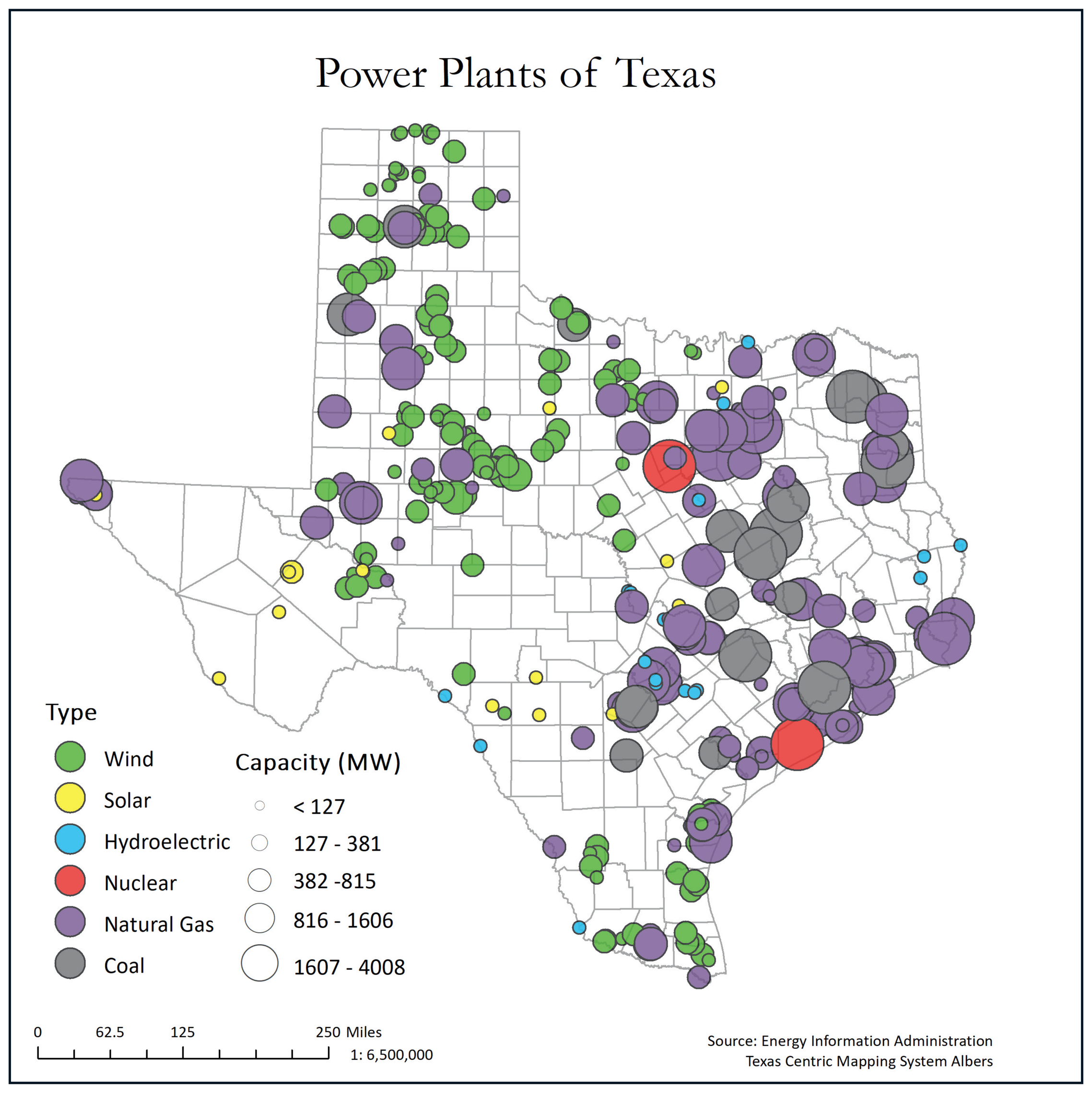
Electricity Production in Texas

Power Plants and Energy Resources

Introduction

The story of Texas is in many ways a story of energy. Since the industrial revolution, the rise of Texas politically and economically has paralleled the rise in energy production across the state. And this energy production has come to define much of the culture of Texas. Energy in Texas presents the very basics of a story that would take entire textbooks to complete.

