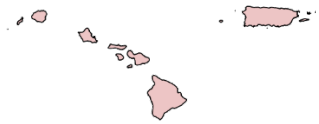
Hawaii and Puerto Rico

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



Summary in Brief

Hawaii and Puerto Rico are the largest U.S. islands in population, size, and energy consumption. These islands are isolated from larger mainland energy supply networks, including pipelines, railroads, and transmission grids. Both are located in tropical climates—Hawaii in the Pacific Ocean and Puerto Rico in the Caribbean—and since they are critically reliant on coastal infrastructure, they are vulnerable to similar climate change impacts such as large storms and sea level rise. Key climate trends affecting the energy sector in the region include the following:

Hurricanes

Atlantic hurricanes are projected to increase in intensity, and the most intense hurricanes are projected to occur more frequently. Pacific hurricane storm tracks are projected to shift toward Hawaii. Increasing hurricane intensity and frequency increases the risk of damage to energy infrastructure, disruptions to fuel shipments caused by coastal and inland flooding and erosion, wind and wave damage, and landslides.

Sea level rise

Average sea levels are projected to rise. Rising sea levels increase storm surge flood stages and storm-driven waves, pushing coastal impacts further inland. Increasing sea levels also decrease the depth of freshwater lenses underlying islands, reducing an important source of cooling water for some thermoelectric generators.

Temperatures

Average temperatures are projected to increase over the course of the next century. Higher temperatures can reduce the efficiency of thermoelectric power plants and the capacity of transmission lines—especially on the hottest days—and cause damage to roads and power transformers, shortening the lifetime of critical energy infrastructure. Higher temperatures are also likely to increase demand for cooling energy.

QUICK FACTS

		Hawaii	Puerto Rico
Population (2013)		1,400,000	3,500,000
Area (square miles)		10,932	5,325
Annual energy expenditures		$7.8 billion	N/A*
ENERGY SUPPLY AND DEMAND*		**Hawaii**	**Puerto Rico**
Electric power	*TWh*	10.5	20.0
Fuel Consumption			
Petroleum	*million bbl*	42	65
Coal	*million tons*	0.8	1.7
Natural gas	*bcf*	2.7	48

**Electricity production and consumption are identical. No fuel is produced.*

ELECTRIC POWER	**Annual Production (GWh)**	***% of Total***	**Capacity (MW)**
Hawaii			
Petroleum	7,483	*71%*	2,181
Coal	1,537	*15%*	203
Renewables	1,039	*10%*	517
Other	410	*4%*	81
Puerto Rico			
Petroleum	13,000	*65%*	4,778
Natural gas	3,600	*18%*	540
Coal	3,200	*16%*	454
Renewables	200	*1%*	224

CRITICAL INFRASTRUCTURE	**Hawaii**	**Puerto Rico**
Oil refineries:	2	0
Petroleum ports (>200 tons/yr):	6	3
Major power plants (> 1 MW):	43	15**

*Annual energy expenditure for Puerto Rico is not available.
** Includes only commercial plants.
Notes: Energy data for Hawaii is from 2012. Energy data for Puerto Rico is from 2013, except total generation data, which is from 2011. Electricity production by fuel is calculated based on both 2011 and 2013 data.

Examples of important energy sector vulnerabilities and climate resilience solutions in Hawaii and Puerto Rico

Subsector	Vulnerability	Magnitude	Illustrative Resilience Solutions
Fuel Transport and Storage	Coastal flooding and erosion; wave and wind damage to ports, ships, terminals, refineries and storage, bridges and roads; landslide and heat damage to roads	Hurricane Georges in 1998 destroyed three bridges and damaged roads costing $20 million; Hawaii's Barbers Point Harbor, the primary interisland distribution fuel hub, vulnerable to amplified tides and waves	Building seawalls or natural buffer zones, hardening infrastructure to resist inundation, replacing equipment with submersible or floating infrastructure, relocating roads
Electricity Generation	Coastal plants vulnerable to flooding and structural damage from storms, sea level rise, and erosion	Majority of power plants vulnerable to sea level rise-enabled coastal flooding	Coastal hardening; increased, diversified, and distributed capacity
Electric Grid	Flooding, erosion, wave, and wind damage to towers and substations	Outages caused by Hurricane Georges for 96% of Puerto Rico's electricity customers in 1998	Strengthened tower and substation designs, selective undergrounding of transmission and distribution lines
Electricity Demand	Increased average and peak demand for cooling energy	Projected rise in average temperatures by 2.0°F–5.0°F in Hawaii and by 3.6°F–9°F in Puerto Rico by 2100	Increased capacity, energy efficiency and load management measures