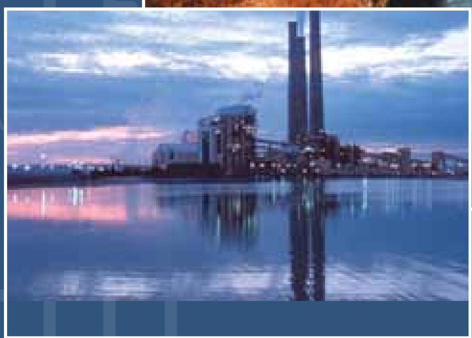
UTAH ENERGY PRIMER



UTAH OFFICE OF
ENERGY DEVELOPMENT

Advancing Utah's Energy Future

Utah Energy Primer

The Governor's Office of Energy Development (OED) has produced the Utah Energy Primer as a resource to provide information about Utah's energy resources and how these resources are provided and delivered. Utah's key priority is to ensure the provision of reliable and affordable energy while at the same time sustaining the state's pristine natural environment. This primer is designed to provide an overall energy picture to promote increased awareness about Utah's energy landscape, and tyo guide stakeholders making important decisions regarding Utah's energy outlook.

Contents

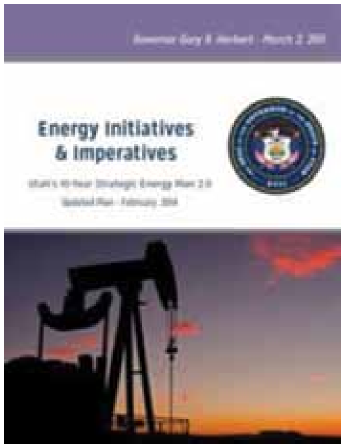
Utah's Energy Imperatives

Utah has addressed the importance of energy through legislation, planning, and stakeholder engagement.

State Energy Policy

Title 63M Chapter 4–Section 301 defines Utah's energy policy. This policy was passed into law in 2007 and is updated as necessary to support the State's energy objectives.

The energy policy is succinct and comprehensive, and asserts the State's responsibility to promote energy resource development, including conventional, unconventional, and renewable energy, as well as energy efficiency, in support of a diverse energy portfolio. To ensure Utah has the ability to responsibly develop its energy resources, the policy defines a proactive role for the state in maintaining pressure on federal land management and regulatory agencies to ensure development proceeds at a reasonable pace that does not stifle investment and expansion.



Specific to energy use, the policy addresses the state's role in maintaining reliable power supplies for Utah homes and businesses, while keeping the cost of power stable and low. It further articulates the State's role in promoting the associated infrastructure required to deliver resources to points in the market for refinement or consumption.

Finally, the policy provides a clear position on the need for energy initiatives to advance in concert environmental and energy conservation objectives. As such, the policy recognizes that balanced, diverse energy development can be achieved to retain and enhance the quality of life enjoyed by Utah's residents. Moreover, the objectives can be realized through both the process of energy production and the act of energy consumption.

Utah's 10-Year Strategic Energy Plan

Governor Gary R. Herbert recognizes Energy as one of the Four Cornerstones of Utah's prosperity, along with Job Creation, Education, and Self-Reliance. In order to establish a unified approach to energy policies and priorities, the Governor assembled an Energy Task Force to create a guiding document entitled, *Energy Initiatives & Imperatives: Utah's 10-Year Strategic Energy Plan* (Plan).

The Plan was released in March 2011, and shortly thereafter the Utah State Legislature addressed the first recommendation through the creation of the Governor's Office of Energy Development.

"The plan represents months of collaboration and planning among an impressive array of stakeholders in the energy arena. More than a to-do list, the plan is an invitation to and a framework for a meaningful public conversation about the future of energy in Utah. It includes guiding principles, goals, models and real-world examples." [1]

The Plan's eight recommendations are:

1) Establish an energy office for the State of Utah, administered by the Governor's energy advisor.
2) Create an effective strategy for the legitimate use of Utah's public lands for energy development purposes.
3) Strengthen Utah's role in research and development of energy technology by enhancing collaboration between Utah's research universities and regional colleges, the energy industry, and nearby national energy laboratories.
4) Strategically use incentives as an economic tool to influence behavior and business decisions.
5) Increase energy development through coordination and transparency in the regulatory and licensing process.
6) Develop a state-wide program aimed at reducing energy consumption.
7) Diversify transportation fuels and build a transportation infrastructure and a fleet to meet the needs and demands of future generations.
8) Review the need for additional base-load sources of energy to supply electrical needs for the future.[2]

The 10-Year Strategic Energy Plan was recently updated and is available on OED's website: www.energy.utah.gov.

Utah's Energy Use

The State of Utah is a net exporter of energy, producing 31% more energy than it consumes. In 2012, approximately 775 trillion BTUs of energy were used statewide, a low per capita usage representing only 0.8% of the energy demand in the United States.[3]

Transportation Energy Consumption

The transportation sector includes all vehicles whose primary purpose is transporting people and/or goods from one physical location to another. Over 80% of the oil consumed in the state is used by the transportation sector.[4]

Industrial Energy Consumption

Industrial energy consumption consists of all facilities and equipment used for producing, processing, or assembling goods, and can be broken up into manufacturing (food, refining, metals and other products) and non-manufacturing (agriculture, mining and construction).

Industrial energy use is closely tied to national economic trends and tends to be more volatile than other sectors. Until Geneva Steel closed in 2001, the industrial sector was the state's largest energy consumer.[5]

A large portion of industrial energy demand in Utah is tied to agriculture, which consists of all facilities and equipment engaged in growing crops and raising animals.

Residential Energy Consumption

The residential energy sector includes electricity and natural gas used in all living quarters for private households. Typical residential energy bills are measured in kilowatts (kWh). A kWh is the equivalent of powering ten 100 watt incandescent light bulbs for an hour. For example, fully charging an electronic tablet every other day would use less than 12 kWh in a year.[6]

Residential energy use tends to increase proportionally with population growth. The average residential energy used per person has stayed relatively constant, around 60 million Btu per person per year for the last two decades.

Commercial Energy Consumption

Commercial energy consumption consists of service-providing facilities and equipment of businesses. Commercial buildings include hospitals, offices, schools, churches, museums, libraries, and warehouses. Lighting and heating and cooling systems consume roughly 50% percent of the energy used by commercial buildings. This sector is the State's leading electricity consumer with 10,877 Gigawatts hours (GWh) sold in 2013.[7]

Utah's Energy Resources

Utah houses a breadth of energy resources with an abundance of fossil fuels, renewable energy opportunities and the chance to maximize these energies through focused energy development.

Conventional Energy

In the State of Utah, 98% of the primary energy production is associated with coal, oil and natural gas, which are typically referred to as "conventional" resources.

Coal

Coal has been mined in Utah for over 100 years. In 2008, Utah produced its one-billionth ton of coal, and coal-fired power plants generated almost 81% of the electricity produced in Utah in 2013.

Utah's most economic coal reserves are located in the three coalfields found in Sevier, Emery and Carbon Counties.[8] Utah's bituminous coal has an average heat content of 11,400 Btu/lb and a low sulfur content (approximately 0.6%).[9] In 2013, 1,638 Utah jobs were directly related to the State's coal production industry (this figure does not include indirect and support jobs).

Coal is used by the industrial sector to produce coke for making steel and fly ash—a byproduct of coal-fired power plants—which is used to produce concrete. While coal-fired power plants are estimated to produce approximately 2 pounds of carbon dioxide (CO_2) per kWh of electricity, clean coal technologies, including coal washing, wet scrubbers, and gasification can be employed to reduce pollutants.[10]

Coal: How it works

Pulverized coal plants first crush coal into a fine powder to enhance combustion. The powder is then conveyed to a boiler unit. Water is piped into the boiler system and heated to create pressurized steam. The steam is used to turn turbine blades attached to a generator (a coil of wire spinning inside a strong magnetic field) where electricity is produced.

Fluidized bed coal power plants rely on compressed air to mix pulverized coal with air, resulting in a turbulent mixture of gas and solids. The "fluidized" coal is mixed with limestone or dolomite, which absorb more than 95% of the sulfur pollutants. This technology burns the fuel at lower temperatures where nitrogen oxides form, helping to reduce pollutants. This process allows for burning lower-quality coals and has also been used with wood and waste-tire combustion systems.

