Energy 101

Key Energy Concepts for Local Governments

LEAP

Local Government
Energy Assurance Planning

pti Public Technology Institute

U.S. DEPARTMENT OF ENERGY

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Local Government Energy Assurance Planning (LEAP)

To find out more about local government energy assurance efforts, we encourage readers to visit www.energyassurance.us. This site, maintained by PTI, is designed to support all local governments, large, medium and small, across the nation that want to learn more about creating energy assurance plans for their communities. Once created, these plans will help ensure that local governments can provide life-saving services during an energy emergency.

Editorial Team

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Energy 101: Key Energy Concepts for Local Governments

1 Overview and Background: Understanding Energy in Energy Assurance Planning

The purpose of creating a local energy assurance plan (EAP) is to assess the current state of the local jurisdiction's preparedness in the case of an energy emergency. To do this, it is necessary to have a basic understanding of where the locality's energy comes from, how it is distributed, where it is used, and what infrastructure is involved. This document serves as an introduction to key energy concepts at the local level, and the energy resources upon which all local governments' essential systems rely, in order to provide a foundation for energy assurance planning.

The U.S. Department of Energy (DOE) reports that the United States consumed approximately 102 quadrillion Btu in 2007, or 21 percent of world energy consumption.[1] Every facet of modern life—from residential, commercial, and industrial buildings to transportation systems (including automobiles, trains, buses, etc.)—requires a steady supply of energy to operate. This energy is delivered primarily in the forms of electricity, natural gas, and petroleum. These energy resources enable a locality to function successfully and provide services to its citizens. Natural and man-made events (from minor incidents to catastrophic disasters) can disrupt the flow of energy supplied to and used by a jurisdiction, which in turn can suffer a disruption in key services—everything from emergency, medical, and social services to education, food supply, and community services.

Developing a comprehensive EAP is an effective way to prepare for and respond to such events, and to help ensure that energy is available for essential operations. Before developing a plan, it is necessary to first understand energy infrastructure, including how energy is generated, delivered, and used.

A good place to start in creating an EAP is to assess the current state of local readiness or preparedness in the event of an energy emergency. The following discussion of energy sources pertains to the national level; some elements will differ at the regional, State, and local level. For example, certain regions of the country rely more heavily on coal than the national average, while others may have more developed renewable energy resources. It is also important to understand where the locality's energy supply originates (e.g., where power plants serving the jurisdiction are located, where transportation fuel and fuel used by power plants to generate electricity comes from, the location of any natural gas pipelines, etc.); this will dramatically improve and expedite the response to any large-scale changes that may affect energy sources serving the jurisdiction, such as supply changes, price fluctuations, or natural or man-made disasters.

[1] http://ei-01.eia.doe.gov/ask/generalenergy_faqs.asp.

Understanding how energy is distributed is just as important as knowing the type and source of energy being used. In planning for an emergency, it is helpful to have a strong knowledge of local energy distribution services, infrastructure, and facilities. Building strong relationships and collaborating with local utilities and other energy suppliers and infrastructure operators is crucial. These relationships can help local governments facilitate the rapid restoration of energy services after an emergency has subsided. Knowledge of this basic information is also essential for understanding local alternative energy and back-up energy supply options, as relevant.

2 Major Energy Resources

To heat our homes, fuel our vehicles, and generate electricity, various forms of primary energy sources are harnessed. Fossil fuels such as coal, natural gas, and petroleum account for 92 percent of total energy used (as measured in Btu) in the Nation. Renewable energy sources, including solar, wind, geothermal, biomass, and hydropower, comprise the remaining 8 percent of total energy used in the Nation. Biomass acts as the largest renewable source, accounting for more than half of renewable energy and 4.1 percent of total U.S. energy consumption (as measured in Btu).[2]

2.1 Petroleum Fuels

Crude oil is created deep under the earth's surface from heated and pressurized dead plant and animal matter, over hundreds of millions of years. Oil is found under land, but many deposits are also located under the ocean. Drilling rigs access the energy-rich crude oil at great depths; oil wells have an average depth of 6,000 feet and can reach as far as 20,000 feet deep into the ground. Once the crude oil is pumped out of the ground, it is transported by pipeline, ship, barge, truck, or train to an oil refinery, where the oil is distilled and separated into its various fuels and byproducts.

