for the entire book is on-line at:

http://www.earth-policy.org/books/wote/wote_data

This is part of a supporting dataset for Lester R. Brown, **World On the Edge: How to Prevent Environmental and Economic Collapse** (New York: W.W. Norton & Company, 2010). For more information and a free download of the book, see Earth Policy Institute on-line at www.earth-policy.org.

World Primary Energy Demand in 2006, with IEA Projection for 2008 and 2020

Energy Source	Growth Rate, 2006-2015	Growth Rate, 2015-2020	World Primary Energy Demand 2006	World Primary Energy Demand 2008	World Primary Energy Demand 2020
	Percent		Million Tons Oil Equivalent		
Coal	3.1	1.7	3,053	3,246	4,374
Oil	1.3	0.9	4,029	4,134	4,744
<i>of which Transport</i>	1.7	1.4	2,105	2,177	2,620
Gas	2.1	1.5	2,407	2,509	3,130
Nuclear	1.3	0.6	728	747	842
Hydro	2.3	1.9	261	273	353
Biomass and Waste	1.7	1.3	396	422	582
Other Renewables	10.2	6.4	66	80	215
Total			10,940	11,412	14,240
Total Non-renewable			10,217	10,637	13,090
Total Renewable			723	775	1,150

Notes: Primary energy demand equals primary energy supply. Nuclear refers to the primary heat equivalent of the electricity produced by a nuclear plant with an average thermal efficiency of 33 percent. Biomass and waste includes commercially traded solid biomass and animal products, gas and liquids derived from biomass, industrial waste, and municipal waste. Other renewables include geothermal, solar, wind, tide, and wave energy for electricity and the direct use of geothermal and solar heat.

Source: Calculated by Earth Policy Institute from International Energy Agency (IEA), *World Energy Outlook 2008* (Paris: 2008), p. 506; IEA, *World Energy Outlook 2004* (Paris: 2004).

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World Electricity Demand in 2006, with IEA Projection for 2008 and 2020

Electricity Source	Growth Rate,	Growth Rate,	World	World	World
	2006-2015	2015-2020	Electricity Demand, 2006	Electricity Demand, 2008	Electricity Demand, 2020
	Percent		Terawatt-hours		
Coal	4.1	2.3	7,756	8,399	12,442
Oil	-0.5	-2.1	1,096	1,085	941
Gas	2.4	2.1	3,807	3,994	5,243
Nuclear	1.3	0.6	2,793	2,865	3,232
Hydro	2.3	1.9	3,035	3,178	4,101
Biomass and Waste	6.4	5.3	239	271	542
Wind	19.9	7.9	130	187	970
Geothermal	5.8	4.5	59	66	122
Solar	33.3	15.9	4	7	111
Tidal/Wave	8.0	8.4	1	1	3
Total Non-renewable			15,452	16,343	21,858
Total Renewable			3,468	3,710	5,849
Total			18,920	20,053	27,707

Notes: Electricity generation is equal to electricity demand and is defined as the electricity generated by power plants including own use and transmission and distribution losses. Hydropower includes both macro and micro hydropower generation. Biomass and waste includes solid biomass and animal products, gas and liquids derived from biomass, industrial waste, and municipal waste. Electricity generation from solar power includes both PV and solar thermal.

Source: Calculated by Earth Policy Institute from International Energy Agency, *World Energy Outlook 2008* (Paris: 2008), p. 507.

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World Energy Consumption in 2008 and Plan B Goals for 2020

Source	2008	Goal for 2020 *
	Petajoules	
Electricity and Heat from Fossil Fuels and Nuclear	70,600	14,600
Electricity from Renewable Sources	16,300	87,000
Thermal Energy from Renewable Sources	10,700	30,800
Transportation	93,000	26,200

* Note: Transportation energy consumption in 2020 is lower than in 2008 because, due to efficiency gains, an electrified transport system requires far less energy than a fossil-fuel-based one. 1 petajoule is equal to 1 billion megajoules.

Source: Calculated by Earth Policy Institute from Table 5-1 using capacity factors from U.S. Department of Energy, National Renewable Energy Laboratory, *Power Technologies Energy Data Book*, (Golden, CO: August 2006), p. 201, with fossil fuels and nuclear data from International Energy Agency (IEA), *World Energy Outlook 2008*, (Paris: 2008), p. 507; and with transportation data from IEA, *World Energy Outlook 2008*, (Paris: 2008), p. 507; F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 18 (26 May 2009), p. 365; F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 14, (26 March 2009), p. 288; energy conversion factors from Oak Ridge National Laboratory, "Bioenergy Conversion Factors," at bioenergy.ornl.gov/papers/misc/energy_conv.html, viewed 10 August 2009.

