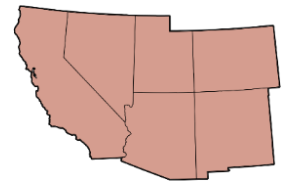


# Southwest

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



### Summary in Brief

The large and geographically diverse Southwest region includes mild coastal climates, an arid interior, and mountain ranges that store critical water supplies as snow. The region is home to a large and growing population. Key energy infrastructure includes oil and gas refineries and large amounts of power plant capacity. Major climate change impacts projected to increasingly threaten the region's energy infrastructure include the following:



Temperatures

**Average temperatures and cooling degree days (CDDs) are projected to increase across the region, with hotter, more frequent, and longer-lasting heat waves.** Increases in CDDs, extreme temperatures, and heat waves result in expanded air conditioner use. These projections are also expected to increase both average and peak demand for cooling while reducing the efficiency and available capacity of power plants and transmission lines.



Droughts

**Average and summer seasonal precipitation is projected to decrease, droughts are projected to intensify, and streamflow in major river basins is projected to decline.** Power plants that rely on surface water for cooling may face shortages and ecological or safety-related curtailments that reduce available generation capacity. Oil producers may also face water shortages.



Temperatures

**Spring thaws are projected to occur earlier, and a greater fraction of precipitation is projected to fall as rain rather than as snow, reducing mountain snowpack.** Alongside reduced overall precipitation, less snowpack could reduce total potential

hydropower production at high-elevation dams. Changing streamflow timing, decreased precipitation, and increased evaporation may impair hydropower production during peak summer electricity demand.



Wildfires

**The risk of wildfire and the annual average area burned is expected to increase across the region.** Wildfires threaten physical damage to power lines, including fouling of lines and increased risk of arcing.

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

Subsector	Vulnerability	Magnitude	Illustrative Resilience Solutions
Electricity Demand	Increased demand for cooling energy from increasing CDDs and average and peak temperatures	Increases of up to 1,000 CDDs by mid-century, with peak demand increasing 12%–24% owing to higher extreme temperatures	Capacity expansion, increased power imports, efficiency, and demand-side management
Thermoelectric Power Generation	Reduced power plant capacity due to higher temperatures and reduced water availability, and coastal plants vulnerable to sea level rise	Capacity reductions of up to 4.5%, up to 12 coal-fired power plants vulnerable to water shortages, and 25 coastal plants vulnerable to sea level rise	Capacity expansion and diversification, water-efficient technologies, coastal hardening
Hydropower Generation	Reduced capacity in some seasons from earlier peak streamflow, and declining snowpack and precipitation	Snowpack reductions of up to 43% in California by the end of the century	Integrated water planning to optimize water use, upgraded equipment to increase efficiency
Electric Grid	Reduced capacity from higher temperatures, and threat of disruptions from increased wildfires	Transmission line capacity losses of 1.5%–2.5%, substation losses of 1%–3% from rising temperatures	Transmission capacity expansion and redundancy, improved vegetation management

QUICK FACTS					
Southwest States:	Arizona, California, Colorado, Nevada, New Mexico, Utah				
Population (2013)	58,000,000	(18% of U.S.)			
Area (square miles)	686,000	(19% of U.S.)			
Energy expenditures	\$208 billion				
ENERGY SUPPLY & DEMAND		Annual Production	Annual Consumption	% for electric power	
Electric power	TWh	474	476	n/a	
Petroleum	MMbbls	362	948	<1%	
Coal	million tons	76	75	96%	
Natural gas	Bcf	3,662	3,920	38%	
ELECTRIC POWER		Annual Production (TWh)	% of Total Production	Capacity (GW)	Power plants >1 MW*
Natural gas	202	44%	84	398	
Coal	136	30%	24	42	
Nuclear	50	11%	9	3	
Hydroelectric	38	8%	19	347	
Wind	19	4%	9	147	
Geothermal	15	3%	3	57	
Biomass	7	1%	2	119	
Solar	3	<1%	2	214	
CRITICAL INFRASTRUCTURE					
<b>Petroleum</b>		<b>Electric Power</b>			
Wells (>1 boe/d):	64,400	Power plants (> 1 MW):	1,346		
Refineries:	29	Interstate transmission lines:	32		
Liquids pipelines:	21	<b>Coal</b>			
Ports (>200 tons/yr):	6	Mines:	26		
<b>Natural Gas</b>		<b>Waterways</b>			
Wells:	68,500	Coal and petroleum routes:	5		
Interstate pipelines:	30	<b>Railroads</b>			
Market hubs:	5	Miles of freight track:	14,000		
Note: Table presents 2012 data except number of oil wells, which is 2009 data. *Some plants use multiple fuels, and individual generating units may be <1 MW.					