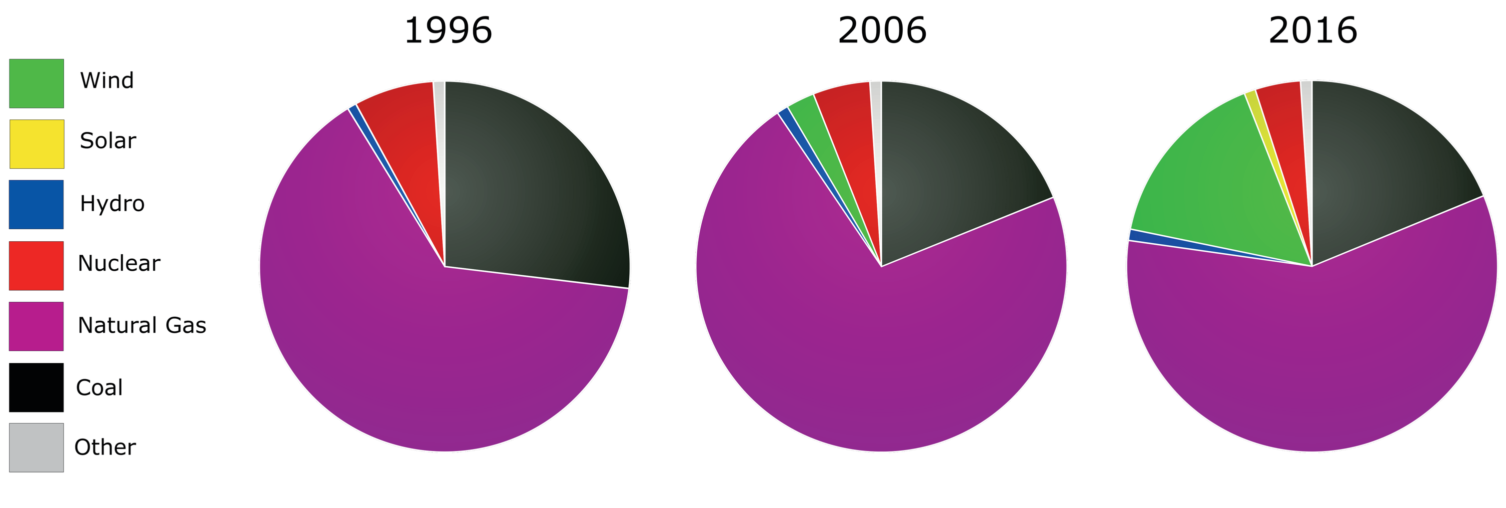


The growth of Texas economically and culturally cannot be described without knowing the story of energy in the state. Other than perhaps the expansion of the railroad, the discovery of oil from the Lucas No. 1 well in 1901 has shaped the state's history more than any other factor. The discovery of oil changed Texas from a primarily agricultural economy to a 20th century powerhouse of petroleum and industry (TSHA 2017). Though Texas may have reached peak oil production in the 1970's, the energy sector continues to thrive. Decline due to depletion of conventional resources was offset in the 1990's by the licensing of Texas' two nuclear power plants, the South Texas Project and Comanche Peak, which are two of the largest electricity generating facilities in the state (Prozzi et al. 2017). Since 2005, oil and gas production has increased due largely to enhanced recovery techniques in unconventional deposits such as the Barnett and Eagle Ford Shale (Prozzi et al. 2017). Between 2002 and 2011, wind energy increased twelve-fold and by 2013 accounted for 10% of energy production in Texas (Texas Renewable Energy). Finally, given the state's capacity for solar energy, many believe the coming decade could see a solar surge equal to that of wind. Enhanced extraction techniques coupled with a surge in renewables make it clear that Texas will remain an energy state for years to come.

