Energy Production, Transportation and Demand in the Transborder Region:

Opportunities and Impacts

Nineteenth Report of the
Good Neighbor Environmental Board
to the President and Congress of
the United States

GNEB
Environmental Advisors Across Borders

December 2019

About the Board

The Good Neighbor Environmental Board (GNEB or Board) was created in 1992 by the Enterprise for the Americas Initiative Act, Public Law 102-532. The purpose of the Board is to "advise the President and the Congress on the need for implementation of environmental and infrastructure projects (including projects that affect agriculture, rural development, and human nutrition) within the states of the United States contiguous to Mexico to improve the quality of life of persons residing on the United States side of the border."

The Board is charged with submitting an annual report to the U.S. President and Congress. Management responsibilities for the Board were delegated to the Administrator of the U.S. Environmental Protection Agency by Executive Order 12916 on May 13, 1994.

GNEB does not carry out border region activities of its own, nor does it have a budget to fund border projects. Rather, its unique role is to serve as a nonpartisan advisor to the U.S. President and Congress and recommend how the federal government can most effectively work with its many partners to improve conditions along the U.S.-Mexico border.

The Board operates under the provisions of the Federal Advisory Committee Act, and membership on the Board is extremely diverse. By statute, GNEB comprises representatives from:

(1) the U.S. government, including a representative from the U.S. Department of Agriculture and representatives from other appropriate agencies;

(2) the governments of the states of Arizona, California, New Mexico and Texas; and

(3) private organizations, including community development, academic, health, environmental and other nongovernmental entities with experience on environmental and infrastructure problems along the southwest border.

The Board also includes representatives from tribal governments with lands in the border region.

The recommendations in this report do not necessarily reflect the official positions of the federal departments and agencies that are represented on the Board, nor does the mention of trade names, commercial products or private companies constitute endorsement. Following historic precedent, the federal departments and agencies represented on the Board have recused themselves from this report.

This report uses the terms "resilience" and "resiliency" interchangeably, as the "term of art" differs among agencies.

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Transmittal Letter to the President and Congress From the Good Neighbor Environmental Board

President Donald J. Trump
Vice President Michael Pence
Speaker Nancy Pelosi

On behalf of your Good Neighbor Environmental Board, I am submitting to you our 19th Report, *Energy Production, Transportation and Demand in the Transborder Region: Opportunities and Impacts.* In this year's report, the Board addresses the dynamic energy sector in the U.S.-Mexico border region that is driven by increased energy production in the U.S. border states, growing energy trade across the border with Mexico and uncertainty regarding Mexico's energy policies under President Andrés Manuel López Obrador.

GNEB's report concludes that, although Mexico has announced policies to reduce energy imports and expand domestic production, it will continue to be a strong market for U.S. natural gas (including liquefied natural gas), refined petroleum products and energy-related technology. As energy trade with Mexico increases, new and expanded cross-border pipelines and electrical connections will be required, and shipments of petroleum products and liquefied natural gas by rail and by tank trucks on the region's highways will increase. Local border communities will need to be engaged early in the process of cross-border energy infrastructure expansion to reduce unnecessary delays for appropriate projects. The One Federal Decision program—designed to improve the timeliness, predictability and transparency of the federal environmental review and authorization process for covered infrastructure projects, including energy projects—will facilitate these important energy investments.

There is also opportunity for expansion of renewable energy in the border region. Investment in renewables is ideal for U.S. border communities that are rural and/or are underserved, including border tribes. Recapitalization of the North American Development Bank should be a priority to build on the bank's excellent record of lending for renewable energy projects in the border region.

GNEB developed recommendations that include research and incentives, regional sustainability planning, and binational collaboration as key principles that federal agencies and Congress should apply to direct federal resources toward building a sustainable new border energy economy.

Thank you for the opportunity to examine these issues and apply the Board's many years of collective experience in addressing border infrastructure matters. Our lives, communities, livelihoods and heritage are rooted along the border we share with Mexico, and we are committed to preserving and protecting them.

Sincerely,

Paul Ganster, Ph.D.
Chair, Good Neighbor Environmental Board
Institute for Regional Studies of the Californias
San Diego State University

Executive Summary

Overview

Energy in the U.S.-Mexico transborder region is the topic of the 19th Good Neighbor Environmental Board (GNEB) report to the U.S. President and Congress. This report begins with a review of the socioeconomic and environmental context of the U.S. border region, pointing out that it is the poorest region of the country and has much to gain from energy development. At the same time, the transborder region faces threats from the effects of energy infrastructure projects and transportation across the region and border.

The overview of the U.S. energy sector included in this report documents the remarkable expansion of production of natural gas and petroleum nationally and in the border region, as well as the rapid growth of renewable energy production in the border area, which likely will accelerate in the future.

Mexico's recent partial opening of the energy sector to foreign participation and more recent policy adjustments point to continued uncertainty in terms of investment policy. Mexico, however, clearly will continue to buy significant amounts of natural gas and petroleum products from the United States during the next decade.

This report reviews the legal and institutional framework for cross-border energy trade. It comments on the mix of bilateral agreements, federal rules and regulations, and different U.S. state regimes that constitute border energy governance. Each of the border states has a distinct mix of renewable and nonrenewable energy production and consumption. Texas is the largest source of gas and oil production in the nation with 38 percent of the total, and California (5%) and New Mexico (5%) also are important producers. Texas leads the United States in wind energy. California has significant installed capacity in solar and wind generation. Renewables are growing components of the energy portfolios of Arizona and New Mexico.

Mexico's six northern border states have an energy mix dominated by nonrenewable sources with slowly emerging renewable sectors. Coahuila has major coal reserves, and Tamaulipas is a major oil and gas producer. All of the Mexican border states have new investments in solar and/or wind energy projects, but renewables remain a small portion of Mexico's energy picture.

The report's section on the energy component of the United States-Mexico-Canada Agreement (USMCA) details the provisions that potentially affect the bilateral energy trade. Importantly, there are no duties for electricity, natural gas, oil, gasoline or diesel fuel.

GNEB developed recommendations that include research and incentives, regional sustainability planning, and binational collaboration as key principles that federal agencies and Congress should apply to direct federal resources toward building a sustainable new border energy economy.

Sections of the 19th Report

1. The Border Socioeconomic, Energy and Environmental Context

The U.S.-Mexico border region is different from other regions in the United States. These differences include rapid economic and population growth; rapid urbanization; shared transborder natural resources such as biota, rivers, groundwater and airsheds; economic, cultural and political differences and asymmetries with Mexican communities across the border; burgeoning international commerce and trade flows; high rates of poverty; and diverse ethnic identities. Overall, the Southwest border is significantly poorer and more urbanized than the rest of the United States. The U.S.-Mexico border region has a hot, dry climate. Changing climate is projected to cause increasing temperatures, decrease total precipitation, decrease streamflow, produce more extreme weather events, cause more frequent and intense wildfires, and drive sea-level rise and more intense storm surges in this region. These changes are expected to affect not only the natural environment, but also the economy and other human systems, including the energy sector. The existing energy infrastructure was designed to perform well under certain historical conditions and may no longer be able to cope with the expected changes in temperature, precipitation, wildfires, hurricanes and sea-level rise.

