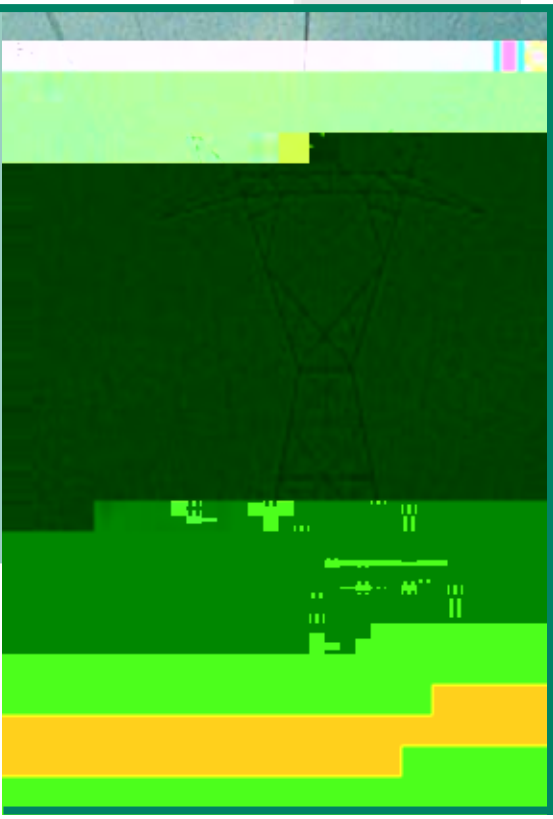


Energy Supply and Use

Key Messages:

- Warming will be accompanied by decreases in demand for heating energy and increases in demand for cooling energy. The latter will result in signifcant increases in electricity use and higher peak demand in most regions.
- Energy production is likely to be constrained by rising temperatures and limited water supplies in many regions.
- Energy production and delivery systems are exposed to sea-level rise and extreme weather events in vulnerable regions.
- Climate change is likely to affect some renewable energy sources across the nation, such as hydropower production in regions subject to changing patterns of precipitation or snowmelt.

Energy is at the heart of the global warming challenge.[3] It is humanity's production and use of energy that is the primary cause of global warming, and in turn, climate change will eventually affect our production and use of energy. The vast majority of U.S. greenhouse gas emissions, about 87 percent, come from energy production and use.[200]

At the same time, other U.S. trends are increasing energy use: population shifts to the South, especially the Southwest, where air conditioning use is high, an increase in the square footage built per person, increased electrification of the residential and commercial sectors, and increased market penetration of air conditioning.[201]

Many of the effects of climate change on energy production and use in the United States are not well studied. Some of the effects of climate change, however,

Energy production is likely to be constrained by rising temperatures and limited water supplies in many regions.

In some regions, reductions in water supply due to decreases in precipitation and/or water from melting snowpack are likely to be significant, increasing the competition for water among various sectors including energy production (see sector).[191,208]

The production of energy from fossil fuels (coal, oil, and natural gas) is inextricably linked to the availability of adequate and sustainable supplies of water.[191,208] While providing the United States with the majority of its annual energy needs, fossil fuels also place a high demand on the nation's water resources in terms of both quantity and quality impacts.[191,208] Generation of electricity in thermal power plants (coal, nuclear, gas, or oil) is water intensive. Power plants rank only slightly behind irrigation in terms of freshwater withdrawals in the United States.[191]

There is a high likelihood that water shortages will limit power plant electricity production in many regions. Future water constraints on electricity production in thermal power plants are projected for Arizona, Utah, Texas, Louisiana, Georgia, Alabama, Florida, California, Oregon, and Washington state by 2025.[191] Additional parts of the United

Energy production and delivery systems are exposed to sea-level rise and extreme weather events in vulnerable regions.