Quick Fact
One barrel of crude oil creates approximately 19 gallons of finished motor gasoline and 10 gallons of diesel fuel, as well as other petroleum products, such as heating oil and propane.

Source: US Energy Information Administration. Use of Oil.

2.2 Natural Gas

While most petroleum deposits are found closer to the surface of the earth at relatively low temperatures, natural gas typically is found farther beneath the surface, where the temperature is hotter. Natural gas deposits usually are found approximately 60,000 feet (about 11.5 miles) beneath the ground. In areas one to two miles beneath the earth's surface, natural gas tends to be found together with petroleum.

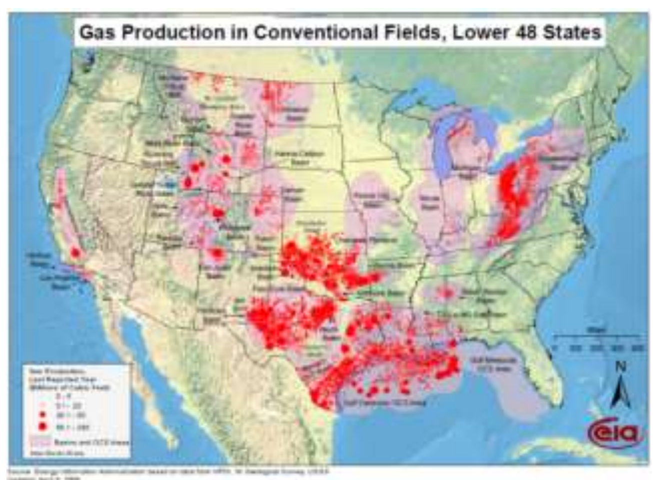

Figure 1. Natural Gas Production in the Lower 48 States
Source: U.S. Energy Information Administration

[2] http://www.eia.doe.gov/aer/.

Natural gas is composed of various gases, including methane, butane, and propane. To capture this energy source, geologists use seismic surveys to locate types of rock that typically hold natural gas deposits. Gas pockets are found under land, but many are also located under the ocean. Wells are drilled, allowing the natural gas to flow up to the surface into pipelines. The natural gas is then transported through the pipelines to gas processing plants to remove impurities and separate it into its component gases.

The primary ingredient, methane, makes up approximately 90 percent of natural gas, and is colorless, odorless, and tasteless. Because methane is a highly combustible gas, a chemical called mercaptan, which gives off a distinct smell of sulfur or rotten eggs, is added to the gas prior to distribution as a safety measure for detecting leaks. Other byproduct gases, such as propane, are used for heating and cooking.

Captured methane from landfills is another source of natural gas. This is considered renewable energy, as its source (garbage) is constantly being created. Landfills provide an environment where methane can be readily produced through anaerobic decomposition of garbage by microorganisms existing in oxygen-deprived environments. The methane captured from landfills is usually burned on-site to produce electricity for related facilities, but it can also be treated and sold as a commercial fuel if it is pure enough.

2.3 Electricity

The majority of U.S. electricity is generated by three types of large power plants: fossil fuel power plants, nuclear power plants, and hydropower plants. Fossil fuel power plants burn coal, natural gas, or petroleum oil to generate electricity. A significant portion of total U.S. energy, approximately 21 percent (in terms of total Btu consumption), is derived from coal. Almost 93 percent of the coal used in the United States is dedicated to generating electricity.

> **Quick Fact**
> One pound of coal provides enough electricity to power ten 100-watt light bulbs for about an hour.
> *Source: US Energy Information Administration. Use of Coal*.

Coal is sedimentary rock made of carbon and hydrocarbons. Once collected, coal is cleaned and processed to increase its heating value, typically at the mining site. Once processed, the coal is ready to be delivered and used. For at least a part of the trip from extraction to combustion, about 71 percent of coal in the United States is transported by train.[3] Coal is also transported by barges, ships, trucks, and pipelines. Because shipping coal can be more expensive than mining it, coal-burning power plants are often constructed near mining sites to reduce costs. Power plants burn the coal to make steam, which turns turbines that generate electricity.