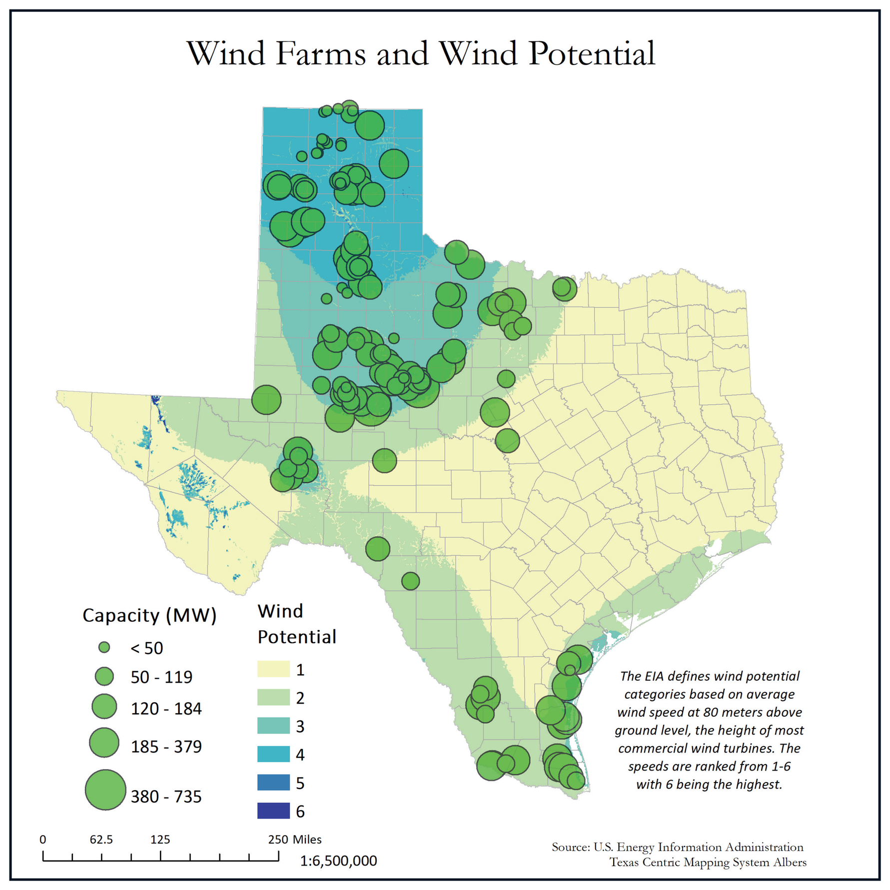
Texas' Changing Energy Profile

By Net Summer Capacity

Net summer capacity as defined by the U.S. Energy Information Administration: The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, as demonstrated by a multi-hour test, at the time of summer peak demand (period of June 1 through September 30.) This output reflects a reduction in capacity due to electricity use for station service or auxiliaries.