Natural Gas

Natural gas is a versatile fuel source with a variety of new applications which are helping to address Utah's changing energy needs. Natural gas power plants are considered to be highly-efficient, converting up to 55% of the fuel source into electricity.[11]

Natural gas makes up approximately 45% of Utah's total produced energy resources, and accounts for 27% of the energy consumed.[12] More than 80% of Utah residents heat their homes by natural gas.[13]

Natural Gas: How it works

A Simple Cycle Combustion Turbine (SCCT) is essentially a jet engine turning a generator. Air is pumped into a combustor and heated. The combined heat and pressure of the gas is pushed through a nozzle into the turbine section pushing its blades to power both the compressor and the mechanical output.

Combined Cycle Gas Turbines (CCGT) include a boiler system and a steam generator. The CCGT capture waste heat, adding about 30% efficiency to the system when compared to the SCCT.

The Rocky Mountain Power Gadsby generation facility utilizes conventional natural gas-fired boilers for three of the six turbines and SCCTs in an additional three units. The Currant Creek and Lake Side generation facilities contain one steam turbine and two CCGT's.

Compressed natural gas (CNG) is made by compressing natural gas to a higher pressure gaseous state (less than 1% of the standard atmospheric pressure it occupies). CNG can be used as an alternative to gasoline, diesel, and propane. Burning natural gas in a vehicle instead of gasoline can reduce carbon monoxide (CO) and CO_2 emissions by 90%-97% and 25% respectively.[14]

Cooling natural gas causes liquefaction and reduces the gas' volume up to 600 times. This liquefying allows natural gas to be shipped from remote areas containing large natural gas fields. Liquefied natural gas (LNG) can be reheated to the gas phase or be used as an alternative vehicle fuel.

Petroleum

Utah currently has five refineries with a capacity to produce more than 173,050 barrels of crude oil per day (1 barrel equals 42 gallons). These refineries primarily produce gasoline, diesel, and jet fuel.

The transportation sector is the main market for petroleum products in Utah.[15] Utah consumed 1,052 million gallons of gasoline and 621 million gallons of distillate oil (used for diesel fuel) in 2012.[16]

Although this energy-dense resource has allowed commerce to move product over large distances quickly and efficiently, air quality concerns abound. According to the EPA, vehicle exhaust accounts nationally for 75% of the carbon monoxide emissions and 50% percent of volatile organic compounds.

Petroleum: How it works

To refine crude oil, the oil is first vaporized through a heating process. The vapor is then cooled in a distillation tower and condenses back to a liquid state. Hydrocarbons vaporize at specific temperature zones within the distillation tower; for example butane and propane condense near the top zone while gasoline and kerosene condense near the middle and the residual settles at the bottom.

Separated products undergo further refining processes that focus on removing sulfur, nitrogen, water, and oxygen to produce a product. Because crude oil is composed of hydrocarbons, larger, less-desired molecules can be "cracked" and reformed to make high-demand molecules such as gasoline.

Internal combustion engines use gasoline for combustion. A piston, connected to a crank shaft, moves down, allowing air and gasoline to fill each cylinder. The crank shaft turns, moving the piston up, compressing the air/gas mixture. A spark plug is used to ignite the compressed mixture, which drives the piston down. An exhaust valve opens, allowing exhaust to leave as the piston moves up and the cycle re-starts.

Diesel fuel-injected engines are similar to the gasoline engine in the basic concept of converting linear motion into rotary motion. Diesel fuel injection systems first compress air and then inject the fuel as opposed to gasoline engines which combine the air and fuel first and then compress the mixture. The compressed air heats and when the diesel fuel is added it ignites creating the motion for the piston.

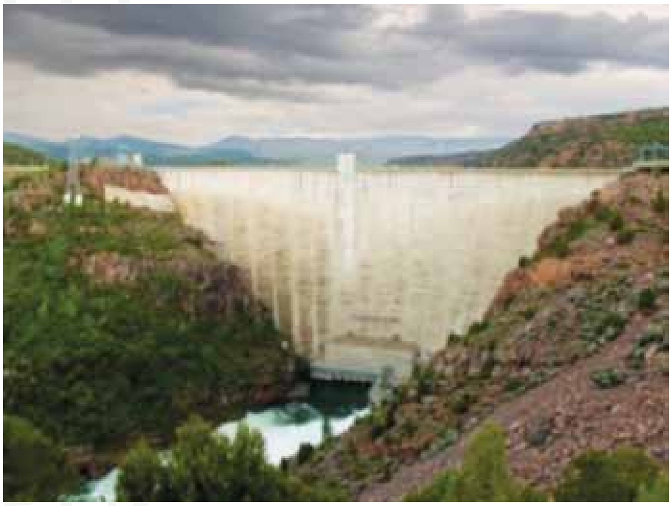
Renewable Energy

Renewable energy is generally defined as energy that comes from resources that naturally replenish within a human – as opposed to geological – timescale. These energy resources include: sunlight, wind, biomass, tides, waves and geothermal heat. Renewable energy is often used to replace conventional fuels in five areas: electricity generation, hot water, space heating, motor fuels, and rural (off-grid) energy services.

Renewable energy resources in Utah include hydro-power, geothermal, solar, wind and biomass with a total existing capacity of 711 MW and 545 MW proposed.[17] The potential for an additional 837 GW exists for geothermal, solar and wind energy.[18]

Hydro-power

Water has been a resource used by people for centuries, from the water wheel used to grind wheat into flour, to today's sophisticated power plants. Hydroelectric power is a clean and efficient energy production alternative due to its lack of emissions. However, several environmental concerns exist for this renewable energy including heavy construction of dams and potential disruptions of plant and animal life.



Utah is home to more than 800 dams; however, less than 8% have associated hydroelectric power generation.[19] The U.S. Bureau of Reclamation operates two hydro plants in the State. These include a small facility at Deer Creek Reservoir and the larger 152 MW plant at the Flaming Gorge Reservoir.

PacifiCorp operates 11 hydroelectric plants in the State, ten of which range in size from 0.16-10.3 MW in nameplate capacity. Local municipal utilities and irrigation companies operate additional smaller facilities throughout the State, the majority of which are 0.5-3 MW in size.

Hydro-power: How it works

Traditional dams built on rivers store water in a reservoir. The dam releases water from the reservoir into the penstock (or large pipe) which flows into a powerhouse. Inside the powerhouse, the moving water creates a force used to spin a turbine connected to a generator, creating electricity. The water is then released, returning to the flow of the river.

Diverting in-stream flow utilizes the natural flow of a river to produce electricity without building dams. Turbines are placed in the river to capture the energy to spin the generator. Negative impacts, including fish habitat disturbance and channel variability, are less significant than those associated with the traditional dam reservoir model.

Pumped storage is similar to the traditional dam system. This technology utilizes times of low energy demand to pump water, using the turbines in reverse, to a reservoir higher in elevation for storage. When electricity demand is high, water from the reservoir is released through the turbines to generate additional electricity.

Smaller in size, micro-hydro systems are ideal for rural areas and locations off the grid with reliable year-round stream flow. These systems range in size, but are usually under 10 MW. Micro-hydro systems do not typically require water storage; rather they use the in-stream flow energy.

Geothermal

Most of the potential for geothermal electric power generation in the United States lies in the western part of the country, particularly where the earth's crust is thin as evidenced by geysers and hot springs.[20] Utah sits in an active geothermal zone. Relying on earth's constant temperature, geothermal energy is a continuously available renewable resource. Since it is a continual resource, geothermal energy is the only renewable resource that offers base-load electricity generation in the absence of energy storage.

Harnessing geothermal energy requires careful location identification, and upfront costs associated with drilling deep wells can be expensive. In contrast, operating costs are relatively-low.

Utah is one of 13 states with geothermal electric power generation.[21] According to the Utah Renewable Energy Zone Phase I report, there is a 2,166 MW potential in the state with 754 MW potential for electricity generation.

The Blundell Geothermal Power Plant located near Milford, Utah, was completed in 1984, making it the first geothermal electric plant built in the United States outside of California. The plant was expanded in 2007 to a total capacity of 38 MW. The facility sits on the Roosevelt Hot Springs with the hydro thermal reservoir lying 3,000 feet below the surface. Unit 1 has a 26.1 MW capacity and uses flash technology while the expanded Unit 2 uses a binary heat-recovery process to optimize the left over brine from the steam separation cycle.[22]

Geothermal: How it works

A flash steam geothermal power plant pulls up hot water from a reservoir, separating steam from the water. The steam is delivered to the turbine to generate electricity while the water is returned back to the reservoir. In a dry steam plant only steam is produced from the geothermal reservoir eliminating the water, which helps reduce waste stream generation.