In 2009, coal combustion provided nearly half (45 percent) of the country's electricity; natural gas provided for 23 percent; and petroleum generated about 1 percent.[4] Nuclear power plants accounted for approximately one-fifth (20 percent) of the Nation's electricity production, while

[3] http://tonto.eia.doe.gov/energyexplained/index.cfm?page=coal_mining.
[4] http://www.eia.doe.gov/energyexplained/index.cfm?page=electricity_in_the_united_states.

hydropower plants supplied approximately 7 percent of the electricity generated. After fossil fuels, nuclear, and hydropower, other renewable energy sources—such as biomass, wind, solar, and geothermal energy—provide the remaining 4 percent of U.S. electricity generation.

An electric utility power station uses a turbine, engine, water wheel, or other similar machine to drive an electric generator. Steam turbine power plants powered by coal or nuclear energy produce about 70 percent of the electricity used in the United States.

3 How Energy is Used

3.1 Petroleum

The United States consumes more energy from petroleum than from any other energy source. In 2009, the United States consumed 19.5 million barrels of oil per day—37 percent of its total energy consumption, as measured in Btu.[5] About two-thirds of U.S. petroleum is used for transportation purposes.[6] Other petroleum products are used for heating our homes and creating products like ink, dishwashing liquid, compact discs, and tires. When a barrel (or 42 gallons) of crude oil is refined, its volume increases to provide slightly more than a total of 44 gallons of gasoline, diesel fuel, jet fuel, heavy fuel oil, heating oil, liquefied petroleum gases (LPG) and/or residue.

Diesel fuel, which has a higher energy value than gasoline, is used in the United States to power vehicles that transport nearly 94 percent of the food and goods produced and purchased nationally, and it fuels the vehicles in the construction and military sectors. Diesel fuel is also used to produce electricity in diesel-engine generators. Many facilities (e.g., industrial, commercial, and medical) and electric utilities use diesel generators as backup forms of electricity generation in case of emergencies where primary power sources are not operational. In 2009, diesel fuel accounted for 7 percent of all national energy use and 17 percent of all petroleum products produced, making it the second largest petroleum product produced after gasoline.[7]

Heating oil and propane, also made from refining crude oil, are used mostly to heat rural homes. In parts of the Northeast, heating oil also is used in urban residential applications.

3.2 Natural Gas

Natural gas makes up approximately 25 percent of U.S. energy consumption. The largest consumers of natural gas are the electric power sector (30 percent) and industrial sector (27 percent), followed by the residential (21 percent) and commercial (14 percent) sectors.[8]

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[5] http://www.eia.doe.gov/aer/.
[6] http://tonto.eia.doe.gov/energyexplained/index.cfm?page=us_energy_home.
[7] http://www.eia.doe.gov/energyexplained/index.cfm?page=diesel_use.
[8] http://tonto.eia.doe.gov/energyexplained/index.cfm?page=natural_gas_use.

This fossil fuel is used to generate electricity; heat our homes; fuel our stoves, clothes dryers, and water heaters; produce steel, glass, and paper; and it is used as a raw material in plastics, fertilizers, dyes, paints, explosives, and medicine.[9]

Propane can be derived from natural gas as well, since it is found mixed with both petroleum and natural gas deposits in the earth. Propane is sold and consumed as a liquefied petroleum gas, because like methane, it can be chilled and compressed into a liquid state, enabling it to be transported more efficiently throughout the United States.

As a liquid, propane occupies 1/270 of the space that it would use in a gaseous state. Propane transforms back into its original gaseous state when a valve is opened to release it from its pressurized container. For example, barbeque grills use propane that is stored as a liquid in propane tanks, which turns into gas when released at normal pressure. Propane is used primarily in cooking, fuel furnaces, water heaters, and some motor vehicles.

3.3 Electricity

Electricity is an essential part of modern life. It is used in commercial and industrial buildings for lighting, running equipment and electronics, and for heating and cooling systems. Most of the electricity used in the residential sector is for air conditioning, refrigerators, space and water heating, lighting, and powering home appliances.