The demand for energy within the U.S.-Mexico border region likely will grow substantially in the future, driven by population growth, economic development, and greater demand for cooling and for moving and treating water because of historically increasing average ambient temperatures. The areas of natural gas, crude oil and renewables represent a significant potential for energy development in the U.S.-Mexico border region. There is substantial potential for growth in cross-border energy trade as the result of high natural gas production in the United States and high demand for that gas in Mexico. Constitutional and regulatory changes in Mexico affecting the energy sector also are likely to foster increased energy trade. Potential for increased development of renewables in Mexico and increased electricity export to the United States also exists. These developments present opportunities for trade and investment and improving energy security and quality of life. They also present significant challenges for border communities as a result of inadequate transportation and border crossing infrastructure and the potential environmental and other impacts of energy-related projects.

2. Overview of the U.S. Energy Sector

The United States derives most of its energy from oil, natural gas, nuclear fuel and coal, although renewables such as solar energy and wind continue to increase in importance. Each of these energy sectors has substantial participation from private companies, with thousands of businesses involved. Recently, the United States has witnessed huge growth in oil and natural gas production through increased use of hydraulic fracturing and horizontal drilling. Most of the newly booming oil- and gas-producing areas that benefit from these new technologies are in Texas, North Dakota and Pennsylvania, with growth in New Mexico as well. The increase in oil production has reduced the United States' dependence on imports of petroleum, as net imports of petroleum (including both crude oil

and petroleum products) have declined substantially in recent years. With respect to natural gas, the increase in production and additions to gas reserves—now estimated at 80 years of reserves—have led to a re-orientation of the natural gas industry toward an export-oriented model. Taking into account the reduction in net imports of petroleum and the growing exports of natural gas, the U.S. Energy Information Administration projects that the United States will become a net energy exporter in 2020 for the first time since 1953.

The United States also has significant and growing quantities of renewable energy resources such as solar and wind. More than half of U.S. states now require a certain percentage of their electricity to come from renewable resources, and seven aim to have more than half of their electricity generated from renewable sources within the next few decades. California is planning to obtain 100 percent of its electricity from decarbonized sources by 2045. The demand for renewables in the U.S.-Mexico border region may lead to imports of renewable energy from adjacent regions in Mexico.

Energy regulators in the United States have placed great emphasis on energy efficiency (i.e., harnessing advancements in technology to use less energy to provide the same or higher level of energy service). Energy-efficiency policy is effectuated by a mix of federal, state and local governments. The effects of increased energy efficiency can be substantial. For example, between the establishment of initial appliance energy-efficiency standards in 1987 and the year 2030, the United States is expected to attain US$2 trillion in cumulative operating-cost savings.

3. Overview of the Mexican Energy Sector

The Mexican energy sector, prior to recent reforms, was directly managed and operated by the Mexican federal government, primarily through the Secretaría de Energía (Ministry of Energy); Petróleos Mexicanos (PEMEX), the Mexican national oil and gas company; and the Comisión Federal de Electricidad (Federal Electricity Commission, known as CFE), the Mexican national electricity company. The central role of the federal government in the energy sector was based on historical traditions of economic and political nationalism and rejection of foreign or private ownership of key resources such as minerals, petroleum or water and public services such as electricity.

PEMEX was the sole legal producer and supplier of oil, which was then the most important source of energy and foreign exchange for the country, with a limited supporting role for the private sector. The electricity sector in Mexico also developed as a state-owned monopoly. CFE was formed in 1934, and during the next several decades, CFE acquired privately owned regional concessions. The electricity sector was fully nationalized by 1960.

Inefficiencies in the Mexican energy sector led to reforms under President Enrique Peña Nieto (2012–2018) and a 2013 amendment to the constitution to permit a greater role for private parties in hydrocarbons and electricity. Legislation in 2014 that enabled constitutional changes was

far-reaching and effected a major overhaul of the Mexican energy sector.

Emerging policies of Mexico's current President, Andrés Manuel López Obrador (elected in 2018), left much of the energy reform intact, but auctions for oil and gas exploration and development as well as auctions for the purchase of renewable energy have been cancelled or delayed while amendments and changes to the original reforms are considered. In the meantime, the Mexican energy sector remains under the full control of the federal government, and President López Obrador's energy policy is focused on boosting the energy sector via government initiative, with the private sector taking a subsidiary role.

4. U.S.-Mexico Cross-Border Energy Relations: The Legal and Institutional Framework

Bilateral agreements and federal reviews form the backbone of the legal and institutional framework for cross-border energy exchange between the United States and Mexico. One instance in which the two countries have directly cooperated is the *Agreement Between the United States and Mexico Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico*, which facilitated production of transboundary oil and gas reservoirs is in the Gulf of Mexico beginning in 2014.

Although initially focused on water and wastewater for border communities, the North American Development Bank (NADB) has expanded its portfolio to include projects for renewable energy sources and for reducing energy consumption. NADB can facilitate small border energy projects for communities and tribal entities.

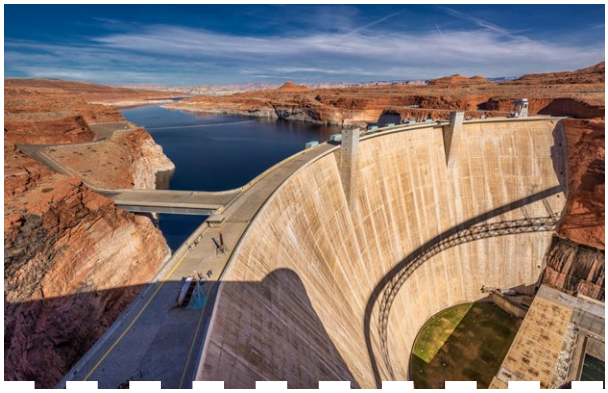
Generally, the construction, operation and maintenance of facilities that cross the U.S.-Mexico border must be authorized by the U.S. federal government through the issuance of a Presidential Permit in accordance with requirements set forth in a series of executive orders. The Presidential Permit process involves interagency coordination to ensure that physical interventions of the international border zone are in the national interest of the United States.

Under the North American Free Trade Agreement (NAFTA), there are no import duties on energy products such as oil, petroleum products (e.g., gasoline, diesel fuel), natural gas and electricity for trade between the United States and Mexico. This will remain the case under the yet-to-be-approved USMCA.

The North American Electric Reliability Corporation (NERC) is charged specifically with overseeing the bulk power system in the United States, and it has established a broader North American strategy in recognition of the increasingly international scope of the grid. As there is more integration between the U.S. and Mexican grids, it can be expected that NERC will take a greater role in Mexico's reliability strategy for its grid, and Mexico will take a greater role in NERC. In the case of California, the law permits renewable resources located in Mexico to satisfy California's renewables requirement.