Binary power plants utilize the hot water from the geothermal reservoir to heat a secondary fluid, usually a hydrocarbon that boils at a lower temperature. The vaporized organic fluid is used to run a turbine. These systems benefit from greatly-reduced waste stream generation and almost zero emissions.

Geothermal heating and cooling for residential and commercial buildings differs from a geothermal power plant. This resource takes advantage of the fairly constant temperature of the earth's crust. Systems are designed to circulate water through an earthen loop (underground pipes) and heat pump. The heat pump functions in a manner similar to a conventional heat pump. Heat is exchanged by extracting heat from circulating water in the winter and adding heat in the summer. The difference comes as the geothermal systems have a constant temperature source versus the changing air temperature, adding efficiency to the heating and cooling system of a building.

Solar

In 1839, French physicist Edmond Becquerel discovered that certain materials conduct electricity when exposed to sunlight called the photovoltaic (PV) effect. Bell Telephone in 1954 used a silicon wafer to convert sunlight into electricity, creating the first solar battery.

The availability of the sun's energy is vast. With an average energy flux striking the earth's surface of 174.7 watts per square meter (W/m2), theoretically there is enough energy to power the world's energy needs in 2020 in just over 2 hours using the suns energy (675 EJ in 2 hrs. and 6 min.)[23] However, due to the intermittent nature of this resource, solar power is best used to offset energy usage mid-day.

Currently, solar capacity in the State comes from small-scale projects that help to offset electricity use from the grid. The Salt Palace Convention Center currently has one of the larger capacities in the state with a total of 6,006 roof-top panels and a total capacity of 1.65 MW.[24]

While there are no utility-scale (more than 5 MW54) solar projects in operation in Utah, the first plant is projected to be ready for generation in 2016. Rocky Mountain Power plans on building the first Utah solar farm which will provide electricity for 500 homes from 9,000 PV panels funded under the company's Blue Sky program.

Solar: How it works

Traditional solar PV cells contain multiple silicon wafers. These wafers contain introduced phosphorous and boron which help create an electric field when the wafer is exposed to the sun. When introduced to sunlight, energy from photons knock electrons from the wafer's layers forming an electric current. Once the current is formed, an inverter converts the direct current power formed in the solar cell into an alternative current, ready for consumptive use.

Thin film solar cells are similar to the traditional PV cells but substitute the silicon for other materials such as cadmium telluride (CdTe) or copper indium gallium diselenide (CIGS). These materials offer higher-efficiency and more economical options for solar PV cells.

Concentrating solar power facilities use mirrors to concentrate reflected sunlight onto receivers that are used to convert the captured energy into heat. This heat is then used to convert water into steam and run a traditional turbine and generator to generate electricity.

Wind

Wind, like water, has been used for centuries to pump water, grind grain and power sail boats. According to the Department of Energy, wind generation could provide 20% of the nation's electricity needs by 2030.[25]

There are no emissions associated with wind generated electricity. However, potential interference with migratory of birds, visual appearance, and a considerable land use component are issues faced by this energy resource. Similar to geothermal energy, while operating costs are low, there is a high upfront cost.

The Spanish Fork Wind Farm was the first utility-scale wind project in Utah. Located at the mouth of Spanish Fork Canyon, the 65-acre area houses 9 turbines with a capacity of 19 MW. Milford Wind is the largest wind farm in Utah and is located in Beaver and Millard counties. Phase 1 consisted of 97 operational wind turbines for a total capacity of 204 MW. Phase 2 added 68 turbines and a 102 MW capacity.

The potential for wind power generation in Utah is varied due to a wide range in the landscape. The Utah Renewable Energy Zones Phase I report reported in the 51 wind sites tested, there is a potential of 9,145 MW. Eleven of the sites have an estimated prospective capacity of at least 250 MW each, totaling 2,750 MW.

Wind: How it works

Wind turbines are modeled after traditional windmills, utilizing propeller-like blades to harness the wind's energy. Usually three, evenly-weighted blades are mounted on a tower over 100 feet high. The blades act as an airplane wing, creating uneven pressure as the wind blows, turning the blades.

The turning blades are used to spin a low-speed shaft (30-60 rpm). This low speed shaft is connected to a high-speed shaft in the gear box to increase the rpm's to about 1000–1800 rpm, which is required for the generator to produce electricity.

Biomass

Potential energy stored in plant materials and animal wastes is considered biomass. Biomass is an expansive resource including everything from municipal solid waste (MSW) and wastewater to agricultural waste, food processing byproducts and various plant-based materials.

In Utah, the Trans-Jordan Landfill and the Salt Lake Valley Landfill capture methane from the landfills to burn for electricity generation. Currently, they have capacities of 4.8 and 3.2 MW respectively. The Davis County Landfill uses a waste-to-energy system with a total capacity of 1.6 MW.[26]

Blue Mountain Biogas, another renewable power plant utilizing biomass, is located near Milford, Utah. This 3.2 MW facility collects waste from large pig farms through a series of pipes and pumps, putting the waste through anaerobic digestion to produce methane. The methane is collected and burned in a power generating system. The facility produces enough power to electrify about 3,000 homes and reduces annual carbon dioxide emissions by approximately 100,000 tons.[27]

Biomass: How it works

Municipal solid waste can be used as a fuel for electricity generation or used for thermal generation. For most applications, it costs more to generate electricity with biomass. However, waste-to-energy plants can reduce the amount of waste put into landfills by up to 87% which offsets the upfront systems costs.[28]

Waste-to-energy plants are similar in design to coal burning power plants but use MSW as the fuel source versus coal. Recyclables are removed before the MSW is conveyed into the boiler. A magnet removes any metals from the remaining ash. Spraying ammonia, using dry scrubbers and good combustion are technologies used to remove potential pollutants.[29]

Gas-to-energy power plants capture gas from landfills or animal waste. The anaerobic bacteria living in landfills produce biogas, containing methane, as they decompose organic material. This biogas is collected and used for electricity generation.

Unconventional Energy

With the demand of energy increasing, newer resources and technologies are needed to extract traditional fossil fuels from non-traditional sources. This unconventional energy sector has a great capacity to provide needed energy, jobs and security for ever-increasing energy demands.

Oil Sands

Oil sands contain a mixture of sand, clay, water, and bitumen. Bitumen is dense hydrocarbon material. Oil sands are found all over the world with large deposits located in Canada, Russia, and the U.S. Historically oil sands were thought to be tar sands and mistakenly were used as tar. Tar is actually a by-product of the destructive distillation of organic matter such as coal, wood, or peat.

Utah oil sands are "oil wet," meaning the bitumen adheres directly to the host sand grains. In contrast, Canadian oil sands contain a film of water between the sand and the bitumen termed "water wet." Utah's oil sands also contain 90% less sulfur than those found in Canada.[30]

Most of Utah's oil sand resources are concentrated in the eastern part of the State. An estimated 15 billion barrels of measured in-place oil exist within Utah.[31]

Oil Sands: How it works

Oil sands are recovered in two ways, surface mining or in-situ. Surface mining is similar to coal open pit mining, using large shovels and trucks to extract the sands.

The Clark Hot Water Extraction Process involves mixing crushed oil sands with water heated to 50-80°C, which lowers the viscosity of the bitumen. The mixture is allowed to settle and the bitumen froth floating on the surface is gathered for further refining to separate fine solids and remaining water. The material is upgraded and transported using heated trucks or pipelines as a synthetic crude oil.

Newer technologies involve processing the sands with a citrus-based solvent. Primary separation allows course solids to separate from fine solids, bitumen, and water. The diluted bitumen is further processed thereby separating the remaining solids and water. A single-stage distillation process is used to remove the solvent from the bitumen.[32]

Oil Shale

Oil shale is a sedimentary rock that contains an organic material called kerogen. Considered the precursor to oil and natural gas, oil shale did not undergo sufficiently intense pressure and heating during its formation to become a liquid or gas. Kerogen can be converted into desirable petroleum products through heating. Oil shale is similar to coal in that both rocks can be burned directly as an energy source.[33]

The greatest known deposits of oil shale in the world are found in the Green River Formation in the Uinta Basin and nearby portions of Wyoming and Colorado. According to the United States Geologic Survey, the formation contains roughly 1.2 trillion barrels of oil in deposits greater than 15 gallons per ton.[34] The Utah Geological Survey estimates that roughly 77 billion barrels of oil could be potentially extracted economically from north-central Utah.

Commercial oil shale projects have been operating in Estonia, Brazil, and China for decades producing tens of thousands of barrels of oil annually. Federal lands administered by the Bureau of Land Management contain about 80% of the oil shale resource in the West.