Electricity demand fluctuates in the short term in response to business cycles, weather conditions and prices. Over the long term, U.S. electricity consumption has been shown to increase. However, electricity demand growth has slowed progressively by decade since 1950, from 9 percent per year in the 1950s to less than 2.5 percent per year in the 1990s. From 2000 to 2008, increases in electricity demand averaged 0.9 percent per year. Demand growth is projected to continue at about 1 percent per year through 2035.[10]

4 Basic Energy Infrastructure

4.1 Petroleum

Approximately 230,000 miles of pipelines are used in the United States to transport large quantities of petroleum. Petroleum is pushed through an underground system of pipelines through pump stations that are spaced at 20- to 100-mile intervals, moving the petroleum at a rate of 5 miles per hour. As it is cheaper to move crude oil than it is refined petroleum products, most refining takes place at regional (or “downstream”) facilities closer to the consumer than the producer. It is at the final refining stage that crude oil is distilled to create gasoline and other petroleum products. Most quantities of gasoline are shipped through pipelines to bulk storage terminals near cities. Trucks are then loaded with the gasoline and deliver the fuel to individual gas stations in a city.

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[9] National Energy Education Development Department, Secondary Energy Infobook, “Natural Gas,” 2009.

[10] http://eia.gov/energyexplained/index.cfm?page=electricity_use.

Heating oil is also transported via pipeline and is kept in storage terminals. It is then delivered to central distribution areas and consuming areas through the use of barges, tankers, trucks, and rail cars. Trucks deliver the heating oil to end-user storage tanks, such as those at retail stores or homes.[11]

4.2 Natural Gas

After being extracted and refined, natural gas is generally stored in huge underground storage systems or reservoirs prior to being delivered to consumers—most significantly when heating demands rise during the winter season. These storage facilities are designed from salt caverns or depleted aquifers and oil and natural gas reservoirs. Approximately 1.5 million miles of mainline and other pipelines create a transportation system that links natural gas production areas to natural gas markets.[12] To move the gas through these lengthy stretches of large, wide-diameter pipelines, compressor stations (or pumping stations), strategically spaced about 50 to 100 miles apart, increase the pressure of the gas to move it at about 15 miles per hour.[13] About 306,000 miles of underground, wide-diameter, and high-pressure interstate and intrastate transmission pipelines transport natural gas from producing areas to market areas across the Nation—farther than the distance between the earth and the moon.

When natural gas is delivered to communities, it travels through these large pipelines, and then flows into smaller pipelines called "mains." More than 200 companies operate mainline transmission pipelines throughout the United States.[14] These mains connect with even smaller-diameter pipelines, called "services," that deliver the natural gas directly to homes or buildings where it will be used, as seen in Figure 2. Once the natural gas reaches a jurisdiction's local gas utility, the pressure is reduced and the mercaptan is added before it is delivered to homes and buildings. More than 1,300 local distribution companies deliver natural gas to end users in the United States through these small-diameter service lines.[15]

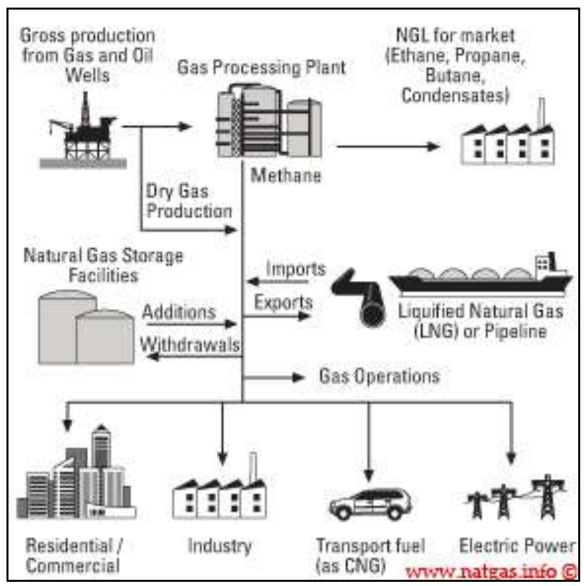


Figure 2. How Natural Gas is Distributed
Source: http://www.natgas.info/html/gaspipelines.html.

In addition to being transported in gaseous form, natural gas can also be chilled to very low temperatures (approximately -260 degrees Fahrenheit), becoming liquefied natural gas (LNG).

[11] http://www.eia.doe.gov/energyexplained/index.cfm?page=heating_oil_use.
[12] http://tonto.eia.doe.gov/energyexplained/index.cfm?page=natural_gas_pipelines.
[13] National Energy Education Development Department, Secondary Energy Infobook, "Natural Gas," 2009.
[14] http://tonto.eia.doe.gov/energyexplained/index.cfm?page=natural_gas_pipelines.
[15] http://tonto.eia.doe.gov/energyexplained/index.cfm?page=natural_gas_pipelines.