5. U.S. Border Energy

Each of the four U.S. border states has a unique mix of renewable and nonrenewable sources of energy production, as well as energy distribution mechanisms with Mexican producers and users. The U.S.-Mexico border area features different types of energy production and transmission at an impressive scale. The states of California and Texas are enormous producers and consumers of fossil fuels and renewable energy that exert tremendous force on energy markets. Three U.S. border states are in the top five U.S. states in terms of oil and gas production: Texas, California and New Mexico. Texas produces the most wind power of any U.S. state and has a growing solar portfolio. California, which for some time has been in the forefront of adoption of renewable energy standards and policies, imports wind power and natural



gas–generated electricity from Baja California and power generated at Arizona's Palo Verde Nuclear Generating Station (3.3 gigawatts), which is the largest producer of electricity in the United States.

6. Mexican Border Energy

Mexico's six border states lead national production statistics in renewable energy, including wind, solar, geothermal and biomass. These states have a mix of renewable and nonrenewable sources of energy and are tied to the United States through northbound and southbound distribution systems, predominantly across the Texas-Mexico border.

Baja California has an abundance of renewable energy sources, of which wind and geothermal predominate, with solar, biomass and ocean-related sources playing a smaller role. Wind generation continues to grow with new projects developed by Sempra Energy (IEnova in Mexico) in the Sierra de Juárez mountain range and existing projects near the town of La Rumorosa. The state's electricity grid is not connected to the larger Mexican grid, but Baja California and California share two interconnection transmission lines. The state of Sonora relies on gas imported from the United States and oil from other Mexican states for most of its electrical supply, although it has some hydroelectric and solar power stations. Thirteen solar power projects currently are under construction. Chihuahua recently had four solar plants come online in 2018, and three more are under construction.

Coahuila is one of Mexico's most energy-abundant states, with large wind and solar potential and shale gas reserves. Coahuila has 95 percent of Mexico's coal reserves, and 13.7 million tons of coal are mined in Coahuila annually for steel and electricity production. Approximately 12 percent of Mexico's

national wind-power potential and 8 percent of its national solar energy potential come from Coahuila. Currently, 24 solar-energy projects and 10 wind-energy projects are authorized in Coahuila. The state of Nuevo León is a tremendous user of energy for its industrial sector. PEMEX operates a refinery for crude oil in Cadereyta, Nuevo Leon, which accounts for 16.2 percent of national production. The state of Tamaulipas is a major oil, gas and wind-energy producer, with several large-scale wind projects located in the state, including a project to produce 184 gigawatt hours of electricity per year that was certified by NADB in 2015.

7. The USMCA and Energy Trade and Investment in the Border Region

In 2018, the United States, Mexico and Canada signed a new trade agreement known as the USMCA, which is envisioned to replace NAFTA. To become effective, the USMCA must be ratified by the three parties. The USMCA has a number of provisions that potentially affect energy trade in the cross-border region. Importantly, there are no import duties for electricity, natural gas, oil, gasoline or diesel fuel for either the United States or Mexico. The USMCA provides for some reduction in investor protections as compared to NAFTA. If U.S. or Mexican investors in oil and gas or in electricity production, however, have claims against Mexico or the United States, respectively, there is less of a "cut-back" of investor protections than for investors in other business sectors.

Recommendations of the 19th Report

Below are the GNEB recommendations for federal agencies and Congress to help build a sustainable new border energy economy.

Research and Incentives

To enhance resilience and support economic development needs specific to the U.S.-Mexico border region, federal agencies and Congress should provide for research and program incentives that are informed by known research gaps and regional vulnerabilities.

1. Support research on energy topics on the U.S.-Mexico border, such as where energy needs are most acute, quantifying economic costs and benefits, and identifying opportunities. For example, the Texas border area is unique as compared to other parts of the state. Border-specific original research is lacking.
2. Support research especially related to *colonias* and tribal areas, which lack adequate energy-related infrastructure. The absence of recent research on *colonias* makes it a challenge to form policy solutions. For example, research support could be valuable to answer such questions as how effective microgrids could be to extend electricity to *colonias* or how to finance infrastructure.

3. Promote incentives and funding for transmission line and microgrid projects, in conjunction with regional energy sustainability plans (described below), that create resilient border communities by locating energy investments in the border region that benefit those communities.

4. Establish the U.S. Environmental Protection Agency (EPA) as the lead agency, in coordination with other federal agencies—including but not limited to the U.S. Department of Energy (DOE), U.S. Army Corps of Engineers, Bureau of Reclamation and the U.S. Section of the International Boundary Water Commission—to conduct research and develop new programs, policies and incentives to promote water conservation and reuse in energy production throughout the U.S.-Mexico border region, much of which is arid and drought-prone. EPA and other agencies should leverage partners and action items in the Water Reuse Action Plan, scheduled to be finalized and released in 2020. For more information on EPA's development of the Water Reuse Action Plan, see www.epa.gov/waterreuse/water-reuse-action-plan.

5. Support sustained and strategic research barriers to energy efficiency, particularly in existing buildings, in the U.S.-Mexico border region. Support incentives to promote efficient cooling and lighting technologies in areas and building types with the greatest potential for increasing energy efficiency.

Regional Sustainability Planning

To provide for a more resilient future energy supply for communities along the border, there must be federal leadership to promote policies and programs that support development and implementation of regional energy sustainability plans that liaise with Mexican communities.

6. Establish a regional energy sustainability planning process for federal agencies to collaborate and communicate with local, state and tribal governments to increase resiliency, provide for strategic economic development, and advance energy-efficiency projects that improve communities. Regional energy sustainability planning requires effective transborder communication and cooperation.

7. DOE should be the lead agency in multi-agency projects that evaluate existing frameworks for sustainable energy planning at the regional scale, adopt a framework after input from the public and the regulated community, and then integrate the planning framework into how energy production projects demonstrate eligibility for federal funding and how projects meet regulatory requirements for permits and other approvals.

8. Integrate the following into the new framework for development and implementation of regional energy sustainability plans:

   (a) Delineate border communities (U.S. and Mexico) and benefits/costs of energy development and trade and identify infrastructure planning that considers sensitive and rural populations along the border, including tribal communities, to aid in regional planning and the most efficient use of governmental assistance.

   (b) Actively coordinate with the Border 2020 Program managed by EPA and its Mexican counterpart agency when federal agencies (federal contractors) are developing and implementing policies that affect energy production and transportation along the U.S.-Mexico border, especially as they relate to energy. Actively leverage resources, projects and expertise toward

addressing vulnerable populations associated with environmental and public health challenges in the energy sector.

(c) Invest in and support the successor program to the U.S.-Mexico Border 2020 Program, which has proven valuable to California, Arizona, New Mexico, Texas and the six neighboring Mexico states. Congress, EPA and other executive branch agencies should encourage improvements to the program based on stakeholder input.

(d) Continue and expand support for the binational NADB, an important source of water and energy infrastructure investment and economic development along the U.S.-Mexico border. Grants and loans to border communities continue to be valuable to binational goals in water quality, air quality and protection of the shared border environment, which enhance the quality of life of border residents.