Producing oil from oil shale is site-specific and traditionally used large amounts of water in the process, however new technologies are reducing water consumption. Because of the large amounts of soil and rocks moved, re-contouring, backfill and re-vegetation as remediation and rehabilitation is required.

Oil Shale: How it works

Traditional underground and surface mining processes are used to remove oil shale from the ground. The oil shale is then heated to convert the kerogen into hydrocarbons in a process called retorting. The shale oil is then upgraded by further processing and sent to refineries.

Newer, experimental technologies involve in-situ processes for extracting the oil from oil shale formations. Electric heaters are placed inside the oil shale formation and heated to 650-700°F, allowing oil to flow out of the shale. The oil is then pumped out of the ground.

Freeze walls are placed outside of the heaters so oil does not flow out or allow groundwater from seeping into the heated zone.[35] This technology is still in its infancy and some companies have abandoned their research in this area due to environmental issues.

Red Leaf's EcoShale technology places the oil shale in a clay-lined excavation, covering the shale with layers of impermeable clay and soil. The shale is then heated with natural gas via steel pipes to the point at which pyrolysis occurs and oil, condensate, and natural gas are produced. This process uses very little water.[36]

Nuclear

There are currently no nuclear power plants in Utah; however, nationally there are 65 nuclear power plants with 104 reactors providing approximately 20% of the electricity in the United States.[37] Nuclear energy is carbon-free and produces no greenhouse gases or air pollutants.

There are large uranium deposits in San Juan and Garfield counties, as well as in southeastern Utah that could be utilized in the case that nuclear power is increased in the U.S. Mined uranium is transported to and processed at the only licensed and operating uranium mill in the U.S., located south of Blanding, Utah.

Radiation leaks, waste disposal, and water contamination are some of the concerns expressed regarding the use of nuclear reactors. After accidents at Three Mile Island (1979), Chernobyl (1986) and Fukushima (2011) public awareness is at an all-time high. However, nuclear facilities have an impressive safety record as these are the only major incidents in over 14,500 cumulative reactor-years.[38]

Many of the new nuclear design technologies are focused on smaller systems that are water efficient and have multiple safety options. Small modular reactors offer the advantage of lower initial capital investment, scalability and siting flexibility at locations unable to accommodate more traditional large rectors.[39]

Nuclear: How it works

Nuclear power is derived from the process of nuclear fission. Fission occurs when low energy neutrons, called a slow neutron or thermal neutron, are absorbed by fissionable isotopes such as uranium-235 (U-235) or plutonium-239 (Pu-239). This energy makes the isotope unstable causing it to split allowing neutrons to break away from the nucleus and releases energy in the form of heat. The heat is used for heating water into pressurized steam and the released neutrons trigger more fission.

There are only two types of reactors currently used in the U.S. Boiling water reactors use the reactor core to heat water creating steam to drive the turbine. In a pressurized water reactor, water is kept under pressure which heats it but not to boiling temperature. This highly pressurized water is passed through a steam generator, supplied from a separate water source, creating steam to run the turbine.

Natural uranium contains 0.7% of the fissionable U-235 isotope with the other 99.3% containing U-238 which indirectly contributes to the formation of fissile isotopes of plutonium. Some plants use natural uranium while others enrich the uranium to contain 3%-5% U-235 in their fuel. The enrichment process requires the uranium to be in the gaseous form. U-235 has 3 fewer neutrons than U-238 allowing the two isotopes to be separated due to differences in their masses.[40]

Energy Efficiency Resources

Energy efficiency is one of the easiest and most cost-effective ways to address energy needs. Energy efficiency is generally considered to be a “clean” energy option that supports environmental conservation while retaining Utah's relative competitiveness in energy pricing, which is important for economic development.[41]

Energy efficiency and conservation are often used interchangeably but represent two different concepts. Efficiency is using more efficient technology to produce the same output, while conservation is behavioral, aiming to use less energy with the same technologies.

Building Energy Efficiency

Residential and commercial buildings account for 40% of the energy consumed in Utah.[42] On average, 30% of the energy used in commercial buildings is lost and buildings account for 38% of the nation's total greenhouse gas emissions.[43] Urban land area has quadrupled from 1945 to 2002, increasing at approximately twice the population rate over the same period.[44]

With advances in technology, reducing energy use through efficiency is possible. Cool roofs, insulated foundations, effective wall and roof insulation and insulating windows can all help improve a building's envelope. New solid-state lighting can reduce lighting electricity consumption by half, avoiding 1,800 million metric tons of carbon emissions and saving the country $250 billion.[45] Advances in HVAC technologies can greatly reduce energy consumption and lower energy bills.

Understanding energy use helps owners manage their buildings more efficiently. Sensors and controls can automate building energy use by measuring and responding to changes in building use and time of day. There are a number of cost-effective opportunities for efficiency gains in heating and cooling systems, which account for approximately 40% of a building's energy use.

Barriers to efficient energy use include education, financing and building codes. Utah's demand side management (DSM) programs, managed by the State's utilities, offer a wide range of options for consumers to invest in efficient technologies and reduce energy consumption.

Alternative Fuels and Transportation

The transportation sector offers opportunities for efficiency and energy portfolio diversification. Utah's energy resources can be optimized to improve the environment by diversifying fuel use and transportation options.

With the recent natural gas boom, Compressed Natural Gas (CNG) has become a viable alternative to traditional gasoline for vehicle fuel. With one CNG station for every 32,232 people, Utah has the most CNG stations per capita in the nation. Other options for alternative fuels include electric vehicles, LNG, or Tier 3 gasoline to power vehicles.

The State is committed to diversifying its transportation fuel portfolio and participates in multiple initiatives. In 2012, Governor Herbert signed an Executive Order prohibiting state fleet vehicles from idling.[46] The Governor also signed a Memorandum of Understanding along with other states in 2011 encouraging automobile makers to produce more natural gas vehicles.

The Utah Department of Transportation (UDOT) has developed a set of strategies, called TravelWise, which encourages alternative transportation options for Utah residents. TravelWise strategies include: flexible work schedules; active transportation such as biking or walking; carpooling; taking public transit; and planning ahead to trip chain, as well as using the UDOT traffic app to access the latest traffic updates.

The GREENbike bike share program is an active transportation option in Salt Lake City. This program allows individuals to use bikes for short trips around downtown Salt Lake City.

Industrial Energy Efficiency

Energy-intensive industrial processes include heating, cooling, assembly, processing, pumping and lighting. Each industrial company is unique, so opportunities are abundant for energy savings through the use of efficient technologies.

Combined heat and power (CHP), also known as cogeneration, is the simultaneous production of electricity and heat from a single fuel source.[47] Waste heat is recovered and used for heaters and boilers, or used to turn water into steam to create additional electricity. These systems can achieve more efficiency, realize cost savings, and reduce emissions.

Energy management plans can provide companies with reasonable goals to achieve improvements in energy use. Financial barriers to industrial efficiencies may include access to capital, funding for training, or other overhead costs. Overcoming barriers requires a combination of directed incentives and education.

Agriculture Energy Efficiency

Agriculture is a leading industry in Utah and is interconnected with many other sectors in the economy. It is also "one of the most energy intensive sectors in the economy, relying on direct sources of energy, such as fuels or electricity that power farm activities, and indirect energy sources, including fertilizers or other agricultural chemicals."[48]

Similar to the industrial sector, agriculture has numerous opportunities to reduce energy use and each operation is unique compared to other operations. Some farms can utilize animal power, such as oxen, mules, or draft horses instead of tractors to reduce fuel costs. Other farms can use smart technologies on farm equipment to reduce running times and enhance fuel consumption.

Micro-hydro power generation systems can be installed in canals, cutting electricity costs. Monitoring crop water consumption and new technologies for irrigation systems can optimize water use. With small profit margins, upfront capital can be difficult to obtain; however, incentives and tax credits can help.

Transmission of Energy

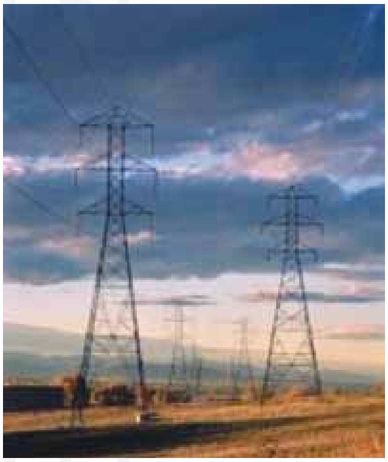
Utah plays a vital role in delivering natural resources from production to end users throughout the state and neighboring region. Utah generates, refines and processes resources, and deliver the energy through wires, pipelines, trucks, and rail.