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World Energy Consumption in 2008 and Plan B Goals for 2020

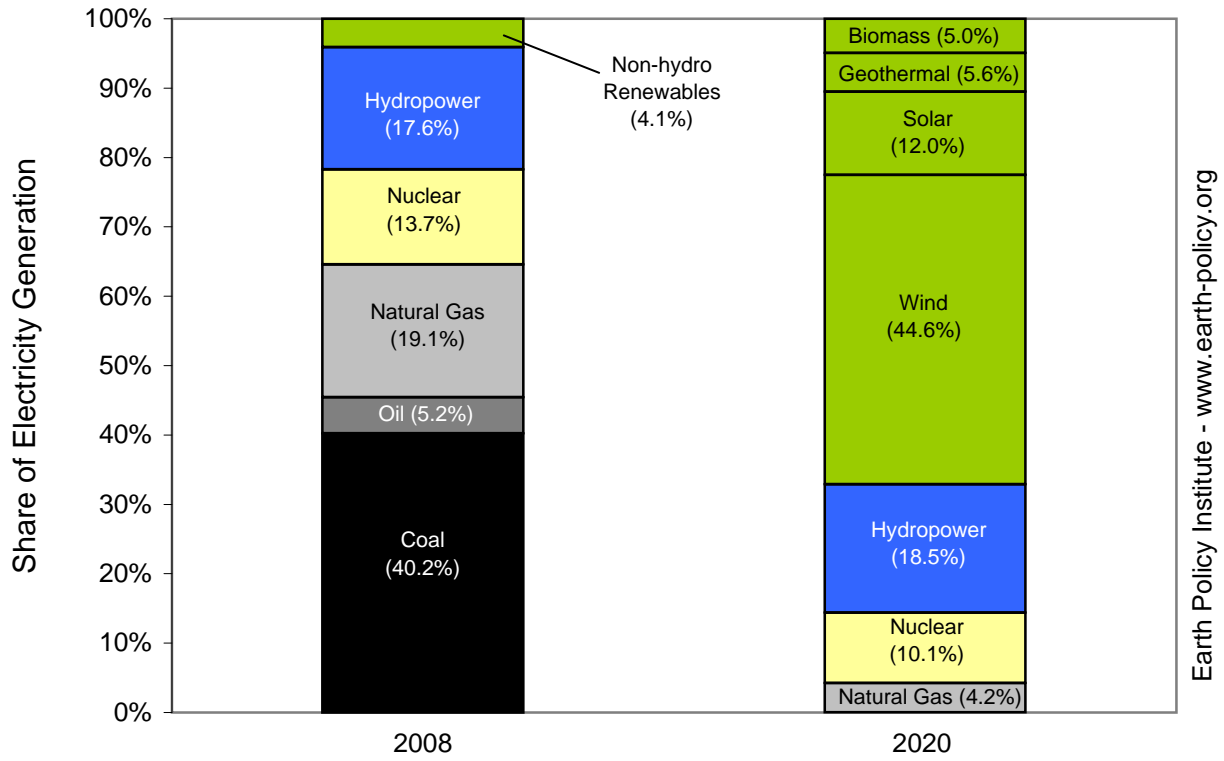
Source	2008 ⁽¹⁾	Goal for 2020
Petajoules		
<u>Electricity and Heat Generation from Fossil Fuels and Nuclear</u>		
Coal	30,237	0
Oil	3,905	0
Gas	14,379	4,314
Nuclear	10,316	10,316
Heat	11,774	0
Total	<u>70,611</u>	<u>14,629</u>
<u>Electricity Generation from Renewables</u>		
Wind	1,366	45,412
Solar Photovoltaics	111	10,643
Solar Thermal Power Plants	3	1,539
Geothermal	301	5,676
Biomass	1,312	5,046
Hydropower	13,228	18,818
Total	<u>16,321</u>	<u>87,134</u>
<u>Thermal Energy Capture from Renewable Sources</u>		
Solar Rooftop Water and Space Heaters	1,057	7,805
Geothermal	2,838	14,191
Biomass	6,812	8,830
Total	<u>10,707</u>	<u>30,826</u>
<u>Transportation Fuel Consumption ⁽²⁾</u>		
Oil	91,155	22,789
Fuel Ethanol	1,400	2,396
Biodiesel	490	1,045
Total	<u>93,045</u>	<u>26,230</u>
Total Energy Consumption	190,684	158,819

Notes: (1) Columns may not add to totals due to rounding; (2) Transportation energy consumption in 2020 is lower than in 2008 because, due to efficiency gains, an electrified transport system requires far less energy than a fossil-fuel-based one. 1 petajoule is equal to 1 billion megajoules.