(e) Encourage rational provision of energy and energy-efficiency services for border communities. Locate energy projects in border communities, including tribal areas, when it makes economic and environmental sense.

(f) Require federal agencies to consider household energy vulnerability ("energy poverty") and low-income status for receipt of federal programmatic funding.

(g) Promote the use of NADB funds to support energy transmission and generation in areas with little existing infrastructure, especially rural communities and tribal areas.

Binational Collaboration

To provide for greater marketability and prosperity, projects must be binational, bi-state and broadcast on a national level.

9. Support export of petroleum products to Mexico and monitor Mexico's efforts to expand its own refining capacity.

10. Support export of natural gas to Mexico and support private sector efforts to complete cross-border pipelines that will support such exports. Evaluate the safety and effects on border communities resulting from increased exports of liquefied natural gas by rail and tank trucks on regional highways.

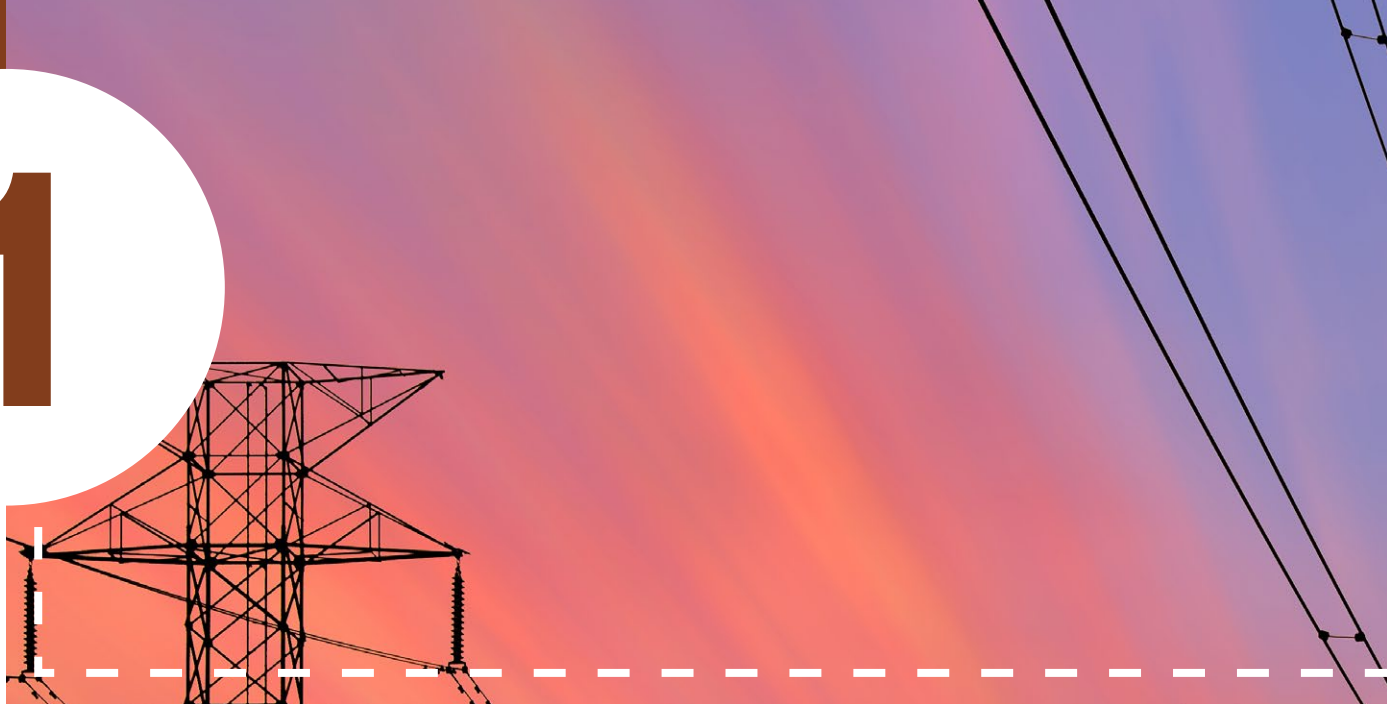
11. Foster the development of renewable energy, particularly solar and wind, in border states.

12. Actively support development of U.S. electricity-generation projects built for the purpose of making cross-border deliveries of electricity to Mexico.

13. Increase efforts by NERC to include Mexico within NERC and also increase NERC's efforts to incorporate cross-border flows to protect and improve the reliability of the bulk electrical system throughout North America.

14. Support binational projects that increase the reliability and efficiency of the shared grid.

15. Promote the promulgation of efficient cooling and lighting technology in the border region. Support binational projects that promote energy-efficient building standards compliance, data collection (monitoring, reporting and verification), demand-side management, and the introduction of reach codes for high-energy-use areas and buildings.



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The Border Socio-Economic and Environmental Context

The U.S.-Mexico border area is defined by the 1983 La Paz Agreement as the area stretching 100 kilometers (km) (62 miles) from either side of the international boundary, which is 1,954 miles (3,145 km) in length. For purposes of the North American Development Bank (NADB), the border zone is 100 km into the United States and extends 300 km (186 miles) into Mexico from the boundary. The border region also has been defined as the U.S. counties and Mexican municipalities contiguous with the international border because socioeconomic data are available for these administrative units. This enables data-based description and analysis of the region. At times, the border zone definition includes U.S. counties and Mexican municipalities that do not touch the border but are partly within the 100 km zone to the north and south of the boundary. Finally, Texas includes additional counties within its border zone. These different demarcations of the border region are illustrated in Figure 1.

The U.S. border region with Mexico is different from other regions in the United States. These differences include rapid economic and population growth; rapid urbanization; shared natural resources such as rivers, groundwater and airsheds; economic, cultural and political differences and asymmetries with Mexican communities across the border; burgeoning international commerce and trade flows; high rates