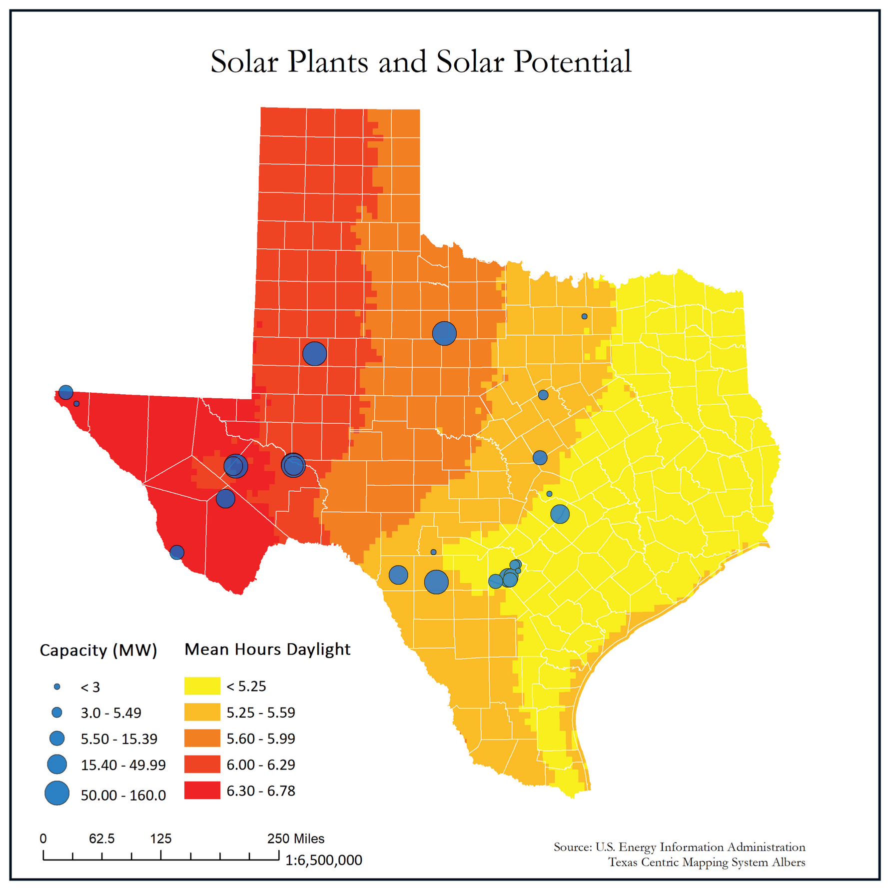


Renewables



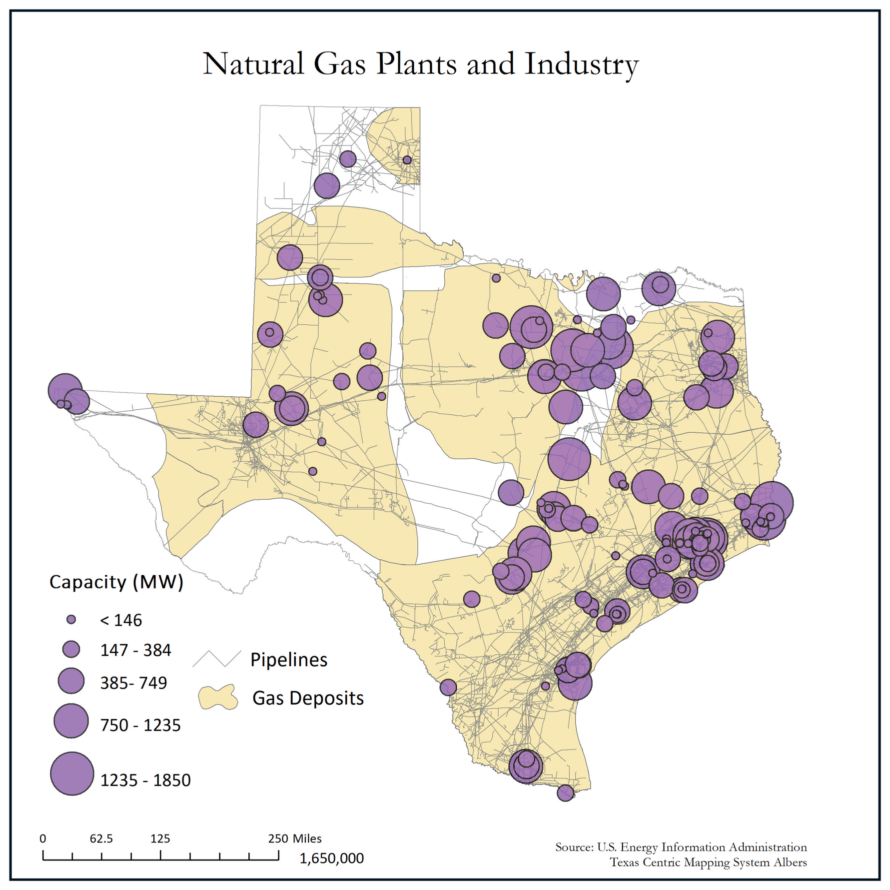
The rise of wind power in Texas from a non-player to the sixth largest producer of wind energy in the world is a story of resources and independence (Texas Renewable Energy, 2014). Texas has abundant wind-energy resources to draw upon and the Texas energy grid is isolated from the remainder of the US. This independence removes Texas from the regulations posed by the Federal Energy Regulatory Comission (FERC) which allowed the state to rapicly expand its wind energy infrastructure. These two factors, abundant resources and independence, have allowed wind power to rival coal in a state that has more installed coal generating capacity than any other state (US EIA, 2017). Furthermore, with planned decommissions of two major coal plants in 2018, wind will likely surpass coal in generating capacity by 2019 (Rhodes, 2017).