Source: Calculated by Earth Policy Institute using capacity factors from U.S. Department of Energy, National Renewable Energy Laboratory, *Power Technologies Energy Data Book*, (Golden, CO: August 2006), p. 201, with fossil fuels and nuclear data from International Energy Agency (IEA), *World Energy Outlook 2008*, (Paris: 2008), p. 507; and with transportation data from IEA, *World Energy Outlook 2008*, (Paris: 2008); F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 18 (26 May 2009), p. 365; F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 14, (26 March 2009), p. 288; energy conversion factors from Oak Ridge National Laboratory, "Bioenergy Conversion Factors," at bioenergy.ornl.gov/papers/misc/energy_conv.html, viewed 10 August 2009.

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World Electricity Generation by Energy Source in 2008 and in the Plan B Economy of 2020



Source: EPI and IEA

World Power and Energy from Renewables in 2008 and Plan B Goals for 2020

Source	Installed Capacity 2008	Installed Capacity 2020	Electricity and Heat Generation 2008	Electricity and Heat Generation 2020	Growth from 2008 to 2020	Share of Total Electricity and Heat Generation from Renewables in 2020
Electricity Generating Capacity	Electrical Gigawatts		Petajoules		x-fold	Percent
Wind	120	4,000	1,366	45,412	33	52
Solar Photovoltaics	16	1,500	111	10,643	96	12
Solar Thermal Power Plants	0	200	3	1,539	459	2
Geothermal	11	200	301	5,676	19	7
Biomass	52	200	1,312	5,046	4	6
Hydropower	<u>949</u>	<u>1,350</u>	<u>13,228</u>	<u>18,818</u>	<u>1</u>	<u>22</u>
Total	1,148	7,450	16,321	87,134	5	100
Thermal Energy Capacity	Thermal Gigawatts		Petajoules		x-fold	Percent
Solar Rooftop Water and Space Heaters	149	1,100	1,057	7,805	7	25
Geothermal	100	500	2,838	14,191	5	46
Biomass	<u>270</u>	<u>350</u>	<u>6,812</u>	<u>8,830</u>	<u>1</u>	<u>29</u>
Total	519	1,950	10,707	30,826	3	100

Source: Wind electricity from Global Wind Energy Council, *Global Wind 2009 Report* (Brussels: 2010), p. 12; solar photovoltaics from European Photovoltaic Industry Association (EPIA), *Global Market Outlook for Photovoltaics Until 2014* (Brussels: May 2010), p. 5; solar thermal power plants from Christoph Richter, Sven Teske, and Rebecca Short, *Concentrating Solar Power Global Outlook 2009* (Amsterdam, Tabernas, and Brussels: Greenpeace International, IEA SolarPACES, and European Solar Thermal Electricity Association, May 2009), p. 7; geothermal electricity, biomass electricity and heat, hydropower, including tidal and wave power, and rooftop solar water and space heaters from Renewable Energy Policy Network for the 21st Century, *Renewables 2010 Global Status Report* (Paris: REN21 Secretariat, 2010), pp. 54, 56; geothermal heat from Jefferson Tester et al., *The Future of Geothermal Energy: Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century* (Cambridge, MA: Massachusetts Institute of Technology, 2006), p. 9; capacity factors used to convert installed capacity into actual electricity generation are from U.S. Department of Energy, National Renewable Energy Laboratory, *Power Technologies Energy Data Book* (Golden, CO: August 2006).

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World Energy Growth Rates by Source, 2000-2009

Energy Source	Average Annual Growth Rate	Compound Annual Growth Rate
	Percent	Percent
Wind Power	27.9	31.8
Solar Photovoltaics	35.2	36.1
Geothermal Power *	3.0	3.0
Geothermal Heat	19.1	16.5
Hydroelectric	2.3	2.4
Oil	1.1	1.1
Natural Gas	2.4	2.2
Nuclear Power	0.7	0.5
Coal	3.9	3.8
Biodiesel	38.6	40.0
Fuel Ethanol	15.1	17.5

* Note: Due to lack of complete data for 2009, growth rates for geothermal power are for 2000-2010.

