


Midwest


Climate Change and the U.S. Energy Sector: Regional vulnerabilities and resilience solutions



Summary in Brief

The Midwest is home to expansive agricultural lands, forests in the north, the Great Lakes, substantial industrial activity, and major urban centers. The region has an energy-intensive economy, and its electricity mix is heavily dependent on thermoelectric plants, with coal- and natural gas-fired power plants accounting for about 70% of annual generation and nuclear power representing more than 20%. More than one quarter of national installed wind energy capacity, one third of biodiesel capacity, and more than two thirds of ethanol production are located in the Midwest. Major climate change impacts projected to increasingly threaten the region's energy infrastructure include the following:

 **Average temperatures are projected to increase, extremely hot days are projected to occur more frequently, and heat waves are projected to become longer and more severe.** The average number of cooling degree days (CDDs) is projected to increase by 150–900 by mid-century. Higher air and water temperatures cause power plants to operate less efficiently and in some cases may force plants to curtail production or temporarily shut down. Transmission line capacity also declines with higher temperatures, reducing the available power supply in the Midwest and in other regions that depend on its electricity exports. At the same time, higher temperatures increase demand for cooling energy, increasing the potential for shortfalls.

 **Heavy precipitation events are projected to occur more frequently, and average winter and spring precipitation levels are projected to increase, increasing the risk of high streamflows and flooding.** Floods can disrupt energy service and damage assets located in flood plains, such as power plants and rail lines. Varying water levels on important shipping routes, including the upper Mississippi River, Illinois River, Missouri River, and Ohio River, as well as the Great Lakes, could disrupt fuel transport along these waterways.

QUICK FACTS				
Midwest States:	Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin			
Population (2013)	61,000,000	(19% of U.S.)		
Area (square miles)	447,000	(13% of U.S.)		
Energy expenditures	\$260 billion			
ENERGY SUPPLY & DEMAND		Annual Production	Annual Consumption	% for electric power
Electric power	TWh	815	771	n/a
Petroleum	MMbbls	24	1,150	<1%
Coal	million tons	112	285	90%
Natural gas	Bcf	225	4,600	17%
ELECTRIC POWER	Annual Production (TWh)	% of Total Production	Capacity (GW)	Power plants >1 MW*
Natural gas	97	12%	69	347
Coal	476	58%	105	208
Nuclear	183	22%	25	17
Hydroelectric	6	1%	2	174
Wind	38	5%	15	261
Biomass	8	1%	2	140
Solar	<1	<1%	<1	10
CRITICAL INFRASTRUCTURE				
Petroleum		Electric Power		
Wells (>1 boe/d):	5,230	Power plants (>1 MW):	1,421	
Refineries:	14	Interstate transmission lines:	48	
Liquids pipelines:	27	Coal		
Ports (>200 tons/yr):	6	Mines:	94	
Natural Gas		Waterways		
Wells:	47,000	Coal and petroleum routes:	17	
Interstate pipelines:	33	Railroads		
Market hubs:	2	Miles of freight track:	35,600	

Note: Table presents 2012 data except for the number of oil wells, which is 2009 data.
*Some plants use multiple fuels, and individual generating units may be <1 MW.

Examples of important energy sector vulnerabilities and climate resilience solutions in the Midwest

Subsector	Vulnerability	Magnitude	Illustrative Resilience Solutions
Thermoelectric Power Generation; Electric Grid	Reduced power plant generation capacity and reduced electric grid capacity due to higher temperatures	More than 90% of power generation is from thermoelectric plants. The region exports significant quantities of electricity, so reductions in generation also affect neighboring regions	Improved operations protocols, expanded capacity, alternative water sources, recirculating, dry, or wet-dry hybrid cooling systems
Fuel Transport	Increased risk of disruption to rail and barge transport of coal and petroleum due to flooding, drought, and changing waterway levels	The Midwest produces 11% of U.S. coal, and 58% of the region's power plant capacity is coal-fired. Disruptions in rail and barge transport also affect other regions	Elevating infrastructure, upgrading drainage systems, ensuring culverts can handle increased runoff, waterway dredging and maintenance
Electricity Demand	Increased demand for electricity for cooling in the summer due to higher temperatures, severe heat waves, and higher humidity	The region is projected to experience 150–900 CDDs per year by mid-century, as well as increased humidity	Energy efficiency, load management, capacity additions