Wind power, like all other forms of power except nuclear, comes from the sun. The differential heating of the Earth's atmosphere by the sun drives wind patterns. The kinetic energy of the wind is captured by the blades of a wind turbine and converted into mechanical energy which is then converted in to electricity (Ristinen & Kraushaar, 2016). Wind has many advantages over non-renewables and even solar. Wind produces no emissions once installed, wind blows both day and night and is often strongest in the winter when electricity is most needed. Modern turbines can convert the kinetic wind energy into electricity at an efficiency of appx. 37%, which is higher than solar (Ristinen & Kraushaar, 2016). While wind farms do require large tracts of land, the majority of the land can still be used for crops or cattle. However, like solar, wind is too variable to be used as a baseload power plant.

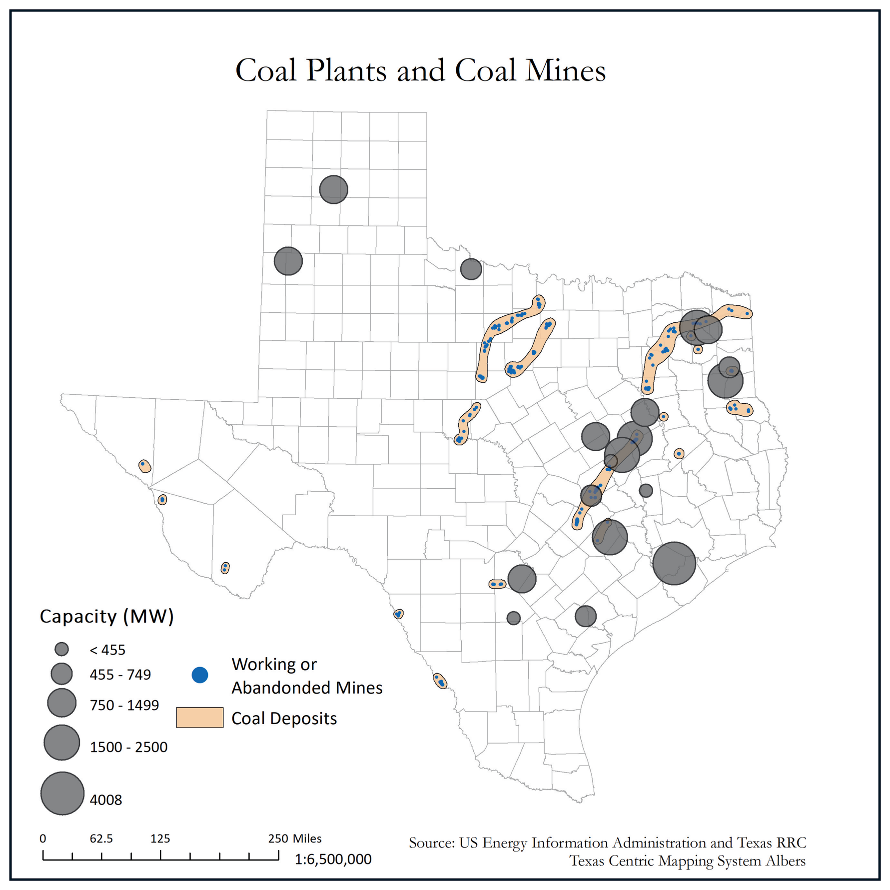


The sun is the ultimate energy source for nearly all types of energy generation, but photovoltaic (PV) solar is the only method to generate electricity directly from sunlight. The key to PV solar is the photoelectric effect. Certain semiconductor materials become electrically charged when light of sufficient frequency strikes them (Chaar 2011). When sunlight reaches solar panels, electrons in the semiconductor material flow from one end to other, creating an electric current. This phenomenon was discovered nearly 100 years ago but large scale solar plants were not considered economic because first generation solar cells had only a 17% efficiency. Today, lab experiments have reported up to 31% efficiency. This increase in efficiency along with reductions in manufacturing costs have made solar competitive in the energy market (Texas Renewable Energy 2014). Given the amount of solar radiation that Texas receives, the prospect of utility grade solar facilities has been of interest for decades. However, large scale solar has been slow to grow because the state's energy policy has favored fossil fuels (Bordie 2014). It wasn't until 1985, when the city of Austin started to experiment with utility grade solar facilities, that the state started to take advantage of its abundant solar energy (Bordie 2014). Although the state is reluctant to move away from fossil fuels, the future for solar in Texas looks promising. Texas receives some of the highest levels of solar radiation in the country and is ranked number one nationally in potential for solar industry growth by the Texas State Energy Conservation Office (Texas Renewable Energy 2014).

