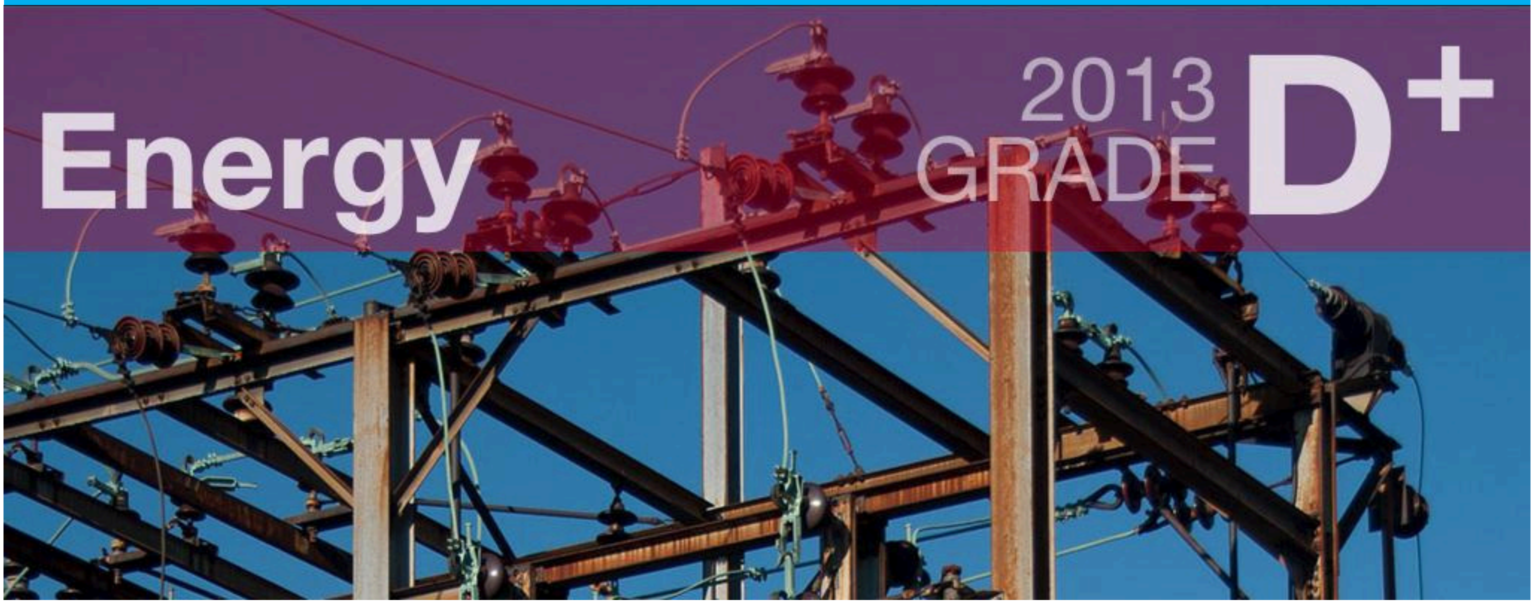


2013 Report Card for America's Infrastructure Findings

America relies on an aging electrical grid and pipeline distribution systems, some of which originated in the 1880s. Investment in power transmission has increased since 2005, but ongoing permitting issues, weather events, and limited maintenance have contributed to an increasing number of failures and power interruptions. While demand for electricity has remained level, the availability of energy in the form of electricity, natural gas, and oil will become a greater challenge after 2020 as the population increases. Although about 17,000 miles of additional high-voltage transmission lines and significant oil and gas pipelines are planned over the next five years, permitting and siting issues threaten their completion.

Energy: Conditions & Capacity

The Electric Grid

The electric grid in the United States consists of a system of interconnected power generation, transmission facilities, and distribution facilities, some of which date back to the 1880s. Today, we have an aging and complex patchwork system of power generating plants, power lines, and substations that must operate cohesively to power our homes and businesses. There are thousands of power generating plants and systems spread across the United States and almost 400,000 miles of electric transmission lines. With the addition of new gas-fired and renewable generation, the need to add new transmission lines has become even greater.

Aging equipment has resulted in an increasing number of intermittent power disruptions, as well as vulnerability to cyber attacks. Significant power outages have risen from 76 in 2007 to 307 in 2011. Many transmission and distribution system outages have been attributed to system operations failures, although weather-related events have been the main cause of major electrical outages in the United States in the years 2007 to 2012. While 2011 had more weather-related events that disrupted power, overall there was a slightly improved performance from the previous years. Reliability issues are also emerging due to the complex process of rotating in new energy sources and "retiring" older infrastructure.