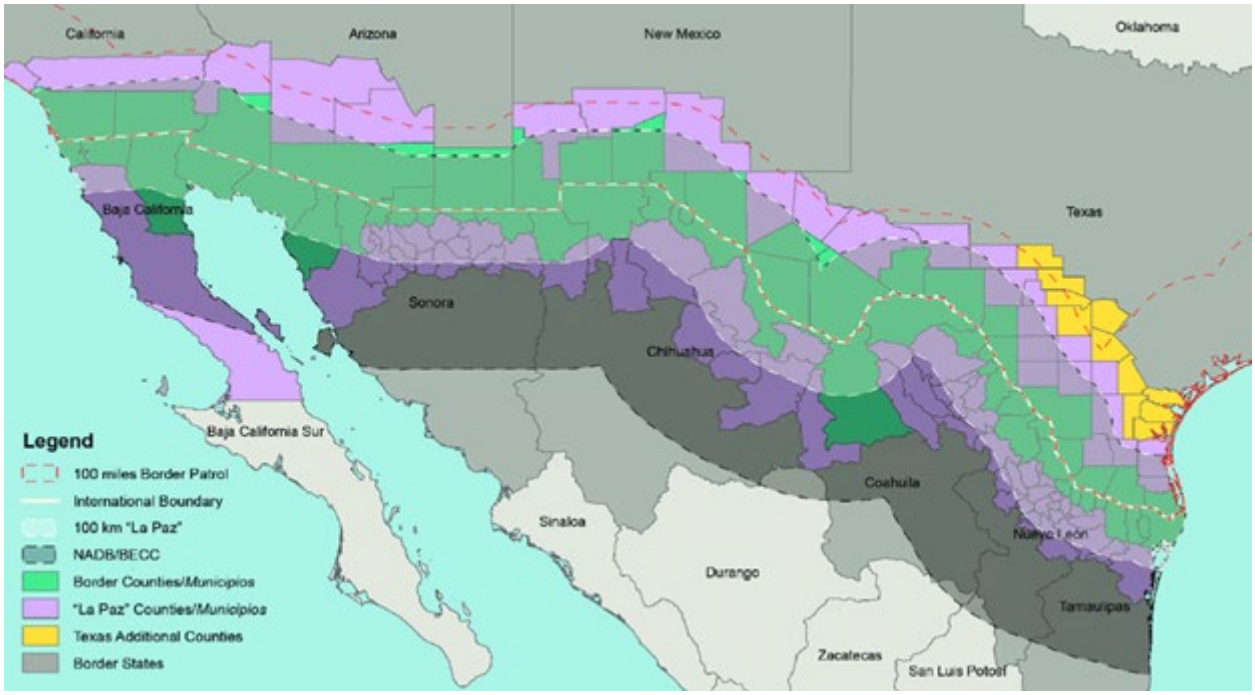


Figure 1. The U.S.-Mexican Border Region as defined by the La Paz Agreement, North American Development Bank and border counties and municipalities.
Source: Pamela Cruz, The Baker Institute (Payan and Cruz 2017).[1]

of poverty; and diverse ethnic identities. Overall, the Southwest border is poorer and more urbanized than the rest of the United States. These features present multiple challenges that other regions of the United States often do not have to overcome.[2]

Since the 1940s, the population of the 10 U.S. and Mexican border states has grown more rapidly than the national averages and, at the same time, the populations of the counties and municipalities along the border have grown faster than the states in which they are located. Driven by internal migration, the populations of Mexican municipalities typically have grown at twice the rate of their U.S. counterparts. By 2010, some 14.4 million people resided in U.S. border counties and Mexican border municipalities. By 2017, nearly 100 million individuals resided in the U.S. and Mexican border states (Table 1), and nearly 8 million residents inhabited the U.S. border counties (Table 2). By

Table 1. U.S. and Mexican Border States Population

U.S. BORDER STATES, 2017*	
State	**Population**
California	39,536,653
Arizona	7,016,270
New Mexico	2,088,070
Texas	28,304,596
Total	**76,945,589**
MEXICAN BORDER STATES†	
State	**Population**
Baja California	3,315,766
Sonora	2,850,330
Chihuahua	3,556,574
Nuevo León	5,119,504
Coahuila	2,954,915
Tamaulipas	3,441,698
Total	**21,238,787**
Total border states	**98,184,376.00**

* U.S. Census Bureau (2019c) 2017 estimate.

† Instituto Nacional de Estadística y Geografía (Mexico's National Institute of Statistics and Geography) 2015 estimate, cuentame.inegi.org.mx/monografias/default.aspx?tema=me.

2020, the border population is projected to reach 19.5 million. Most of the border's population resides in 15 paired U.S. and Mexican interdependent sister cities, including seven along the Texas border with four Mexican states (Ganster and Lorey 2016).

Of the 26 U.S. federally recognized Native American tribes in the border area, some have tribal members living in adjacent areas of Mexico and several occupy large reservations along the international boundary (EPA 2011). The Tohono O'odham tribal reservation is located in Arizona along about 65 miles (105 km) of the border with Mexico. Other tribes with strong cross-border connections to Mexico include the Yaqui, Kickapoo Traditional Tribe of Texas and Kumeyaay of California. Hispanics constitute the largest ethnic group in the border region, are the largest minority group in the United States, and are a majority of the population in 19 of the 24 counties along the international border with Mexico. In 2015, 82 percent of the population of the border counties was Hispanic, excluding San Diego (California) and Pima (Arizona) counties, where the percentages were 33.9 and 37.3 percent, respectively.

The 24 U.S. counties bordering Mexico (again excepting San Diego and Pima counties), if

Table 2. U.S. Border States and Counties Population, 2017

STATE & COUNTY	2017 ESTIMATE
California	**39,536,653**
San Diego	3,325,468
Imperial	181,574
Total CA counties	**3,507,042**
Arizona	**7,016,270**
Yuma	207,534
Pima	1,022,769
Santa Cruz	46,212
Cochise	124,756
Total AZ counties	**1,401,271**
New Mexico	**2,088,070**
Hidalgo	4,305
Luna	24,148
Dona Ana	216,186
Total NM counties	**244,639**
Texas*	**28,304,596**
Brewster	9,337
Brooks	7,235
Cameron	423,725
Crockett	3,564
Culberson	2,231
Dimmit	10,418
Duval	11,273
Edwards	1,953
El Paso	840,410
Frio	19,600
Hidalgo	860,661
Hudspeth	4,408
Jeff Davis	2,280
Jim Hogg	5,202
Kenedy	417
Kinney	3,745
La Salle	7,584
Maverick	58,216
McMullen	778
Pecos	15,634
Presidio	7,156
Real	3,429
Reeves	15,281
Starr	64,454
Sutton	3,767
Terrell	810
Uvalde	27,132
Val Verde	49,205
Webb	274,794
Willacy	21,584
Zapata	14,322
Zavala	11,948
Total TX counties	**2,782,553**
Total U.S. border county population	**7,935,505**

*Includes counties on the border or within 100 km (62 miles) of the border.

Source: U.S. Census Bureau. data.census.gov/cedsci.

considered a state, would rank 51st—or dead last among U.S. states—in poverty rate, percentage of persons under 65 without health insurance, percentage of high school or higher graduates, and per capita income. In some cases, the differences are staggering. For example, only 69.1 percent of residents of these counties older than age 25 are high school graduates compared to 84 percent for the United States overall (Soden 2006). All of these are indicators of poverty. Poverty and ethnicity coincide in the U.S.-Mexico border region, where the health effects of deteriorated environmental conditions also harm the population.

Because of rapid urban growth and scarce infrastructure funding, U.S. and Mexican border communities have chronic deficits of basic urban services, including potable water, sewage treatment and proper solid-waste disposal. In all states of the U.S. border region, principally in Texas and New Mexico, residential communities called *colonias* developed without standard infrastructure. *Colonias* are located in rural areas of counties and lack basic services such as water, sewage, electricity and often paved roads. The Texas Secretary of State found that in 2014 nearly 38,000 residents in the six largest border counties in Texas with colonias lacked potable water or sewer services.