Non-Renewables

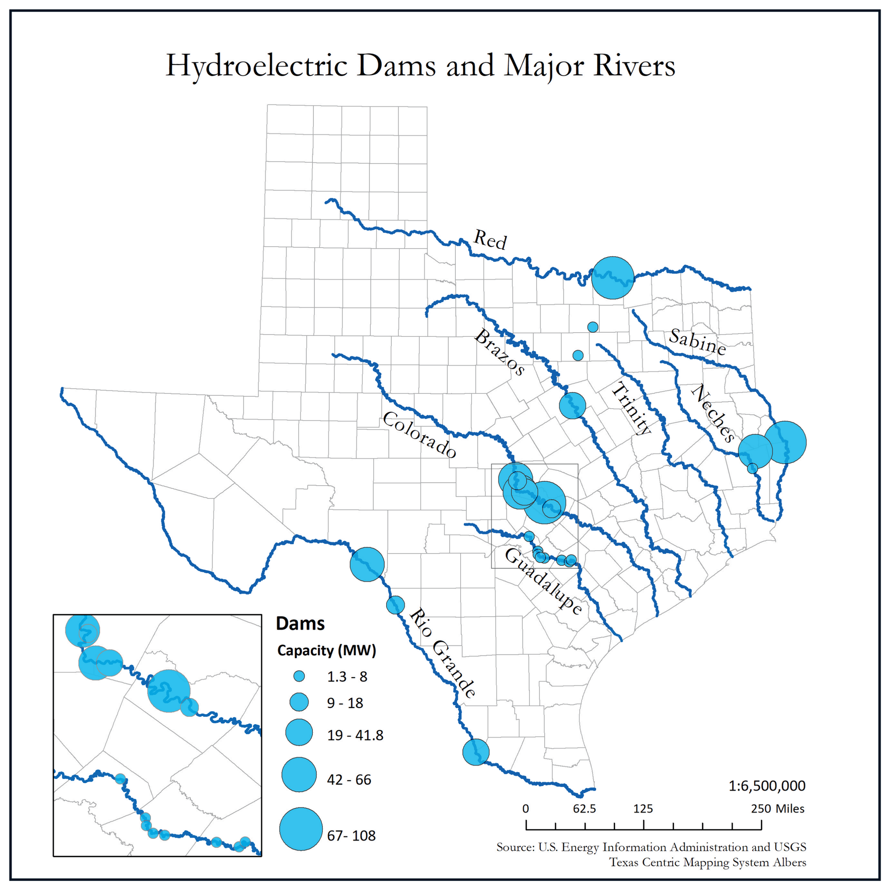


Natural gas is king in Texas. More electricity is generated from natural gas plants than any other source of energy, and this has been true for decades. Between 1990 and 2016, the total annual electricity generation in Texas jumped from 281,559,635 GW to 454,047,591 GW. In this time, production from natural gas kept pace, never dropping below 45% of total electricity production (EIA, 2017). In this same time period, coal fell from a max of 43% of electricity production in 1993 to only 26% in 2016. This shouldn't be surprising, Texas leads the nation in both natural gas reserves and extraction (EIA, 2017). The continued increase in natural gas extraction is due to evolving technologies such as directional drilling and especially hydrologic fracturing, or fracking. Fracking is the process of pumping a mixture of water and chemicals into subsurface rock at pressures high enough to fracture the rock and allow gas trapped in pockets to flow. This process is highly controversial and is linked to contamination of groundwater. In a state that depends heavily on subsurface aquifers for both municipal use and agriculture, fracking could become a major environmental problem. However, between natural gas and coal, gas may prove to be the lesser of two evils. Natural gas, which is primarily methane, burns much cleaner than coal and has a higher energy density (Reisner & Mott, 2017). If the price of natural gas continues to decrease, coal will likely see its market share continue to drop which will help bridge the gap between non-renewables and newer technologies like wind or solar.