Source: Compiled by Earth Policy Institute with wind power from Global Wind Energy Council, *Global Wind 2009 Report* (Brussels: 2010), p. 12; solar photovoltaics data from European Photovoltaic Industry Association (EPIA), *Global Market Outlook for Photovoltaics Until 2013* (Brussels: April 2009), pp. 3-4; 2007-2009 from EPIA, *Global Market Outlook for Photovoltaics Until 2014* (Brussels: May 2010), p. 5; geothermal power from International Geothermal Association, "Installed Generating Capacity," at www.geothermal-energy.org/226,installed_generating_capacity.html, updated 2 July 2010; and from Alison Holm et al., *Geothermal Energy International Market Update* (Washington, DC: Geothermal Energy Association, May 2010), p. 4; geothermal heat from International Geothermal Association, "Direct Uses," at www.geothermal-energy.org/246,direct_uses.html, updated 5 July 2010; Renewable Energy Policy Network for the 21st Century (REN21), *Renewables Global Status Report* (Paris: REN21 Secretariat, various years); hydroelectric, oil, natural gas, nuclear, and coal from BP, *Statistical Review of World Energy June 2010* (London: 2010); biodiesel from F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 2 (23 September 2008), p. 29; and from F.O.Licht, *World Ethanol and Biofuels Report*, vol. 8, no. 13 (15 March 2010), p. 265; fuel ethanol from F.O. Licht, *World Ethanol and Biofuels Report*, vol. 7, no. 18 (26 May 2009), p. 3; and from F.O. Licht, *World Ethanol and Biofuels Report*, vol. 8, no. 16 (28 April 2010), p. 328.

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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 U.S. Department of Energy (DOE), Energy Information Administration, *Electric Power Annual 2007* (Washington, DC: January 2009); Renewables from DOE, National Renewable Energy Laboratory, *Power Technologies Energy Data Book* (Golden, CO: August 2006), p. 201.

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Fossil Fuel Consumption Subsidies in Selected Countries by Fuel Type, 2009

	Iran	Russia	India	China	Indonesia
Total					
Subsidies (Billion Dollars)	66.4	33.6	21.1	18.6	12.2
<i>per capita (Dollars)</i>	895	238	18	14	53
<i>as share of GDP (Percent)</i>	20.1	2.7	1.7	0.4	2.3
Rate of Subsidization (Percent)	89	23	15	4	25
By Fuel					
Oil (Billion Dollars)	30.1	n/a	12.1	5.0	8.6
<i>Rate of Subsidization (Percent)</i>	88	n/a	18	3	28
Natural Gas (Billion Dollars)	24.8	18.7	2.7	0.5	n/a
<i>Rate of Subsidization (Percent)</i>	95	50	77	2	n/a
Coal (Billion Dollars)	n/a	n/a	n/a	4.3	n/a
<i>Rate of Subsidization (Percent)</i>	n/a	n/a	n/a	7	n/a
Electricity (Billion Dollars)	11.4	14.9	6.3	8.8	3.6
<i>Rate of Subsidization (Percent)</i>	82	27	12	4	31

Note: n/a indicates data that are unavailable. The five countries profiled are those selected and analyzed by the International Energy Agency; they have some of the largest fossil fuel subsidies but have plans to introduce market-based pricing gradually in the future. For a list of fossil fuel subsidies by fuel and country, see www.worldenergyoutlook.org/docs/weo2010/key_graphs.pdf.

Source: Compiled by Earth Policy Institute from International Energy Agency, *World Energy Outlook 2010* (Paris: 9 November 2010), pp. 598, 601, 605, 611, 614.

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World Carbon Dioxide Emissions from Fossil Fuel Combustion in 2006 and 2008, with IEA Projection for 2020

Emissions	Growth Rate,	Growth Rate,	CO ₂ Emissions,	CO ₂ Emissions,	CO ₂ Emissions,
	2006-2015	2015-2020	2006	2008	2020
	Percent		Million Tons Carbon		
By Fuel:					
Coal	3.1	1.6	3,185	3,431	4,555
Oil	1.3	0.9	2,937	2,947	3,454
Gas	2.0	1.5	1,484	1,602	1,918
By Sector:					
Power Generation	2.9	1.6	3,119	3,250	4,365
Coal	3.2	1.7	2,273	2,365	3,300
Oil	-0.4	-1.9	241	236	211
Gas	2.8	2.0	605	650	853
Total Final Consumption	1.7	1.1	4,123	4,323	5,090
Coal	2.7	1.1	855	990	1,150
Oil	1.5	1.2	2,515	2,527	3,033
<i>of which transport</i>	1.7	1.3	1,708	1,746	2,126
<i>of which marine bunkers</i>	1.0	1.0	159	158	326
<i>of which international aviation</i>	2.2	1.8	108	124	145
Gas	1.4	1.2	754	807	907
Other Energy Sector			364	406	472
Total CO₂ Emissions	2.2	1.4	7,606	7,980	9,927