Oil and Gas Distribution

The coal, oil, and gas industry includes facilities such as coal mines and oil and gas wells, processing plants (e.g., refineries), and systems to transfer raw materials from collection through processing plants to consumers. There are nominally 150,000 miles of crude oil and product pipelines and over 1,500,000 miles of natural gas transmission and distribution pipelines in the United States, many located underground and crossing multiple states. In general, this energy infrastructure is owned by private industry. Since 2008, a series of oil and gas pipeline failures have led to deaths, injuries, significant property damage, and environmental impacts. Such failures, including those in San Bruno, California, and Marshall, Michigan, have demonstrated a need for greater pipeline management and maintenance programs. New federal safety requirements were enacted in 2011 to address the increase in the number of incidents due to aging infrastructure and maintenance concerns.

Capacity

AVERAGE COST OF A POWER INTERRUPTION IN THE U.S.

DURATION OF INTERUPTION	RESIDENTIAL	COMMERCIAL	INDUSTRIAL
MOMENTARY	$2.64	$733	$2,294
1 HOUR	$3.27	$1,074	$3,943
SUSTAINED INTERRUPTION*	$3.62	$1,293	$5,124

** Note that the mean time of sustained interruptions is 106 minutes.*

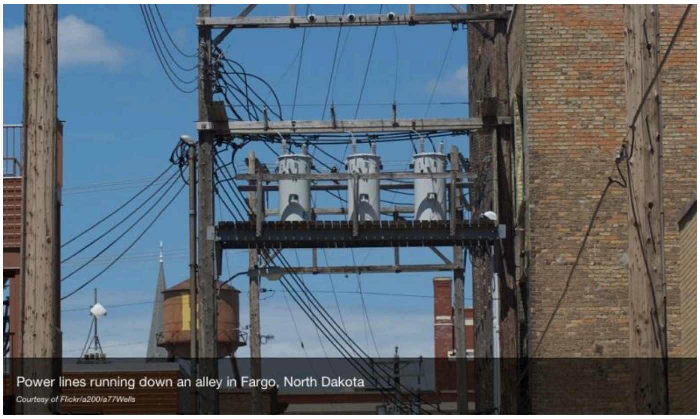
Source: LaCommare and Eto, 2004

In the near term, it is expected that energy systems have adequate capacity to meet national demands. From 2011 through 2020, demand for electricity in all regions is expected to increase 8% or 9% in total, based on population growth and projections from the U.S. Energy Information Administration. The rate of growth in energy use is expected to be stable and relatively low due to moderate population growth, an extended economic recovery, and increased energy efficiency. Supply forecasts show that the United States will add about 108 gigawatts (10% of current capacity) in generating capacity by 2016, mostly through new natural gas-fired and renewables generation as enhanced environmental regulations, old coal-fired facility retirements, and lower natural gas prices take hold.

After 2020, capacity expansion is forecast to be a greater problem, particularly with regard to generation, regardless of the energy resource mix. Excess capacity, known as planning reserve margin, is expected to decline in a majority of regions, and generation supply could dip below resource requirements by 2040 in every area except the Southwest without prudent investments. The adequacy of energy pipelines and related operations is also a growing concern, partially due to capacity constraints in refineries and oil and gas transmission systems.

Congestion at key points in the electric transmission grid has been rising over the last five years, which raises concerns with distribution, reliability and cost of service. Preliminary findings of the 2012 National Electric Congestion Study indicate that critical areas of congestion still exist in the Northeast and in southern California.

This congestion can lead to system-wide failures and unplanned outages. The public has a low tolerance for these outages, even in extreme weather events.



Power lines running down an alley in Fargo, North Dakota
Courtesy of Flickr/a200/a77Wells

Additionally, these outages put public safety at risk and increase costs to consumers and businesses. The average cost of a one-hour power outage is just over $1,000 for a commercial business. Utilities also often pass on “congestion charges” to consumers when transmission lines are overloaded.

New transmission lines are being planned in response to the need for integrating and delivering new energy sources. During the next five years, about 17,000 circuit miles of additional high-voltage transmission lines are planned, which is much larger than the historical average of 6,500 miles.

However, the permitting and siting of these transmission lines often meet with public resistance, which can result in significant project delays or eventual cancellations while driving up costs. Over three times as many low-voltage line projects, which are typically built in more urban areas, were delayed in 2011, compared to high-voltage lines. The result is that while new transmission lines are needed, many are being delayed due to permitting issues.