Although the North American Free Trade Agreement (NAFTA), which began in 1994, produced a large increase in trade and investment, it did not create widely shared prosperity in U.S.-Mexico border communities. NAFTA stimulated international commerce and created many jobs along the border, but those jobs tended to be low-skill and low-paying, while U.S. border communities lost higher paying assembly and manufacturing jobs that moved into Mexico and elsewhere offshore. Trade growth brought increased vehicular crossings that saturated the border infrastructure and overwhelmed communities along the major trade corridors with increased air pollution, producing health as well as safety concerns (Quintana et al. 2015, Rincón 2003). Regions throughout the United States benefited from the growth of NAFTA-related trade and investment, but border communities absorbed a disproportionate share of the environmental costs related to congestion. Federally funded programs associated with NAFTA, such as the NADB and the U.S. Environmental Protection Agency's (EPA) border environmental program (in conjunction with Mexico's environmental agency), were established to address the many border environmental problems. Although significant strides were made to address border environmental issues, those programs have not been adequately supported in recent years.

Expanding trade and commerce, along with continued urban growth on both sides of the border and aging environmental and urban infrastructure, have produced an environmental crisis in many border communities. Sewerage infrastructure has exceeded its useful life in many of these communities, resulting in frequent spills of contaminated wastewater. Border law enforcement agencies in San Diego and elsewhere indicate this has produced dangerous working conditions for field personnel (Moreno Ducheny 2019, U.S. Customs and Border Protection 2017). Sewage flows into the ocean can cause unsafe water quality for recreation along beaches in San Diego and Tijuana, resulting in transboundary beach closures and economic impacts.

Air quality in the border region is affected by pollutants from a number of sources, most related to energy. Motor vehicles, electric-generating plants, industrial facilities, agricultural operations, mining, dust from unpaved roads and open burning all affect urban and regional air quality along the U.S.-Mexico border. The most common and harmful pollutants from these sources include suspended coarse and fine particulate matter and ground-level ozone (Quintana et al. 2015).

Although substantial improvements have been made, air quality still is a major concern throughout the border region. The pressures associated with industrial and population growth, differences in governance and regulatory frameworks across the border, and topographic and meteorological conditions combine to present a challenging context in which to address air quality management. Traffic congestion at ports of entry adversely affects air quality in the surrounding sister cities, especially in local communities close to the border crossings. In addition, some U.S. and many Mexican border cities, including Ciudad Juárez, lack a robust or sustainable air-quality monitoring program. Without basic air-quality data, effective policies cannot be implemented to resolve public health issues (EPA 2011).

1.1 Other Factors

A number of national parks in both countries—including Big Bend National Park in Texas, Organ Pipe Cactus National Park in Arizona, and the Maderas del Carmen Biosphere Reserve and El Pinacate y Gran Desierto del Altar Biosphere Reserve in Mexico—are spectacular and remote. Other large areas of the border region are protected and managed by federal, state or local agencies; tribal authorities; or nonprofit organizations. Of the 1,954 miles (3,145 km) of the boundary, almost 780 miles (1,255 km; 40%) are along U.S. Department of the Interior lands. Texas has the most land along the border that is privately owned, although Big Bend National Park, other federal lands and state parks are important. Deserts, mountains and riparian areas help to provide significant diversity in plant and animal species and contribute to ecotourism. The border has areas of great natural beauty and value. Some of these areas are compatible with energy development and transmission infrastructure; others are problematic.

The natural environment and climate of the border region provide many challenges for environmental quality and sustainability of communities. The border is mostly arid, and water is an extremely limited resource in many parts of the border region. Population growth—along with growth in agriculture and other economic activities, including energy production—places increasing stress on water quantity and quality. As the Good Neighbor Environmental Board (GNEB) described in its 17th report (2016), the historic increases in ambient temperature and long-term drought point to continuing decline of fresh water supply in the border region. Some energy development in the border region has the potential to affect water resources through use of fresh water and contamination of water resources. Protecting the quantity and quality of water sources is important for ecological, human and economic health in the region.

The effects of a changing climate on energy supply, delivery and demand also are of concern, especially for the border region where the projected increases in energy expenditures likely will be among the highest in the United States by the end of the century. For example, the Fourth National Climate Assessment notes three significant issues that likely will necessitate greater energy expenditures: (1) how the United States' energy system already is being affected by extreme weather events; (2) how changes in energy technologies, markets and policies are affecting the energy system's vulnerabilities; and (3) the actions already being taken or considered to enhance energy reliability and resilience (Zamuda et al. 2018).

1.2 Energy Access, Energy Poverty and Energy Insecurity

One characteristic of the U.S.-Mexico border region is the high rate of poverty suffered by urban and rural inhabitants. One consequence of poverty is energy poverty or insecurity (i.e., "the inability to adequately meet basic household energy needs" [Hernandez 2016, 2019]), often defined as a household spending more than 10 percent of its income on utility costs (Wilder et al. 2016). For these low-income border residents, the cost of the energy consumption needed to maintain a healthy lifestyle creates a significant or unnecessary economic burden (Harmon, Haley and Funkhouser 2017). Energy insecurity has been "linked to health and other hardships [and] … children in moderately and severely energy insecure homes are more prone to food insecurity, hospitalizations, poorer health ratings, and developmental concerns than children in 'energy secure' homes" (Hernandez 2016).[3] GNEB's 17th report (2016) details the health effects of increased temperatures on low-income border populations.

A California "climate gap" study found that households in the lowest income bracket use more than twice the proportion of their total income on electricity than households in the highest income bracket (Morello Frosch et al. 2009). In Texas, a study found that almost half of the families with extreme (0–30% Area Median Income[4]) and very low (30–50% Area Median Income) income faced difficulties in paying electricity bills. Participants sacrificed mostly clothing and food to pay electricity bills, and in extreme circumstances, they cut transportation, medicine and housing needs. In border counties, the energy burden rate ranges from 8 to 18 percent (Harmon and Moss 2019).

Energy insecurity is a serious problem nationwide, and according to the U.S. Energy Information Administration (EIA), close to one in three households in the United States cannot meet its basic energy needs (EIA 2015). This issue, however, is exacerbated in areas with high levels of poverty, as in the border region. Low-income households spend significantly more of their income on energy costs because of structural issues with housing (e.g., substandard housing, lack of weatherization) and the high cost of energy. Insufficient cooling and heating systems are a major concern for low-income households in the border region. In Texas, one of every three people (32.5%) are below 200 percent of the poverty line. In 2017, despite the obvious need, only 4.7 percent of Texans received Low Income Home Energy Assistance Program (LIHEAP) funding (Harmon, Haley and Funkhouser 2017). In New Mexico, for example, residents on average spent US$3,520 to meet their energy needs in 2017 (EIA 2019). For the 20 percent of New Mexicans living at or below the poverty line, this translates to at least one-quarter of their income being put toward energy expenses.[5]

Although energy poverty is an under-researched field, its importance is increasingly evident given the existing arid climate of the border region and projections for future climate change. As noted above, border communities have higher rates of poverty and are more ethnically diverse than the U.S. population on average. At the same time, border communities are subject to disproportionate adverse effects from increasing temperatures and, in some cases, increasing severe weather events. Low-income households with children or elderly people are particularly at risk for energy poverty. Race, ethnicity and immigration status are related to higher risk of energy poverty. The consequences include tradeoffs for basic necessities (food, medical) and adverse health consequences (e.g., heat-related illness and mortality). Minorities and the poor are more likely to live in urban centers with less tree cover to reduce heat and more concrete and pavement to trap it. They also have less access to air conditioning and are less likely to own cars to escape extreme weather events (Morello Frosch et al. 2009).