Notes: Power Generation refers to fuel use in electricity plants, heat plants, and combined heat and power, including both public plants and small plants that produce fuel for their own use. Total Final Consumption includes industry (e.g. construction, mining, manufacturing, and petrochemical feedstocks), transport, agriculture, residential, and non-energy use. Other Energy Sector includes transformation and transmission losses. Growth rates and 2020 projection are for the International Energy Agency Reference Scenario, which is "based on established trends and policies, without new initiatives by governments on energy security or climate change."

Source: Calculated by Earth Policy Institute with rates, 2006 data, and 2020 projection from International Energy Agency (IEA), *World Energy Outlook 2008* (Paris: 2008), p. 507; 2008 data from International Energy Agency (IEA), *World Energy Outlook 2010* (Paris: 2010), p. 620, with bunker data from Michael Chen, e-mail to Alexandra Giese, Earth Policy Institute, 30 November 2010.

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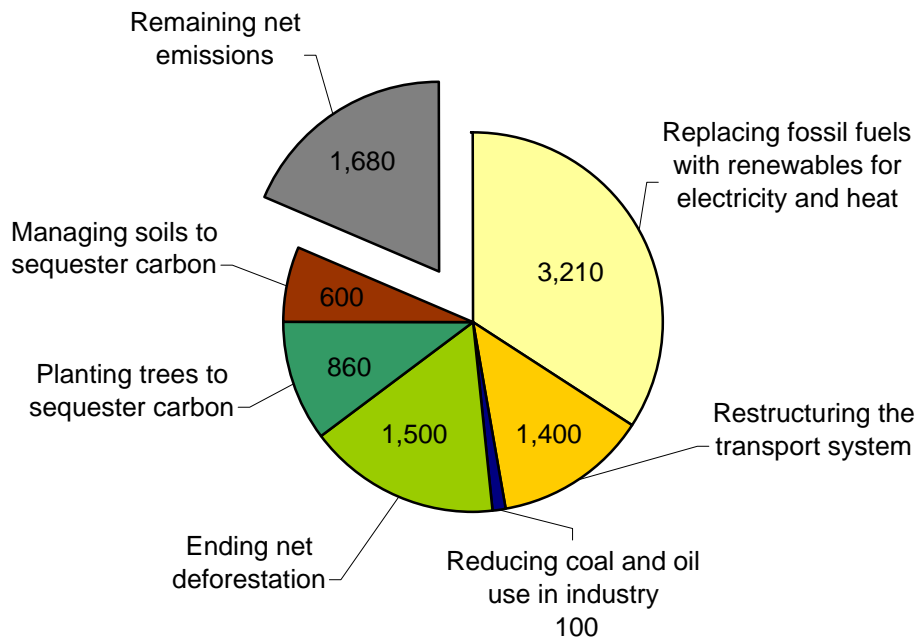
Plan B Carbon Dioxide Emissions Reductions and Sequestration in 2020

Action	Amount
	Million Tons of Carbon
Energy Restructuring	
Replacing fossil fuels with renewables for electricity and heat	3,210
Restructuring the transport system	1,400
Reducing coal and oil use in industry	100
Biological Carbon Sequestration	
Ending net deforestation	1,500
Planting trees to sequester carbon	860
Managing soils to sequester carbon	600
Total Carbon Dioxide Reductions in 2020	7,670
Carbon Dioxide Emissions in 2006	9,350
Percent Reduction from 2006 Baseline	82.0

Source: Calculated by Earth Policy Institute using International Energy Agency (IEA), *World Energy Outlook 2008* (Paris: 2008), p. 507; IEA, *Tracking Industrial Energy Efficiency and CO2 Emissions* (Paris: 2007); Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, U.K.: Cambridge University Press, 2007), pp. 543, 559; and Rattan Lal, "Soil Carbon Sequestration Impacts on Global Climate Change and Food Security," *Science*, vol. 304 (11 June 2004), pp. 1,623–27.

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Plan B Carbon Dioxide Emissions Reduction Goals for 2020 (Million Tons of Carbon)



Baseline Emissions (2006) = 9,350 Million Tons of Carbon

Source: EPI