LNG uses only 1/600 of the volume that natural gas occupies in a gaseous state.[16] This allows natural gas to be transported efficiently by tankers for export, and shipped by trucks to locations near end-users. LNG can be stored in chilled tanks until it is needed, at which point it can be turned back into a gaseous state to be used in homes and buildings.

Propane is typically transported through underground pipelines from the refinery to pipeline terminals across the country. Trucks, trains, barges, and supertankers deliver propane to bulk distributor plants, where it is stored for local propane dealers to purchase. These dealers fill up their tank trucks and deliver the propane to storage tanks outside consumer homes or to retail stores where people can buy, refill, or exchange their small propane containers.

4.3 Electricity

From the power plant, electricity traverses long distances to reach the consumer in residential, commercial, or industrial settings. As demonstrated in Figure 3, first, the electricity is produced at the power plant with a voltage of between 2,300 volts and 22,000 volts. It is then moved by a wire to a transformer that "steps up" the voltage to as much as 765,000 volts, with a typical voltage of 345,000 volts (transporting higher voltage electricity is more energy-efficient than moving electricity at lower voltages). The electricity is then delivered to a nationwide network of transmission lines, which are large tower lines connected to one another (e.g., large poles and wires often paralleling highway corridors). These high voltage transmission lines extend nearly 160,000 miles nationwide and are collectively known as the "grid."

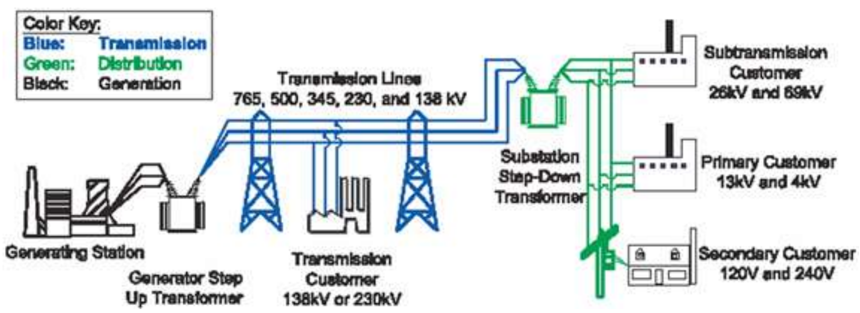
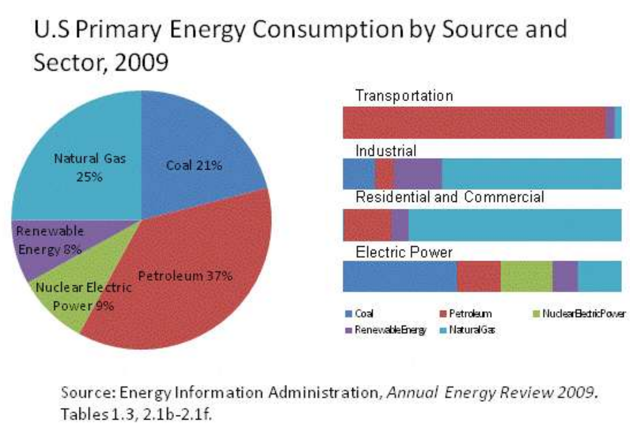


Figure 3. **How Electricity is Distributed.**
Source: www.oe.energy.gov/information_center/electricity101.htm

Electricity is taken to local substations where transformers "step down" the voltage to approximately 12,000 volts. These substations are fenced-in, small buildings that house switches, transformers, and other electrical equipment. From here, distribution lines that run along streets (or are installed underground) carry the electricity to buildings.



[16] http://tonto.eia.doe.gov/energyexplained/index.cfm?page=natural_gas_delivery.

Prior to reaching a building, electricity is once again reduced by a transformer (typically seen as a large gray cylindrical container attached to a utility pole) to 120 volts, which is the voltage used in U.S. households to turn on lights; power computers, electronics, and appliances; and heat and cool spaces.

5 Energy Use at the Local Level

5.1 Energy Use by Sector

National energy use falls into four major consuming sectors: residential (22 percent), commercial (19 percent), industrial (30 percent), and transportation (29 percent)[17].