Air conditioning dominates electricity use, except in the higher altitude regions of the Southwest. As Southwestern states with semi-arid warm climates in their lower altitudes, Arizona and New Mexico often are ignored in discussions about high per-capita energy consumption and costs. In terms of absolute and average outlays per capita, that impression is correct: In 2009, household energy expenditure in Arizona was US$1,959 and in New Mexico

A heat and health project was conducted during the summer of 2018 with low-income families living in *colonias* in San Elizario, Texas (Garfin et al. forthcoming). An interdisciplinary team from The University of Arizona, The University of Texas at El Paso, the National Oceanic and Atmospheric Administration, and the Adult and Youth United Development Association, Inc. community center designed a train-the-trainer curriculum for *promotoras* (community health workers) on how to reduce the health effects of extreme heat and how to cool houses through passive cooling techniques. Once trained, the *promotoras* conducted door-to-door visits to almost 260 families to ask questions and provide recommendations and materials. Almost all participants thought that summers are getting hotter. Only one-third acknowledged that their personal health risk from high temperatures was low or very low. One-third of the participants were satisfied with the cooling systems in their homes. Although families reported some health symptoms during the summer, such as headaches, muscle cramps, dizziness, nausea and/or vomiting, only 24 percent of those who suffered symptoms sought medical care.

The intervention revealed that some families had implemented passive cooling changes, such as insulation in walls, covered porches, and solar films or screens on windows. During focus groups, families recognized that they are unable to afford household improvements for cooling and expressed feeling stressed because increasing temperature forecasts will mean higher electricity bills. This project provides an overview of personal beliefs, energy burdens and strategies to keep a home safe and comfortable during the summer (Garfin et al. forthcoming).

US$1,802, below the national average (US$2,024) and at the low end of the range of all states for average annual energy expenditures (EIA 2012). Energy costs per square foot, however, are slightly higher, and inequalities in income across the region mean there are many people who are energy-poor in relation to their income and needs.

An important federal program to address energy insecurity is LIHEAP,[6] administered by the U.S. Department of Health and Human Services (HHS) pursuant to the Low-Income Home Energy Assistance Act of 1981.[7] LIHEAP provides block grants to states, tribes and tribal organizations, and territories to assist low-income households in meeting their home energy costs, depending on annual appropriations from Congress. HHS released approximately US$3.65 billion of regular block grant funding to LIHEAP grantees on October 26, 2018. Approximately $3.32 billion of regular block grant funding for federal fiscal year 2020 was released to LIHEAP grantees on November 1, 2019 (HHS 2019).

In Arizona, the number of households eligible for energy assistance under LIHEAP has risen in the last decade to 686,900 by 2017, although only 24,000 households received assistance in 2017, and this was mostly for heating rather than cooling (National Energy & Utility Affordability Coalition 2019). Three-quarters of these households were below the poverty threshold, and one-third were homes occupied by elderly residents. In New Mexico, one of every five families is estimated to be in energy poverty, using 20 percent of household income for utility bills (Wilder at al. 2016). In 2010, only US$35 million of an estimated need of US$222 million was available for energy assistance for LIHEAP-eligible families in Arizona (Wilder et al. 2016).

Another program that addresses energy insecurity is the U.S. Department of Energy's (DOE) (2019a) Weatherization Assistance Program (WAP), which reduces energy costs for low-income households by increasing the energy efficiency of their homes.[8] Under this program, DOE (2019b) awards grants to state governments, which then contract with local agencies to deliver weatherization services to eligible, low-income residents who apply for assistance. DOE funding for WAP for fiscal year 2019 was US$257 million (Garcia 2019).

The states play an important role in implementing LIHEAP and WAP. For example, the New Mexico Human Services Department implements benefits under LIHEAP and provides energy assistance for homes qualified to participate in other social service programs, such as the state's Supplemental Nutritional Assistance Program. Currently, the New Mexico Human Services Department considers households that are at or below 150 percent of the federal poverty level guidelines or 60 percent of the state median income to be in poverty. A point system is used for the complete analysis, and the cut off levels for assistance may differ, depending on the assistance (e.g., 200% for low-cost weatherization assistance). According to the New Mexico Human Services Department monthly statistical report for January 2019, there were 8,540 cases for LIHEAP assistance, averaging US$295 per case, at a cost of more than US$2.5 million (a 14.5% increase compared to January 2018). Out of the 19,842 recipients that benefitted, 8,279 (44%) were children (New Mexico Human Services Department 2019).

HHS has assembled state-by-state information on LIHEAP and related state programs, including those offered by the state public utility commissions.[9] HHS also has assembled information on each of the state's policies/programs regarding disconnections, with respect to inability to pay and/or medical condition, which can be found at liheapch.acf.hhs.gov/Disconnect/disconnect.htm.

1.3 Indigenous People Border Region Energy Issues

Twenty-six federally recognized tribes are located in the U.S. portion of the border region, and seven Baja California and eight Arizona Sonora indigenous communities are recognized by the government of Mexico. **Figure 2** highlights the location of U.S. tribal communities located in the U.S.-Mexico border region. Tribes hold approximately 24 percent of the lands within the U.S. border area; the large Tohono O'odham Nation reservation in Arizona shares approximately 65 miles (105 km) of boundary with Mexico. The biologically diverse tribal areas encompass urban and rural areas, deserts, mountains,

Figure 2. U.S. tribal communities located in the U.S.-Mexico border region. **Source:** U.S. Environmental Protection Agency Border 2020 Program, www.epa.gov/sites/production/files/documents/Border2020-map.pdf.

wetlands, rivers and aquifers. The Tohono O'odham of Arizona recognize one indigenous community in Mexico as an extension of their own tribal community. In the border region, California has 18 federally recognized tribal reservations and two recognized tribes without reservations, Arizona has four tribal reservations, and Texas has two reservations (San Diego County Water Authority 2013).

Tribes have existed for thousands of years in the border region and have thrived using their cultural practices for hunting, planting and harvesting. Tribes became modernized as basic services that make life easier, such as running water, electricity, telecommunications and so forth, became available in tribal areas. Along with those services came tribal concerns about the effects of energy projects—whether located on or off tribal lands—on the air quality, water quality, wildlife and habitat of the natural environment. Tribes also became concerned about the effects of these development projects on sacred sites and traditional cultural practices. These concerns apply not only to fossil-fuel projects, but also to green-energy projects. Rights-of-way, leases and other agreements that allow energy projects to be located on tribal lands, or that have the potential to affect tribal resources and communities, must be negotiated in consultation with tribes to minimize harm and maximize benefit. Increasing outreach and communication between tribal governments and federal, state and local government agencies are priorities for tribes.