Coal, crude oil, natural gas and other resource are delivered for use throughout the state, region, and Canada via a vast network of energy transportation systems. With an increasing population in Utah and an aging infrastructure, there is a need to invest in delivery systems to sustain reliable, affordable energy.

Need exists across the state, including in rural areas where electrical transmission constraints occasionally limit energy development options. Additionally, infrastructure availability is a significant concern for developers of generation facilities, new oil and gas, agriculture, mining and other natural resource development activities in a variety of locations within the state.

Transmission Lines

The importance of transmission lines to effective and reliable energy delivery often goes unnoticed. These systems comprise an essential part of the "grid" that connects the multitude of dislocated electric generation systems to the point of use. The electric grid includes power plants, transformers, substations, transmission lines, distribution lines and other components to deliver reliable, affordable power.



The U.S. electric grid is split between three different interconnections. Utah is part of the Western Interconnection which is governed by the Western Electricity Coordinating Council (WECC). As power is not stored on the grid, transmission lines constantly carry a current so that power can be continuously provided to consumers.

Transmission lines are sets of, "conductors, insulators, supporting structures, and associated equipment used to move large quantities of power at high voltage, usually over long distances between a generating or receiving point and major substations or delivery points."[49]

Technologies are being explored that could enhance the performance of the power grid. These include micro-grids to cut transmission distances, updating infrastructure to the digital age, and deploying energy storage technologies that will help allow for the expanded use of renewable energy generation.

Transmission Lines: How they work

Electricity is the flow of electrons. Power plants produce oscillating power called alternating current (AC), which has a periodic change of direction in the current. Direct current (DC), in contrast, is a steady stream of electrons that flow in the same direction, flowing from the negative side to the positive.

Using AC has some advantages as opposed to using DC for power distribution. Electrical generators generate AC power. Converting AC to DC adds a step and converting back to AC is expensive versus converting from AC to DC. Transformers also only work with AC.

Transformers are the key to the electric grid. In transporting electricity, large voltages are desired so the electrical current can be low. Otherwise, larger wires are needed to carry a large current, which also increases energy loss through heat. Transformers are housed in substations to step up voltage to the transmission lines and step down voltage to distribution lines. This allows the current to change as power plants and consumers need higher current, not high voltage.

Transmission lines are like the highway system; they carry large voltages hundreds of miles over a wide range of landscapes. Rocky Mountain Power, which serves approximately 80% of Utahns with electrical power, carries 345 kV, 138 kV and 46 kV in their transmission lines to distribution substations.

Natural Gas Pipelines

Natural gas pipeline systems are like the human circulatory system with a few veins and thousands of miles of capillaries. Utah has 3,123 miles of gas transmission lines and 16,746 miles of distribution pipelines.[51]

The Questar Pipeline Company transports natural gas from production areas to major pipeline systems including the Questar Gas local distribution system serving natural gas utility customers in Utah.[52]

Utah also has interstate pipelines crossing the state, serving customers further west. The Kern River Gas Transmission Company transmits gas from Wyoming to Nevada and California with 740 miles of pipeline crossing from northeast to southwest Utah.

The Ruby Pipeline owned by Kinder Morgan transmits natural gas across northern Utah from Wyoming to end users in Nevada, Oregon and California. Kinder Morgan also owns the Altamont Gathering in the Uinta Basin which consists of over 500 miles of low pressure gas gathering pipelines.[53]

Natural Gas Pipelines: How they work

Natural gas pipeline systems follow the simple principle of moving from high to low pressure. Compressor stations keep pressure up as the gas travels large distances through transmission lines. Distribution lines then deliver the gas to individual customers.

At the production area, natural gas is manufactured through producing wells and delivered to a processing and treatment plant (to remove impurities such as water or non-methane hydrocarbons) through gathering lines.

Several methods are used to extract natural gas from the ground. Sometimes natural gas is mixed with oil and freely flows up wells from pressure built up underground. Most of these wells are gone in the United States so other methods are being employed to extract natural gas.

Hydraulic fracturing or "fracking" pumps liquid underground to fracture rocks containing natural gas. This liquid usually contains sand or ceramic beads to prop rocks open allowing natural gas and oil to flow for extraction.

Crude Oil Pipelines

In the 1850s, crude oil was first refined for burning oil and heating. Transporting crude oil in its early history included putting the precious resource into whiskey barrels and hauling them to trains via wagons. As oil production and consumption increased, a vast network of pipes and refineries were established and continue to crisscross and dot our nation. In Utah there are 489 miles of crude oil pipeline and 716 miles of refined and/or petroleum product pipeline.[54]

While Utah is an overall net exporter of energy, it imports approximately 40%

of the crude oil consumed in the state, although the imported fraction was almost 75% a few years ago. Imports come principally from Canada, along with Wyoming and Colorado. Crude oil production in the state comes mostly from eastern Utah with 75% from Duchesne and Uintah counties.

Utah serves as a link to the oil industry in the west with 5 refineries in the Salt Lake City area. Several intrastate and interstate pipelines carry crude oil and petroleum products. The 425 mile UNEV pipeline, owned by Holly Energy Partners, carries gasoline and diesel from Salt Lake City to Las Vegas with a terminal near Cedar City, Utah.[55]

Tesoro's Salt Lake City refinery, the largest in Utah with a capacity of 58,000 barrels per day, processes crude oil from Utah, Colorado and Wyoming. Manufactured products include gasoline, diesel fuel, jet fuel, heavy fuel oils and liquefied petroleum gas, which are distributed to markets in Utah and surrounding states including supplying the Salt Lake City International Airport.[56]

Crude Oil Pipelines: How they work

Oil is transported mainly from pipes, similar to the natural gas network. Most pipelines are buried below ground but some are above ground depending on the terrain and environment. Pumps or compressor stations move the oil through the pipe.

After refining, oil products are either delivered to distribution centers or piped directly to their end use destination, such as a manufacturing plant. Oil trucks pick up the oil from distribution centers to deliver to their respective destinations such as gas stations.

Uinta Basin oil contains large amounts of paraffin, in the form of both yellow and black wax crude, which congeals at room temperature. Currently, the oil is transported to Salt Lake City by trucks. Building a heated pipeline or refining in the basin provides alternative solutions to this unique problem.

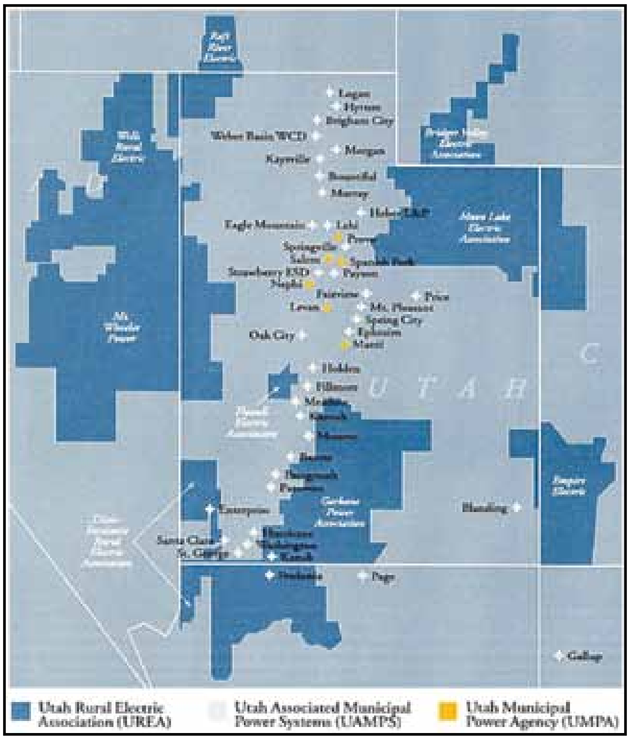
With new areas of oil production, getting oil to refineries is difficult through the pipeline network as it takes time to build the infrastructure. Railroads offer a way to transport the oil to refineries until a pipeline can be built. In 2013 about 11% of the U.S. total, approximately 784,000 barrels of oil per day, was moved by rail.[57]

Energy Providers in Utah

Rocky Mountain Power

Before the company's name was changed in 2006, Rocky Mountain Power served customers in Utah and Idaho as Utah Power.

Utah Power dates back to 1881, when Salt Lake City became the fifth city in the world to have central station electricity. Known then as Utah Power & Light (UP&L), the company itself was formed in 1912 from several small electric companies in Utah, Idaho and western Colorado. In organizing dozens of small power companies, serving 130 small cities and towns, the new company supplied about 39,700 customers in 1912. In just 10 years, UP&L grew to serve 205 communities and 83,000 customers.