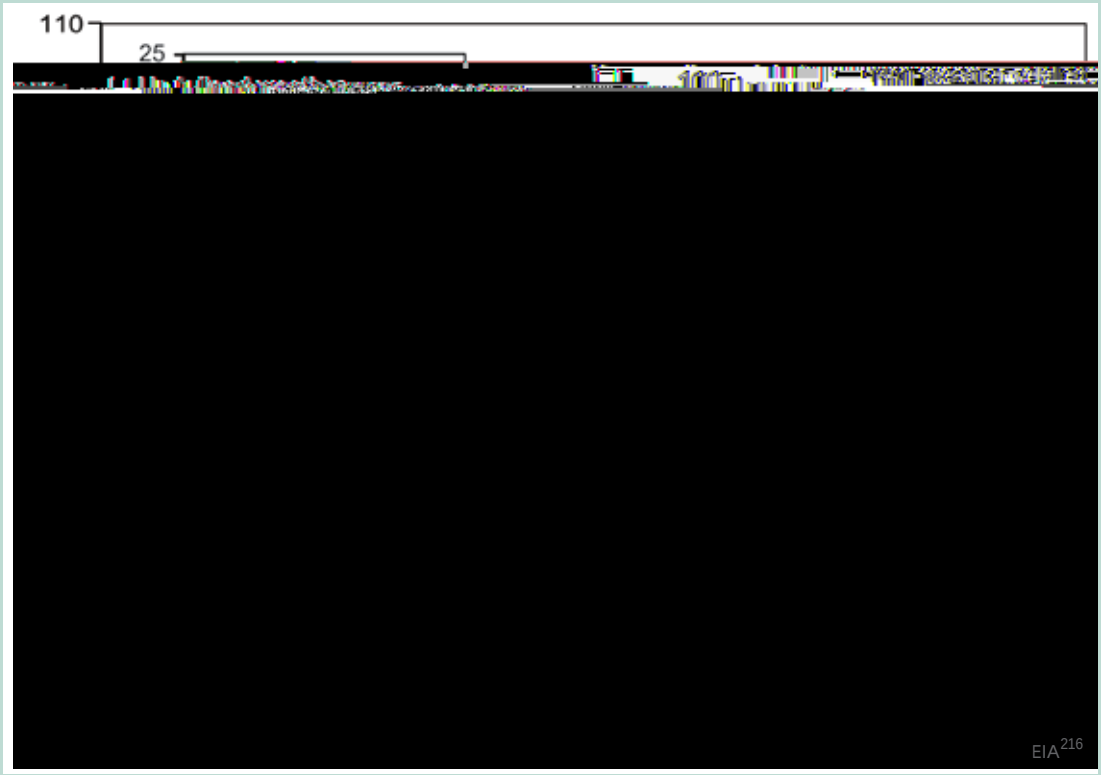
Sea-level rise

A significant fraction of America's energy infrastructure is located near the coasts, from power plants, to oil refineries, to facilities that receive oil and gas deliveries.[191] Rising sea levels are likely to lead to direct losses, such as equipment damage from flooding or erosion, and indirect effects, such as the costs of raising vulnerable assets to higher levels or building new facilities farther inland, increasing transportation costs.[191] The U.S. East Coast and Gulf Coast have been identified as particularly vulnerable to sea-level rise because the land is relatively flat and also sinking in many places.[191]

Extreme events

Observed and projected increases in a variety of extreme events will have sijeaf mn mpcant 3[l)12nbecaiety oica's s-15(n)5(d p)-7an ev1

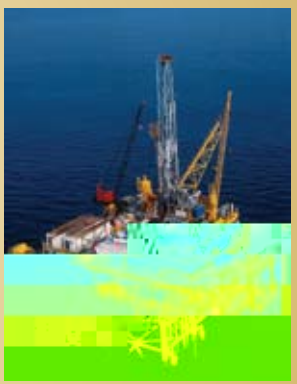
Significant Weather-Related U.S. Electric Grid Disturbances



The number of incidents caused by extreme weather has increased tenfold since 1992. The portion of all events that are caused by weather-related phenomena has more than tripled from about 20 percent in the early 1990s to about 65 percent in recent years. The weather-related events are more severe, with an average of about 180,000 customers affected per event compared to about 100,000 for non-weather-related events (and 50,000 excluding the massive blackout of August 2003).[201] The data shown include disturbances that occurred on the nation's large-scale "bulk" electric transmission systems. Most outages occur in local distribution networks and are not included in the graph. Although the figure does not demonstrate a cause-effect relationship between climate change and grid disruption, it does suggest that weather and climate extremes often have important effects on grid disruptions. We do know that more frequent weather and climate extremes are likely in the future,[68] which poses unknown new risks for the electric grid.