High Voltage transmission towers anchoring the power lines that are strung down to the transformers at the base of the Glen Canyon Dam located near Page, Arizona.
Courtesy of Flickr/Alan Stark

Energy: Investment & Funding

From 2001 through 2010, annual capital investment in electricity infrastructure averaged $63 billion, including over $35 billion in generation, $8 billion in transmission, and nearly $20 billion in local distribution lines. Funding comes from a variety of sources, including government agencies, regulated utilities, private companies and developers, and nonprofit cooperatives.

Investment for transmission has been increasing annually since 2001 at a nearly 7% annual growth rate. For local distribution systems, however, national-level investment peaked in 2006 and has since declined to less than the level observed in 1991. Construction spending has decreased in recent years, although the aging of local distribution networks, lack of funding for maintenance, and resulting equipment failures have received public attention and put pressure on some utilities to make improvements.

INVESTMENT GAP BY REGION IN 2020

REGION	TRANSMISSION GAP ESTIMATE	DISTRIBUTION GAP ESTIMATE
FLORIDA	$1.8 BILLION	$2.4 BILLION
MID-ATLANTIC	$6.4 BILLION	$11.8 BILLION
MIDWEST	$1.4 BILLION	$3 BILLION
NORTHEAST	$1.6 BILLION	$6.4 BILLION
SOUTHEAST	$10.9 BILLION	$18.8 BILLION
SOUTHWEST	0	$2.4 BILLION
TEXAS	0	$2.3 BILLION
WEST	$15.2 BILLION	$10.3 BILLION
TOTAL	$37.3 BILLION	$57.4 BILLION

Source: ASCE, "Failure to Act: The Economic Impact of Current Investment Trends in Electricity Infrastructure," 2012, p. 35

The investment gap for distribution infrastructure is estimated to be $57 billion by 2020, much larger than the investment gap for transmission infrastructure of $37 billion. The increase in adoption of smart grid technologies – computer-based, automated systems for the delivery of electricity – has led to additional investment in recent years. For example, as part of the American Reinvestment and Recovery Act, the United States invested more than $4.5 billion for electricity delivery and energy reliability modernization. These funds were matched by more than $5.5 billion from local agencies and the private sector to fund smart grid and energy storage technologies across the country, with additional funding going toward workforce training. Additionally, the Rural Utilities Service provided $7.1 billion in loans in 2010 to support the modernization of the electric infrastructure serving rural America, including more than $152 million for the installation of smart meters.

To date, 25 states have already adopted policies relating to smart grid technology. At least nine states discussed smart grid deployment bills in the 2011 legislative sessions, and more than 70 million smart meter units were deployed in 2010, compared to 46 million in 2008. Ensuring that these systems work together will be an ongoing challenge.

COMPLETED TRANSMISSION PROJECTS BY VOLTAGE

VOLTAGE	PROJECTS IN 2012	PROJECTS IN 2011	PROJECTS IN 2010	PROJECTS IN 2009
LESS THAN 230KV	603	951	700	958
345KV	792	516	628	660
500KV	170	262	112	160
TOTAL	1,565	1,688	1,440	1,777

Source: FERC

The coal, oil, and gas industry has similar concerns with congestion and safe and efficient delivery of resources. In particular, the proliferation of shale gas recovery in several regions of the country has not been accompanied by the expansion of the transportation systems necessary to carry the gas and associated liquids to the market.

Energy: Conclusion

Trans-Allegheny Interstate Line from Pennsylvania to Virginia

Demand for electricity in the Mid-Atlantic region was threatening to overload the transmission system for Allegheny Power. Throughout the region, the demand for electricity has increased significantly over the years, while the transmission infrastructure has not increased at a proportional pace.

Crews erect a lattice steel tower for the Trans-Allegheny Interstate Line (TrAIL) 500-kV line near Mt. Storm in Grant County, WV. The line was energized in May 2011, two weeks ahead of schedule.
Courtesy of FirstEnergy Corp

To prevent electrical problems on the grid, Allegheny Energy Inc. built a new 500-kilovolt transmission line extending from Southwestern Pennsylvania to West Virginia to Northern Virginia, known as the Trans-Allegheny Interstate Line (TrAIL).

Construction took about three years, and the project was completed in 2011. With the transmission line crossing three states, it took complex coordination across jurisdictions to make the project a success.