PacifiCorp is one of the West's leading utilities, serving approximately 1.8 million customers in six western states. PacifiCorp was formed in 1984, when its electric utility, natural resource development and telecommunications businesses grew into full-fledged enterprises. In 1989, it merged with UP&L, and continued doing business as Pacific Power and Utah Power. The company was acquired by MidAmerican Energy Holdings Company, now Berkshire Hathaway Energy, in 2006.

Today, PacifiCorp consists of three business units, aggregating up to PacifiCorp: PacifiCorp Energy, containing the electric generation, commercial and energy trading functions, and the coal-mining operations of the company, is headquartered in Salt Lake City, Utah; Pacific Power; and Rocky Mountain Power, which delivers electricity to customers in Utah, Wyoming and Idaho, is headquartered in Salt Lake City, Utah."

Questar

Questar Corporation's origins date to the 1922 discovery of natural gas in southwestern Wyoming by a predecessor exploration and production company.

The company built a pipeline, completed in 1929, to transplant natural gas from Wyoming to Utah. In 1935 various holdings were consolidated under the name Mountain Fuel Supply Company. In the 1980s, the company restructured and was renamed as "Questar."

"Today, Questar is a natural gas-focused energy company with three lines of business – retail gas distribution; interstate gas transportation and storage; and gas development and production."[59]

"Questar Gas provides retail natural gas-distribution service to almost 900,000 customers in Utah, southwestern Wyoming and a small portion of southeastern Idaho. A Questar Gas predecessor began serving customers in 1929. In the decades since, there has never been a major natural gas service interruption."[60]

"Questar Pipeline Company is an interstate natural gas pipeline company that provides transportation and underground storage services in Utah, Wyoming and Colorado. Questar Pipeline owns and operates more than 2,500 miles of pipeline with total daily capacity of 2,530 Mdth."[61]

"Wexpro, Questar's one-of-a kind exploration and production company, develops and produces gas reserves on behalf of our utility, Questar Gas, and delivers natural gas at its cost of service under the terms of a comprehensive agreement, The Wexpro Agreement."[62]

Utah Associated Municipal Power Systems ("UAMPS")

"UAMPS was established in 1980 under the Utah Interlocal Cooperation Act, and is a political subdivision of the State of Utah. Its 45 members (the 'Members') include public power utilities in eight states: Utah, Arizona, California, Idaho, Nevada, New Mexico, Oregon and Wyoming. Each of the Members has entered into the UAMPS Agreement for Joint and Cooperative Action, which provides for the organization and operation of UAMPS.

UAMPS' purposes include the planning, financing, development, acquisition, construction, operation and maintenance of various projects for the generation, supply, transmission and management of electric energy for the benefit of its Members.

UAMPS is a project-based organization and presently operates 16 separate projects that provide a variety of power supply, transmission and other services to the Members that participate in them. The Members make their own elections to participate in UAMPS' projects and are not obligated to participate in any particular project. In general, UAMPS and its Members that elect to participate in a project enter into a contract that specifies the services of product to be provided by UAMPS from the projects, the payments to be made by the participating Members in respect of the costs of the project and other matters relating to the project."[63]

Utah Municipal Power Agency ("UMPA")

"UMPA is a consumer owned corporation, established in 1980 with a mission to: 'develop a reliable and economic power supply program to meet all the required electric power and energy needs of its member municipalities". UMPA's members consist of the Utah municipalities of: Levan, Manti, Nephi, Provo, Salem and Spanish Fork.

UMPA is a Joint Action Agency whose services include: power supply and control area support, scheduling, joint financing, energy load forecasting, wheeling arrangements, load research, limited political action, demand-side management, engineering, legal assistance and Federal Energy Regulatory Commission (FERC) case support.

The Agency is governed by a six member Board of Directors, consisting of the Mayors or Council Members, of each of the member cities. In addition, a Technical Board with an appointee from each of the member cities, usually the city energy director, provide technical studies, recommendations and detailed analysis to assist the Board of Directors.

Objectives:

- To develop a reliable and economic power supply program to meet the electric power and energy needs as required by the members and their customers.
- To provide the benefits of economies of scale through joint endeavors relating to generation, transmission and distribution of electric power and energy.
- To involve each member in the planning, operating and developing stages undertaken by the Agency."

Other Power Providers

Utah customers are served by the following rural electric cooperatives: Bridger Valley Electric Association, Inc.; Deseret G&T Cooperative; Dixie Escalante Rural Electric Association; Empire Electric Association, Inc.; Flowell Electric Association, Inc.; Garkane Energy; Moon Lake Electric Association; Mt. Wheeler Power, Inc.; Raft River REC, Inc.; South Utah Valley Electric Service District; and Wells Rural Electric Cooperative.

The Governor's Office of Energy Development

The Governor's Office of Energy Development (OED) is the only entity in the state focused exclusively on advancing the responsible development of Utah's energy resources. Statutorily the role of the Governor's Office of Energy Development is to implement the state energy policy (63M-4-301). This is in large part accomplished through the execution of the Utah's 10-Year Strategic Energy plan.

OED's Activities

OED is involved in identifying challenges and proposing solutions, from streamlining regulation to policy, planning and implementation. OED partners with key stakeholders to plan for coordinated and responsible growth, whether through incentive programs, land swaps, or other innovative solutions. Additionally, OED provides outreach and education through a number of venues, including the Governor's Energy Development Summit. OED also provides economic analyses on the impacts of endangered species listings and of newly proposed environmental rules and regulations such as EPA's new carbon emissions reduction plan.

Overall, OED advances Utah's energy goals by convening diverse stakeholders to coordinate shared development and conservation goals, engaging in active energy planning, promoting and implementing policy measures, and the administering of post-performance tax credits and other development incentives.

OED is led by Dr. Laura Nelson, and the office works closely with Cody Stewart, Energy Advisor and Policy Director to Governor Gary R. Herbert.

The Governor's Energy Development Summit

The Governor's Office of Energy Development annually hosts the Governor's Energy Development Summit, which has become the largest event of its kind in the West in just three years. In 2014 more than 1,200 energy stakeholders and 380 organizations participated in the event, which featured 16 break-out sessions and more than 85 expert speakers from around the world. Each year the Summit provides networking and messaging opportunities for business, educational opportunities for non-profits and the public, and a productive policy dialogue for state legislators and others. Overall, the Summit is instrumental in identifying trends in the energy sector, informing stakeholders of the state's energy objectives and supporting the advancement of energy opportunities in Utah.

State Energy Program

The State Energy Program (SEP) has been with the state for decades, and supports optimizing the development of Utah's resources and retention of the state's competitive advantage in the energy sector. Through the SEP, OED provides trainings and seminars, offers tax credits to homeowners and business to support distributed generation, and helps partners secure grant funding to support related activities. The SEP assists OED to reach across the state—especially in Utah's rural communities—to improve energy access, encourage economic opportunities, and enhance the overall quality of life for Utah's citizens.

Incentive Programs

The Alternative Energy Development Incentive (AEDI) is a tax credit designed to advance the development of oil shale, oil sands, and large-scale alternative energy resources. The post-performance incentives are tied to the generation of new state revenue by projects meeting production thresholds calculated in terms of barrels per day, or nameplate capacity, depending on the resource type.

The Renewable Energy Systems Tax Credit (RESTC) includes both an investment tax credit for distributed generation projects, and a production tax credit for utility scale projects. The investment credit is a one time, non-refundable tax credit based on a percentage of the system's total eligible cost, and the production credit is a refundable credit based on the actual kilowatt hour generation for each of the project's first four years.

U-Save Energy Fund

The U-Save Energy Fund Program finances energy-related cost-reduction retrofits for publicly owned buildings including state, tribal, and municipal governments, as well as school districts, charter schools, and higher educational institutions. U-Save provides low-interest loans to assist those entities with the financing of various energy efficiency or distributed generation projects, providing a direct investment in the diversification of local energy portfolios.

Utah Energy Infrastructure Authority

The Infrastructure Authority was created in the 2012 General Session with the aim of helping facilitate energy delivery projects that help to advance responsible energy development in the state. To that end, the Authority Board may authorize tax-free bonds to support the development of any transmission line or pipeline that meets broad criteria related to responsible energy development and rural economic development.