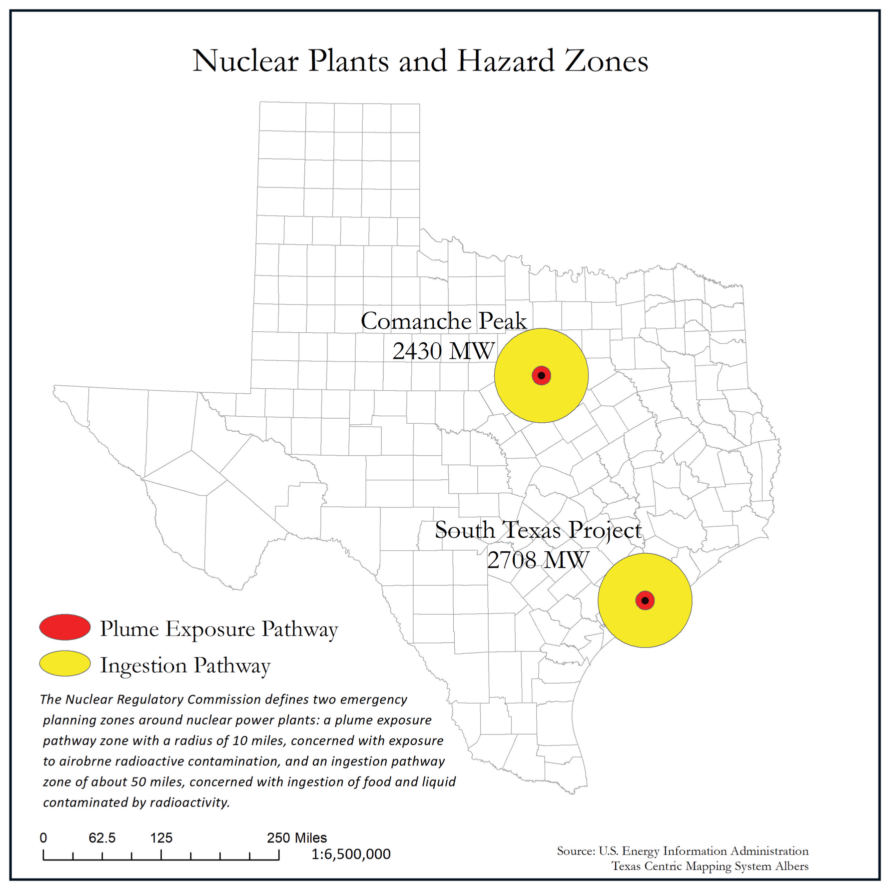


Historically, Texas was a coal state in both the production of the resource and the production of electricity from coal power plants (TSHA, 2017). The energy economy in Texas has shifted away from coal in recent years. The shift from coal is often thought to be a success of the ever-growing environmental movement, but this is not the complete picture. The pressure from the federal government under the Obama administration did play a role in the shift from coal, but the change was largely a business tactic (TSHA, 2017). Tax credits on wind energy from the federal government, coupled with the high wind potential in the state allowed for the rapid expansion of wind energy (Texas Renewable Energy, 2014). Similar circumstances are causing the current rise of solar energy in the state. The largest cause of the reduction in coal, however, came with advances in fracking technology which has allowed the state to become the largest producer of natural gas in the country (EIA, 2017). With two of the state's largest coal-fired power plants scheduled for decommission in 2018, the trend away from coal is likely to continue.

Special Cases



Hydroelectric dams have been a staple in the US for more than 100 years. Hydroelectric dams stored water and provided the electricity needed for the rapid growth of the western US. Excess power from dams like Grand Coulee and Bonneville in the Pacific Northwest fueled the aluminum smelters that gave the US a decided manufacturing advantage in WWII (Reisner & Mott, 2017). Hydropower is traditionally deemed a green renewable energy as hydroelectric dams are a non-consumptive use of water and do no produce emissions. Hydropower has been utilized in Texas since as early as 1822 but it wasn't till the 1890s that new innovations in the water turbine gave way to the first hydroelectric power plants. These remained small scale and privately owned until the 1940's. In 1946, twenty-six hydroelectric plants produced 15 percent of the state's total electric power. This rapid growth of water generated hydropower did not persist. By 1992, only 1 percent of the nearly 400 power generating stations in Texas were hydroelectric (EIA, 2017). Texas does not have an abundance of surface water and with frequent droughts, more water is being stored than is released for