Energy is used in homes in a variety of ways: from heating and cooling rooms and washing and drying clothing to storing and cooking food and providing lighting. Forty-one percent of energy used in homes in 2005 (as measured in Btu) was dedicated to space heating, provided primarily through natural gas, followed by electricity, heating oil, and propane. The next largest portion (26 percent) was used by lighting and appliances (excluding refrigerators, which accounted for 5 percent of household energy use). One-fifth of the energy used in the residential sector was allocated for heating water, and the remaining 8 percent was used for air conditioning.[18]

Within the commercial sector, buildings such as offices, hospitals, stores, police stations, and hotels used the most energy for heating (36 percent) in 2003, followed by energy used for lighting (21 percent). Specifically, retail and service buildings use the most energy (20 percent) of all types of commercial buildings, including offices (17 percent), schools and universities (13 percent), health care (9 percent), and lodging (8 percent). These five building types dominate the commercial sector, using about two-thirds of energy consumed by all commercial buildings.[19]

The industrial sector uses one-third of all the energy consumed in the United States. Industry uses many types of energy for a variety of purposes, with boiler fuel to superheat water into steam as one major application. Highly energy-intensive industries include the petroleum refining industry and the chemical industry, which use 32 percent and 24 percent, respectively, of the energy used by the industrial sector.[20]

5.2 Energy Use in Essential Local Services and Facilities

5.2.1 Petroleum

Gasoline is by far the most common fuel used for passenger vehicles in the United States. It also fuels light trucks, boats, recreational vehicles, and farm, construction, and landscaping equipment. Extra gasoline is often produced and stored so that it can be used later during times of higher demand. Local government services that rely on transportation, particularly those

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[17] http://tonto.eia.doe.gov/energyexplained/index.cfm?page=us_energy_use.
[18] http://www.eia.doe.gov/energyexplained/index.cfm?page=us_energy_homes.
[19] http://www.eia.doe.gov/energyexplained/index.cfm?page=us_energy_commercial.
[20] http://www.eia.doe.gov/energyexplained/index.cfm?page=us_energy_industry#tab1.

including light vehicles (such as law enforcement) are particularly susceptible to gasoline supply instability. As such, local and State governments often use supplementary purchases and mutual aid agreements to ensure continued supply of gasoline in the event of a shortage.

As mentioned earlier, diesel fuel, while less commonly used than gasoline, powers 94 percent of all shipping in the United States. It also fuels essential transportation assets at the local government level, such as many city fleets, fire trucks and utility company trucks. Diesel fuel can produce electricity in diesel-engine generators, and many facilities use diesel generators as backup power sources during electrical outages.

Local governments in areas with high concentrations of homes using heating oil are often responsible for ensuring reserve stock in the case of an emergency. Of the 111 million homes in the United States, approximately 8 million use heating oil as their main heating fuel, especially those households in the Northeast region, which consume approximately 82 percent of all heating oil used in the Nation. Such a concentrated use of the Nation's heating oil in one region prompted the creation of the Northeast Regional Heating Oil Reserve in 2000. The two million barrels now stored in New Jersey and Connecticut would last the region 10 days during a shortage.[21]

5.2.2 Natural Gas

Natural gas provides energy for a diverse set of essential end uses, including electricity, heating, and industrial processes. Liquid natural gas can be stored in above-ground storage tanks or underground in old oil or gas storage tanks or reservoirs for use during periods of high demand, or for emergencies if necessary. Natural gas is imported into the United States through nine ports. From those ports, natural gas is transported to more than 100 production, transport, storage, and regasification facilities nationwide.[22]

Propane is a common substitute for natural gas in rural areas that do not have natural gas service. Propane is used on farms to power equipment and to dry corn. Propane generators (similar to diesel or other combustion-engine generators) can also be used to pump water from irrigation wells through irrigation systems. Propane is the second-largest alternative transportation fuel used in the United States, and as such, it is often used as back-up fuel for local government vehicles capable of running on it.[23]

5.2.3 Electricity

Electricity is integral to all aspects of a local government's ability to meet the needs of its constituents. Electricity powers the basic requirements of nearly every building and service a locality provides its citizens, whether in municipal buildings or in private-sector buildings, such as offices, stores, and hotels. Local governments can be important mediators between electricity utilities and their customers, particularly in times of limited or fluctuating supply. All essential

[21] http://www.fossil.energy.gov/programs/reserves/heatingoil/.
[22] http://www.fossil.energy.gov/programs/oilgas/storage/lng/feature/howisitshipped.html.
[23] http://eia.gov/energyexplained/index.cfm?page=propane_use.

services, such as law enforcement, fire personnel, health care, information technology services, and transportation management, rely on a local government's ability to access electricity, whether via the grid or backup generators if need be.