2014 Utah Energy Efficiency and Conservation Plan

Recommendation #6 of the Plan states that "Utah should have a state-wide program aimed at reducing energy consumption." In August 2013, OED began the creation of the Energy Efficiency and Conservation Plan (EECP). The stakeholder-driven EECP addresses energy efficiency and conservation in the following five sectors:

- Residential and Commercial Buildings
- Alternative Transportation and Fuels
- Agriculture
- Industry
- Public Education and Outreach

These five sectors were represented by over 70 experts in their fields and, through their hard work and dedication, the EECP produced 26 total recommendations under the plan released in June 2014. In addition, a responsibility matrix was developed to identify organizations with potential for EECP leadership roles in order to facilitate implementation of the recommendations.

Energy Research Triangle

In order to address Recommendation 3 of the Governor's 10-Year Strategic Energy Plan, the Office of Energy Development has provided leadership and funding to develop the Utah Energy Research Triangle (ERT). The ERT is a research initiative that builds collaboration on energy research and development across three research institutions in Utah—the University of Utah, Brigham Young University, and Utah State University. The ERT is unique in its focus on advancing energy research projects aimed at addressing Utah-specific energy impediments or opportunities, and also in that it requires collaboration among Utah's premier institutions. In 2014 OED, in partnerships with the Utah Science Technology and Research (USTAR) initiative and Utah Cluster Acceleration program (UCAP), delivered Phase 1 of the ERT, providing six research grants across the three research institutions. The ERT's $445,000 in grants and stipends helped to establish 25 new research initiatives all aimed at advancing Utah's energy sector.

Again in partnership with USTAR, OED anticipates delivering Phase 2 of the ERT in 2015.

Utah's Energy Outlook

Utah's all-of-the-above energy policy encourages the expansion of all forms of energy production, including:

- Conventional energy resources such as coal, oil and natural gas;
- Unconventional resources, including oil shale and oil sands;
- Renewable resources such as wind, solar, and geothermal.
- Energy efficiency and conservation

The energy sector is poised for unprecedented and sustained growth and Utah is prepared to be a key leader in that growth, both nationally and internationally. Already Utah is an energy-exporting state, in 2013, Utah exported 31% of the BTUs it produced. As that percentage continues its upward trajectory, Utah and the nation will be ever more energy secure.

For more detailed information on the production profiles of Utah's energy resources, please refer to the Utah Geological Survey's "Utah's Energy Landscape" document, which OED partners to produce every two years. The document currently available online is the most recent version, published in the first quarter of 2014.

Additionally, OED has commenced the development of a new comprehensive study characterizing the direct and indirect benefits of Utah's energy sector to the state's economy. That report is expected to be finalized in time for distribution at the 2015 Governor's Energy Development Summit scheduled for May 21.

Glossary

Agriculture: An energy-consuming subsector of the industrial sector that consists of all facilities and equipment engaged in growing crops and raising animals.

Anaerobic decomposition: Decomposition in the absence of oxygen, as in an anaerobic lagoon or digester, which produces CO2 and CH4.

Alternative fuel: Alternative fuels, for transportation applications, include the following: methanol; denatured ethanol, and other alcohols; fuel mixtures containing 85% or more by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas (propane); hydrogen; coal-derived liquid fuels; fuels (other than alcohol) derived from biological materials (biofuels such as soy diesel fuel); and electricity (including electricity from solar energy).

Barrel: A unit of volume equal to 42 U.S. gallons.

Baseload: the minimum amount of electric power delivered or required over a given period of time at a steady rate.

Bitumen: A naturally occurring viscous mixture, mainly of hydrocarbons heavier than pentane, that may contain sulfur compounds and that, in its natural occurring viscous state, is not recoverable at a commercial rat through a well.

Biofuels: Liquid fuels and blending components produced from biomass feed-stocks, used primarily for transportation.

Carbon capture and sequestration: A process to mitigate CO2 emissions. It begins with capture of CO2 at its source, such as a coal fired power plant, transporting the CO2 to a location where it can be sequestered or stored safely away from the earth's atmosphere and oceans.[65]

Carbon dioxide (CO2): A colorless, odorless, non-poisonous gas that is a normal part of Earth's atmosphere. CO2 is a product of fossil-fuel combustion as well as other processes. It is considered a greenhouse gas as it traps heat (infrared energy) radiated by the Earth into the atmosphere and thereby contributes to the potential for global warming.

Carbon dioxide equivalent: The amount of carbon dioxide by weight emitted into the atmosphere that would produce the same estimated radiative forcing as a given weight of another radiatively active gas.

Carbon monoxide (CO): a colorless, odorless gas emitted from combustion processes. The majority of CO emissions to ambient air come from mobile sources. CO can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues.[66]

Catalytic cracking: The refining process of breaking down the larger, heavier, and more complex hydrocarbon molecules into simpler and lighter molecules.

Coal: A readily combustible black or brownish-black rock whose composition, including inherent moisture, consists of more than 50% by weight and more than 70% by volume of carbonaceous material. It is formed from plant remains that have been compacted, hardened, chemically altered, and metamorphosed by heat and pressure over geologic time. In the U.S., the standard ranks of coal include lignite (least carbonaceous), subbituminous coal, bituminous coal, and anthracite (most carbonaceous) and are based on the proximate analyses of various properties including fixed carbon, volatile matter, heating value and agglomerating (or caking) properties.

Coal gasification: The process of converting coal into gas. The basic process involves crushing coal to a powder, which is then heated in the presence of steam and oxygen to produce a gas. The gas, called "syngas," is then refined to reduce sulfur and other impurities. The gas can be used as a fuel or processed further and concentrated into chemical or liquid fuel.

Coal Washing: The treatment of coal to remove waste material such as: Dense (heavy) medium processes, floatation processes, hydraulic processes and pneumatic processes.

Coke (coal): A solid carbonaceous residue derived from low-ash, low-sulfur bituminous coal from which the volatile constituents are driven off by baking in an oven at temperatures as high as 2,000°F so that the fixed carbon and residual ash are fused together. Coke is used as a fuel and as a reducing agent in smelting iron ore in a blast furnace. Coke from coal is grey, hard, and porous and has a heating value of 24.8 million Btu per ton.

Commercial Sector: An energy-consuming sector that consists of service-providing facilities and equipment of businesses; Federal, State and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters and sewage treatment facilities.

Compressor station: Any combination of facilities that supply the energy to move gas in transmission or distribution lines or into storage by increasing the pressure.

Conservation: A reduction in energy consumption that corresponds with a reduction in service demand. Service demand can include buildings-sector end uses such as lighting, refrigeration, and heating; industrial processes; or vehicle transportation. Unlike energy efficiency, which is typically a technological measure, conservation is better associated with behavior. Examples include adjusting the thermostat to reduce the output of a heating unit or car-pooling.

Crude oil: A mixture of hydrocarbons that exists in liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities. Liquids produced at natural gas processing plants are excluded. Crude oil is refined to produce a wide array of petroleum products, including heating oils; gasoline, diesel and jet fuels; lubricants; asphalt; ethane, propane, and butane; and many other products used for their energy or chemical content.

Demand Side Management (DSM): A utility action that reduces or curtails end-use equipment or processes. DSM is often used in order to reduce customer load during peak demand and/or in times of supply constraint.

Distillate oil: A general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils.

Dry natural gas: natural gas which remains after: 1) the liquefiable hydrocarbon portion has been removed from the gas stream (i.e., gas after lease, field, and/or plant separation); and 2) any volumes of nonhydrocarbon gases have been removed where they occur in sufficient quantity to render the gas unmarketable. Note: Dry natural gas is also known as consumer-grade natural gas.

Electric hybrid vehicle: An electric vehicle that either (1) operates solely on electricity, but contains an internal combustion motor that generates additional electricity (series hybrid); or (2) contains an electric system and an internal combustion system and is capable of operating on either system (parallel hybrid)

Electric motor vehicle: A motor vehicle powered by an electric motor that draws current from rechargeable storage batteries, fuel cells, photovoltaic arrays, or other sources of electric current.

Electric power grid: A system of synchronized power providers and consumers connected by transmission and distribution lines and operated by one or more control centers. In the continental United States, the electric power grid consists of three systems the Eastern Interconnect, the Western Interconnect, and the Texas Interconnect.

Electric power plant: A station containing prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or fission energy into electric energy.

Electric Utility: A corporation, person, agency, authority or other legal entity or instrumentality aligned with distribution facilities for delivery of electric energy for use primarily by the public. Included are investor-owned electric utilities, municipal and State utilities, Federal electric utilities, and rural electric cooperatives.

Electricity generation: The process of producing electric energy or the amount of electric energy produced by transforming other forms of energy, commonly expressed in kilowatt-hours (kWh) or megawatt hours (MWh).