hydropower. Perhaps the largest problem with large dams is that the reservoir fills with silt over time. As reservoirs fill with sediment, the storage capacity decreases and eventually the dam and reservoir no longer serve as a useful site for water storage and electricity production. Once this occurs, the dam will become economically useless while still requiring maintenance to ensure safety and protection for downstream areas (Ristinen & Kraushaar 2016).



Heat for nuclear power plants is created by nuclear reactions involving atomic nuclei, the protons and neutrons that make up atoms. There are two basic types of nuclear reactions, fusion and fission. In fission reactions, heavy nuclei are split into free neutrons, smaller nuclei, and energy (Konya and Nagy 2018). The excess energy released is the energy used to create steam to drive a turbine. Nuclear energy was once hailed as the solution to the world's energy problems, and indeed it does have many benefits. But concerns over security and safety have stagnated the growth of the industry. Perhaps the largest benefit of nuclear energy is that it is emissions free, only water vapor is released into the atmosphere (Murray 2015). Furthermore, unlike wind and solar, nuclear power plants can act as baseload providers with high capacities and the ability to ramp up production quickly. Aside from fears of catastrophe or attack, the issue with nuclear power plants is the waste coolant water. Water surrounds the reaction chamber to cool the reactor (Konya and Nagy 2018). Eventually this water becomes too radioactive to use and must be changed. Originally, the plan was to transport the water to a permanent waste facility deep underground Yucca mountain in Utah. Opposition from the public and politicians in Utah halted the project and for now nuclear waste continues to sit onsite at nuclear power facilities. If fears could be overcome and security guaranteed, nuclear energy could provide emissions free baseload power for the future.

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See the webmap!

https://cramos95.github.io/EnergyAtlas/Energy_index.html

Map Projection: EPSG 3083, Texas Centric Albers Equal Area Conic
Map Data: US Energy Information Administration 2017 State Energy Profile; Layer Information for Interactive Maps
Works cited: https://cramos95.github.io/WorksCited.pdf