Adaptation: Addressing Oil Infrastructure Vulnerabilities in the Gulf Coast

Port Fourchon, Louisiana, supports 75 percent of deepwater oil and gas production in the Gulf of Mexico, and its role in supporting oil production in the region is increasing. The Louisiana Offshore Oil Port, located about 20 miles offshore, links daily imports of 1 million barrels of oil and production of 300,000 barrels in the Gulf of Mexico to 50 percent of national refning capacity. One road, Louisiana Highway 1, connects Port Fourchon with the nation. It transports machinery, supplies, and workers and is the evacuation route for onshore and offshore workers. Responding to threats of storm surge and fooding, related in part to concerns about climate change, Louisiana is currently upgrading Highway 1, including elevating it above the 500-year food level and building a higher bridge over Bayou LaFourche and the Boudreaux Canal.[217]



Florida's energy infrastructure is particularly vulnerable to sea-level rise and storm impacts. Most of the petroleum products consumed in Florida are delivered by barge to three ports, two on the east coast and one on the west coast. The interdependencies of natural gas distribution, transportation fuel distribution and delivery, and electrical generation and distribution were found to be major issues in Florida's recovery from recent major hurricanes.

effects of severe weather events on power lines, such as from ice storms, thunderstorms, and hurricanes. In the summer heat wave of 2006, for example, electric power transformers failed in several areas (including St. Louis, Missouri, and Queens, New York) due to high temperatures, causing interruptions of electric power supply. It is not yet possible to project effects of climate change on the grid, because so many of the effects would be more localized than current climate change models can depict; but, weather-related grid disturbances are recognized as a challenge for strategic planning and risk management.

Climate change is likely to affect some renewable energy sources across the nation, such as hydropower production in regions subject to changing patterns of precipitation or snowmelt.

Renewable sources currently account for about 9 percent of electricity production in the United States.[203] Hydroelectric power is by far the largest renewable contributor to electricity generation,[191] accounting for about 7 percent of total U.S. electricity.[218] Like many things discussed in this report, renewable energy resources have strong interrelationships with climate change; using renewable energy can reduce the magnitude of climate change, while climate change can affect the prospects for using some renewable energy sources.

Hydropower is a major source of electricity in some regions of the United States, notably in the Northwest.[191] It is likely to be significantly affected by climate change in regions subject to reduced precipitation and/or water from melting snowpack. Significant changes are already being detected in the timing and amount of streamflows in many western rivers,[164] consistent with the predicted effects of global warming. More precipitation coming as rain rather than snow, reduced snowpack, earlier peak runoff, and related effects are beginning to affect hydropower availability.[164]

Hydroelectric generation is very sensitive to changes in precipitation and river discharge. For example, every 1 percent decrease in precipitation results in a 2 to 3 percent drop in streamflow;[219] every 1 percent decrease in streamflow in the Colorado River Basin results in a 3 percent drop in power generation.[191] Such magnifying sensitivities occur because water flows through multiple power plants in a river basin.[191]

Climate impacts on hydropower occur when either the total amount or the timing of runoff is altered, such as when natural water storage in snowpack and glaciers is reduced under hotter conditions. Glaciers, snowpack, and their associated runoff are already declining in the West, and larger declines are projected.[164]

Hydropower operations are also affected by changes to air temperatures, humidity, or wind patterns due to climate change.[191] These variables cause changes in water quantity and quality, including water temperature. Warmer air and water generally increase the evaporation of water from the surface

winds affect wind power, and temperature and water availability affect biomass production (particu-