Energy Efficiency: A ratio of service provided to energy input (e.g. lumens to watts in the case of light bulbs). Services provided can include buildings-sector end uses such as lighting, refrigeration, and heating; industrial processes; or vehicle transportation. Unlike conservation, which involves some reduction of service, energy efficiency provides energy reductions without sacrifice of service. May also refer to the use of technology to reduce the energy needed for a given purpose or service.

Energy Demand: The requirement for energy as an input to provide products and/or services.

Fossil Fuels: An energy source formed in the Earth's crust from decayed organic material. The common fossil fuels are petroleum, coal, and natural gas.

Generator: Coils of electric conductors, usually copper wire, tightly wound around a core and mounted to spin inside an array of large magnets. When the electric conductor moves through a magnetic field, the magnetic field interacts with the electrons in the conductor to induce a flow of electrons, creating an electrical current.[67]

Generator nameplate capacity (installed): The maximum rated output of a generator, prime mover, or other electric power production equipment under specific conditions designated by the manufacturer.

Global warming potential (GWP): An index used to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emission of 1 kg of a GHG to that from the emission of 1kg of CO2 over a fixed period of time, such as 100 years.

Greenhouse gases: Those gases, such as water vapor, CO2, nitrous oxide, methane, hydroflurocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride, that are transparent to solar (short-wave) radiation but opaque to long-wave (infrared) radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. The net effect is a trapping of absorbed radiation and a tendency to warm the planet's surface.

HVAC: an abbreviation for the heating, ventilation, and air-conditioning system; the system or systems that condition air in a building.

Hydrocarbon: An organic chemical compound of hydrogen and carbon in the gaseous, liquid or solid phase. The molecular structure of hydrocarbon compounds varies from the simplest (methane, a constituent of natural gas) to the very heavy and very complex.

Industrial Sector: An energy-consuming sector that consists of all facilities and equipment used for producing, processing, or assembling goods. The industrial sector encompasses the following types of activity manufacturing; agriculture, forestry, fishing and hunting; mining, including oil and gas extraction; and construction. Overall energy use in this sector is largely for process heat and cooling and powering machinery, with lesser amounts used for facility heating, air conditioning, and lighting. Fossil fuels are also used as raw material inputs to manufactured products.

Interconnection: Two or more electric systems having a common transmission line that permits a flow of energy between them. The physical connection of the electric power transmission facilities allows for the sale or exchange of energy.

Kerogen: the solid organic material found in some rocks, such as oil shale, that produces hydrocarbons similar to petroleum when heated.[68]

Metallurgical coal: Coking coal and pulverized coal consumed in making steel.

Methane (CH_4): A colorless, flammable, odorless hydrocarbon gas which is the major component of natural gas. It is also an important source of hydrogen in various industrial processes. Methane is a greenhouse gas.

Nitrogen Oxides (NO_x): Compounds of nitrogen and oxygen produced by the burning of fossil fuels.

Nonattainment: Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.[69]

Nuclear reactor: An apparatus in which a nuclear fission chain reaction can be initiated, controlled, and sustained at a specific rate. A reactor includes fuel (fissionable material), moderating material to control the rate of fission, a heavy-walled pressure vessel to house reactor components, shielding to protect personnel, a system to conduct heat away from the reactor, and instrumentation for monitoring and controlling the reactor's systems.

Off peak: Period of relatively low system demand. These periods often occur in daily, weekly, and seasonal patterns; these off-peak periods differ for each individual electric utility.

On peak: Periods of relatively high system demand. These periods often occur in daily, weekly, and seasonal patterns; these on-peak periods differ for each individual electric utility.

Peak Demand: The maximum load during a specified period of time; also called "peak load".

Petroleum: A broadly defined class of liquid hydrocarbon mixtures. Included are crude oil, lease condensate, unfinished oils, refined products obtained from the processing of crude oil, and natural gas plant liquids. Note: Volumes of finished petroleum products include non-hydrocarbon compounds, such as additives and detergents, after they have been blended into the products.

Pressurized Water Reactor: A nuclear reactor in which heat is transferred from the core to a heat exchanger via water kept under high pressure, so that high temperatures can be maintained in the primary system without boiling the water. Steam is generated in a secondary circuit.

Primary Energy: Energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy. For example, coal can be converted to synthetic gas, which can be converted to electricity; in this example, coal is primary energy, synthetic gas is secondary energy, and electricity is tertiary energy.

Primary Energy Production: Production of primary energy. The EIA includes the following in U.S. primary energy production: coal production, waste coal supplied, and coal refuse recovery; crude oil and lease condensate production; natural gas plant liquids production; dry natural gas excluding supplemental gaseous fuels production; nuclear electricity net generation; conventional hydroelectric net generation; geothermal electricity net generation, and geothermal heat pump energy and geothermal direct use energy; solar thermal and photovoltaic electricity net generation, and solar thermal direct use energy; wind electricity net generation; wood and wood-derived fuels consumption; biomass waste consumption; and biofuels feedstock.

Reserve: That portion of the demonstrated reserve base that is estimated to be recoverable at the time of determination.

Residential Sector: An energy-consuming sector that consists of living quarters for private households. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances.

Small modular reactor: are nuclear power plants that smaller in size (300 MWe or less) than current generation base load plants (1,000 MWe or higher). These smaller, compact designs are factory-fabricated reactors that can be transported by truck or rail to a nuclear power site. To date, none of the existing small modular reactor concepts have been designed, licensed or constructed.[70]

Solid state lighting: differs from other kind of lighting in that it's based on light-emitting diodes (LEDs) or organic LEDs (OLEDs) instead of filaments, plasma, or gasses.[71]

Substation: Facility equipment that switches, changes, or regulates electric voltage.

Sulfur: A yellowish nonmetallic element, sometimes known as "brimstone." It is present a various levels of concentration in many fossil fuels whose combustion releases sulfur compounds that are considered harmful to the environment. Coal is classified as being low-sulfur at concentrations of 1% or less or high-sulfur at concentrations greater than 1%.

Sulfur Dioxide (SO2): A toxic, irritating, colorless gas soluable in water, alcohol, and ether. Used as a chemical intermediate, in paper pulping and ore refining, and as a solvent.

Sulfur Oxides (SOx): Compounds containing sulfur and oxygen, such as sulfur dioxide (SO2) and sulfur trioxide (SO3).

Transportation Sector: An energy-consuming sector that consists of all vehicles whose primary purpose is transporting people and/or goods from one physical location to another. Included are automobiles; trucks; buses; motorcycles; trains, subways, and other rail vehicles; aircraft; and ships, barges, and other waterborne vehicles. Vehicles whose primary purpose is not transportation (e.g. construction cranes and bulldozers, farming vehicles, and warehouse tractors and forklifts) are classified in the sector of their primary use. Note: Various EIA programs differ in sectoral coverage.

Tier 3 program: The Tier 3 program is part of a comprehensive approach to reducing the impacts of motor vehicles on air quality and public health. The program considers the vehicle and its fuel as an integrated system, setting new vehicle emissions standards and lowering the sulfur content of gasoline beginning in 2017.[72]

Turbine: A machine for generating rotary mechanical power from the energy of a stream of fluid (such as water, steam, or hot gas). Turbines convert the kinetic energy of fluids to mechanic energy through the principles of impulse and reaction, or a mixture of the two.

Uranium (U): A heavy, naturally radioactive, metallic element (atomic number 92). Its two principally occurring isotopes are uranium-235 and uranium-238. Uranium-235 is indispensable to the nuclear industry because it is the only isotope existing in nature, to any appreciable extent, that is fissionable by thermal neutrons. Uranium-238 is also important because it absorbs neutrons to produce a radioactive isotope that subsequently decays to the isotope plutonium-239, which also is fissionable by thermal neutrons.

Volt: The volt is the International System of Units (SI) measure of electric potential or electromotive force. A potential of one volt appears across a resistance of one ohm when a current of one ampere flows through that resistance. Reduced to SI base units, 1V = 1kg × m2 / s3 × A (kilogram meter squared per second cubes per ampere).

Western Electricity Coordinating Council (WECC): is the regional entity responsible for coordinating and promoting Bulk Electric System reliability in the Western Interconnection. WECC is geographically the largest and most diverse of the eight Regional Entities that have Delegation Agreements with the North American Electric Reliability Corporation (NERC). WECC's service territory extends from Canada to Mexico. It includes the provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico, and all or portions of the 14 Western states between.[73]

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Page 26: Map of Consumer Owned Electric Utilities – Utah Department of Commerce Division of

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