Benefits of the TrAIL project include:

- improving system reliability;
- meeting the growing demand for electricity;
- increasing west-to-east transfer capability, making cost-effective generation available to more consumers.

Sunrise Powerlink Transmission Line from Sand Diego to the Imperial Valley, California

For the Sunrise Powerlink project in San Diego, California, over half of the structure sites had no roads and were constructed entirely by helicopter.
Courtesy of San Diego Gas & Electric

The San Diego region is prone to brownouts and blackouts as summer heat waves strain the electric grid. To address the need for additional transmission and greater reliability, San Diego Gas & Electric (SDG&E) completed the Sunrise Powerlink in 2012, a 500,000-volt transmission line linking San Diego to the Imperial Valley, one of the most renewable-rich regions in California.

What made this project so unique and innovative? The project included 18 months of construction that encompassed both overhead and underground technology as well as different climates and rough, remote terrain. For environmental reasons, nearly 75 percent of the construction was performed by helicopters, and the project logged more than 30,000 flight hours. In addition, the Sunrise Powerlink was the subject of a five-year regulatory review considered to be the most comprehensive study of a proposed transmission power line in state history.

The transmission line will eventually carry 1,000 megawatts of power, or enough energy to serve 650,000 homes. This includes a significant amount of wind and solar power. By 2020, 33 percent of SDG&E's power will be derived from renewable resources.

Improving Bottlenecks in Texas Region: Texas Competitive Renewable Energy Program

Wind turbines create energy at the Horse Hollow Wind Energy Center in central Texas.
Courtesy of the Danish Wind Industry Association

Texas is one of the few areas of the country where having enough energy capacity is expected to be an issue in the near term. Texas also wanted to ensure that renewable energy sources were a major part of the resource mix for adding capacity. As a result, they developed the Texas Competitive Renewable Energy Zone (CREZ).

The CREZ program is a Public Utilities Commission of Texas (PUCT) inspired enterprise to deliver 18,500 megawatts of west Texas wind generation to markets within the Electric Reliability Council of Texas (ERCOT). All work on Texas CREZ — stations, towers, and cable — is scheduled to be finished by the end of 2013, the deadline established by the PUCT.

This deadline requires an ambitious schedule. Crews set 556 steel poles across three counties in six months along a 90-mile right-of-way in North Texas, the longest section of transmission line included in the CREZ program. The siting of the transmission lines also requires complex permitting and construction. For example:

- Approximately 117 rights-of-way were acquired for the Clear Crossing — Dermott transmission line, one of seven transmission lines that are part of the program.

- The anchor bolt foundations for the poles, which stand 600–800 feet apart, required 8,850 cubic yards of concrete.
- To connect the Clear Crossing and Dermott stations, about 1,080 miles of cable coiled on 540 spools will be needed.

With an ambitious regional plan and successful project delivery, Texas is taking steps to ensure it will be ready for the future.

Energy: Conclusion

Looking ahead in the 21st century, our nation is increasingly adopting technologies that will automate our electric grid and help manage congestion points. In turn, this will require robust integration of transmission and distribution systems so that the network continues to be reliable.

Investments in the grid, select pipeline systems, and new technologies have helped alleviate congestion problems in recent years, but capacity and an aging system will be issues in the long term. In addition, with an automated, dynamic energy grid system comes the increased risk of cybersecurity threats. Protecting the nation's energy delivery systems from cyber attacks and ensuring that these systems can recover is vital to national security and economic well-being.

A solar farm in Raleigh, North Carolina
Courtesy of ASCE

Raising the Grades: Solutions that Work Now

- **Adopt a national energy policy** that anticipates and adapts to future energy needs and promotes the development of sustainable energy sources, while increasing the efficiency of energy use, promoting conservation, and decreasing dependence on fossil fuels as sources are depleted. Such a policy must be adaptable and scalable to local and state policy.
- **Provide mechanisms for timely approval of transmission lines** to minimize the time from preliminary planning to operation.
- **Identify and prioritize risks to energy security**, and develop standards and guidelines for managing those risks.
- **Design and construct additional transmission grid infrastructure** to efficiently deliver power from remote geographic generation sources to developed regions that have the greatest demand requirements.
- **Create incentives to promote energy conservation** and the concurrent development and installation of highly efficient coal, natural gas, nuclear, and renewable (solar, wind, hydro, biomass, and geothermal) generation.
- **Continue research to improve and enhance the nation's transmission and generation infrastructure** as well as the deployment of technologies such as smart grid, real-time forecasting for transmission capacity, and sustainable energy generation which provide a reasonable return on investment.