6 Large-Scale Changes that May Affect Energy Sources

While these modes of energy generation, transmission, and consumption have been largely consistent for decades, they are by no means certain to remain unchanged. In the coming years, the U. S. energy portfolio may be subject to numerous possible shifts, many of which are interdependent, rely on uncontrollable variables, and are difficult to predict, such as changes in the supply and demand of energy, and the occurrence of natural or man-made disasters. Nevertheless, to create a comprehensive, long-term EAP, it is helpful to understand some of the issues that may impact local energy supplies.

6.1 Supply

The principle of supply and demand plays a large part in the energy security and reliability of any given area. In addition to expected shifts in power generation, transmission and distribution capabilities, energy assurance planning must take into account the possibility of changes in supply and demand that are larger than everyday issues like price fluctuations, daily peak usage times, and local accidents or disasters.

One of the most visible issues in global energy planning is the depletion of our non-renewable energy sources, of which oil is the largest concern. "Peak oil" is the term used for the point at which global production of oil reaches the maximum allowed by the planet's supply. Past this point, production will necessarily decline, leading to global oil shortages and cost increases. Experts are not in agreement on when we will reach peak oil or how this phenomenon will take shape, and estimates for its occurrence range from imminently to 2050 and beyond.[24]

While oil production may peak and then tail off, almost all other energy sources, such as coal and nuclear, are projected to continue increasing production until at least 2035.[25] Production of energy from a diverse array of renewable sources—including biomass, solar, and wind—will likely continue to increase in coming years. Most renewable energy sources have supply and distribution limitations, however, that prevent them from being implemented on a scale comparable to conventional energy sources in the near term. The U.S. power grid is not currently capable of handling the intermittency of many renewable energy sources effectively. Energy from solar and wind installations is subject to natural fluctuations, and cloud cover or still air can stop its generation altogether. As effective sites for renewable installations are often a significant distance from existing transmission corridors, new, costly transmission connections often must be made to utilize these resources.

[24] National Energy Technology Laboratory, "Peaking of World Oil Production: Recent Forecasts," 2007.
[25] U.S. Energy Information Administration, Annual Energy Outlook 2010.

Despite these barriers to the use of renewable energy, the feasibility of renewable technologies and the scalability of these resources at a local level continues to grow. Solar photovoltaic panels, and small, community-level wind turbines can be used to provide backup power or help supplement power supplied by backup generators at critical facilities during an energy disruption.

Local governments can also use solar panels, wind turbines, biomass plants, geothermal energy, or hydropower resources, where feasible, to supplement their electricity usage during normal operating conditions and reduce reliance on the electric grid. A decreased reliance on the electric grid, and an increase in the diversification of energy sources, can help local governments increase resiliency within their jurisdiction.

To supply its end users with a reliable baseload of electricity, the grid needs to manage its power sources as intelligently as possible. A “smart grid” at the national level is one that can react to real-time changes in supply and demand, effectively transferring energy from areas of surplus to areas of demand, and storing surplus energy for use in periods of low production from sources prone to fluctuation.[26] Smart grid, energy storage, and large-scale renewable energy transmission and distribution technologies are improving quickly and are in use in some limited areas of the Nation, but have yet to be widely implemented.

6.2 Demand

Energy demand in the United States is expected to increase 14 percent over the next 25 years. Projected improvements in energy efficiency and energy intensity (energy consumed per unit of GDP), however, will decrease energy consumption by more than 40 percent per capita over that same time period.[27] Mirroring this trend locally, energy assurance planners can ensure the continued viability of their available energy sources by promoting energy efficiency and conservation measures in local government buildings.

Reducing the amount of energy used in local government buildings and in a community can help lessen the impact of an energy disruption. For instance, a reduction in the amount of energy required to operate government buildings may help local electric utilities better manage peak energy demand and prevent a disruption in the electricity supply. Diversifying energy sources also can reduce the frequency and duration of certain energy disruptions by reducing a local government’s reliance on a limited number of energy sources. This can help increase the reliability of a jurisdiction’s energy supply, and can increase resiliency.

Due to increased public awareness of issues like climate change, consumer demand for shifts in energy production and consumption will make a continually larger impact on the Nation’s energy portfolio. Emissions from the burning of fossil fuels are responsible for the increased

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[26] U.S. Department of Energy Office of Electricity and Energy Reliability, “The Smart Grid: An Introduction,” 2009.
[27] U.S Energy Information Administration, Annual Energy Outlook 2010.

concentration of carbon dioxide and other greenhouse gases in the planet’s atmosphere, which likely contributes to global shifts in climate.

Recently, many government officials at the local, State, and Federal levels have focused their planning efforts on various policies to reduce fossil fuel consumption and promote the creation of more clean-energy sources. Clean energy tax credits, State renewable energy portfolio standard (RPS) programs, and American Recovery and Reinvestment Act (ARRA) funding have helped increase investments in technologies such as wind, solar, and biomass energy.

Future Federal legislation, possibly in the form of a cap and trade system or related mechanisms for assigning a price to carbon emissions, may further the goal of reducing energy-related greenhouse gas emissions. Under a cap and trade system, an annual limit on the amount of carbon emissions is set, and a defined number of credits are issued that meet this cap. Energy providers and others would then have to purchase or trade their allowances to ensure they have enough credits based on their emissions, or reduce the amount of carbon emissions they produce. Many projections of energy use and carbon emissions rely on the passage (or the failure) of these Federal regulations, and the expected effects of such legislation vary widely.[28]

6.3 Natural or Man-Made Disasters

Both man-made and natural forces pose threats to the reliable supply of energy. While short-term, localized disruptions are common in some parts of the country due to seasonal storms, other larger threats are important to consider when creating local EAPs.

The interconnectivity of the Nation’s electrical systems can create cascading power failures. The widespread outage in August of 2003, caused by a sagging power line in Cleveland coming in contact with a tree, subsequently affected 50 million people in eight northeastern States and one Canadian province. These failures are often the result of multiple issues, requiring decision-makers to address numerous aspects of energy infrastructure and policy to prevent similar problems. A task force created to analyze the 2003 failure reported that the blackout “was caused by deficiencies in specific practices, equipment, and human decisions by various organizations... deficiencies in corporate policies, lack of adherence to industry policies, and inadequate management of reactive power and voltage.”[29]

While the 2003 blackout illustrates how systematic deficiencies can lead to devastating cascading impacts to the electric grid, the grid is also vulnerable to a number of common hazards. Wind and ice storms, flooding, wildfires, and other natural events frequently impact electricity generation and transmission on a local and regional basis.

A local government’s energy profile will determine the extent to which failures of certain energy supplies will need to be anticipated. With the presence of an oil refinery, a region may be

[28] U.S. Energy Information Administration, Annual Energy Outlook 2010.
[29] National Governors Association, Governor’s Guide to Energy Assurance, 2006.

temporarily less vulnerable to an interruption in crude oil shipments than other localities, and a region with an electricity generating station may continue to have power even though a failure occurs in the State's electricity grid.

On the other hand, such significant infrastructure also may be targets for malicious acts. While energy terrorism and sabotage have been limited in the United States, the increasing prominence of homeland security issues requires local governments to consider the possibility of both large and small malicious behaviors that can affect energy use and supply.

7 Conclusion & Resources

Understanding where energy sources come from, how energy is distributed and used, and related volatility in the supply and demand of energy sources is one of the first steps to evaluating preparedness and creating an EAP. Understanding the local energy profile and the effects of changes in energy supply and demand can help local governments evaluate and plan for short- and long-term energy disruptions and build resilience and energy reliability at the local level via an energy assurance planning process.

The U.S. Energy Information Administration (EIA), a subsidiary of DOE, publishes a comprehensive and easy-to-understand guide to all energy sources, uses, and infrastructure titled *Energy Explained*. Available for free on the EIA Web site, *Energy Explained* is an excellent additional resource for any local government official interested in learning more about energy sources.

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