Most border tribes are economically disadvantaged with high levels of poverty. Although renewable energy projects have the potential for economic development and to provide electrical power to low-income residents, including tribal members, border tribes face many challenges to be able to develop alternative energy projects to benefit the community (DOE 2004). These challenges include complex land use issues, inadequate access to transmission systems, and financing and cost barriers. Tribal land ownership categories include:

- Federal lands owned by a tribe;
- Allotted lands that are individually owned federal trust acreage; or
- Fee lands that are nontrust individuals who could be Indians or non-Indians who own lands on reservations.

A number of federal agencies are involved in the leasing process for tribal energy projects. The Bureau of Indian Affairs reviews leases and reclamations issues. The U.S. Department of the Interior's (DOI) Office of

Natural Resources Revenue (formerly the Minerals Management Service) reviews royalty rate provisions to ensure clarity of calculations and distributes royalty payments. DOI's Office of Surface Mining Reclamation and Enforcement reviews mining leases.

Because many reservations are located in remote rural areas, access to transmission systems is a problem for siting an energy project. Infrastructure costs for connecting to the grid can be cost-prohibitive, especially if the energy project is not a large one.

Another financial barrier relates to tax incentives or subsidies for alternative energy projects. The sovereign status of tribes limits their use of these mechanisms in project development. Investors may be taxed by both the state and tribe (depending on whether energy is used by nontribal customers). This makes it less feasible to use tribal energy resources to power nontribal areas. Other financial barriers for tribal energy projects exist. The National Environmental Policy Act (NEPA) process can be costly for a project on a large scale, especially when a tribe does not have tribal members qualified to conduct the environmental review. The required tribal and federal administrative processes also add cost and delay to projects. Finally, if a tribe cannot fund a project through its own resources, finding external funding can be difficult.

Some options are available, however, to increase alternative energy projects in tribal communities. Tribal community colleges are a valuable option for training the workforce in the energy sector. For example, the Tohono O'odham Community College offers electrician training for students. Curricula could be expanded to include solar- and wind-installer training. This could provide opportunities for students to pursue internships with tribal utilities, which would help to address the issue of high unemployment among tribal members in the U.S.-Mexico border region.

1.4 Overarching View of Climate Change

The U.S.-Mexico border region is generally characterized by a hot, dry climate. Global climate change is projected to cause increasing temperatures, decreased total precipitation, decreased streamflow, more extreme weather events, more frequent and intense wildfires, and sea-level rise and more intense storm surges in this region (GNEB 2016). These changes in climate are expected to affect the environment, as well as the economy and other human systems, including the energy sector.

Figure 3 illustrates the general increase in average temperatures in the Southwest United States. The average annual temperature of the Southwest increased 1.6°F (0.9°C) between 1901 and 2016 (Vose et al. 2017). This trend is projected to continue (Hawkins and Sutton 2011).

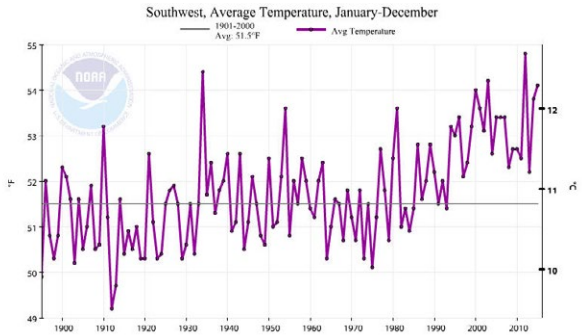


Figure 3. Southwest average yearly temperatures have increased 1.9°F (0.9°C) between 1901 and 2018. Temperatures reflect data from the Southwest region as defined by the National Oceanic and Atmospheric Administration, which includes the states of Arizona, New Mexico, Colorado and Utah.
Source: National Oceanic and Atmospheric Administration Climate at a Glance, www.ncdc.noaa.gov/cag/regional/time-series/107/tavg/12/12/1895-2019?base_prd=true&firstbaseyear=1901&lastbaseyear=2018.

Precipitation is projected to become more variable, with dry areas becoming drier and wet areas becoming wetter (GNEB 2016, Satija and Malewitz 2015, U.S. Bureau of Reclamation 2013, Wilder et al. 2013). An overall decrease in precipitation, however, is expected. Figure 4 highlights the changes in average precipitation in the Southwest United States during the last century. Heat waves and periods of drought along the U.S.-Mexico border region are projected to become extended and more severe and to occur more frequently, whereas cold waves may become less intense (GNEB 2016, Kunkel et al. 2017, Wilder et al. 2013). Extreme weather and flood events may occur more frequently and become more severe, with property losses and public safety increasingly threatened by urbanization and the increase of impervious surfaces (GNEB 2016, Kloesel et al. 2018, Satija and Malewitz 2015).

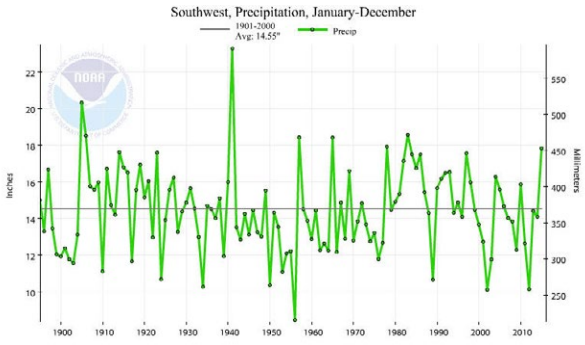


Figure 4. Southwest annual precipitation. Precipitation reflects data from the Southwest region as defined by the National Oceanic and Atmospheric Administration, which includes the states of Arizona, New Mexico, Colorado and Utah.
Source: National Oceanic and Atmospheric Administration Climate at a Glance, www.ncdc.noaa.gov/cag/regional/time-series/107/pcp/12/12/1895-2019?base_prd=true&firstbaseyear=1901&lastbaseyear=2018.

The effects of climate change on natural resources are expected to affect energy systems in the border region. Three main characteristics of a region determine the design of its energy systems: available resources (e.g., water, solar, wind, biomass); energy demand (e.g., requirements for heating and cooling, population); and technology and operations (e.g., cooling water intakes and effluent systems for thermoelectric power plants, transformers equipped with cooling systems to prevent overheating) (DOE 2013). All three factors are affected by climate patterns. As regional climates begin to change, however, energy infrastructure that has been designed to perform well under certain historical conditions may no longer be able to cope with the projected changes in temperature, precipitation, wildfires, hurricanes and sea-level rise (DOE 2015a, Kloesel et al. 2018).

Along the U.S.-Mexico border, the reliability of energy systems is increasingly threatened by higher temperatures, declining water availability and greater risk of wildfire (DOE 2013, Kunkel et al. 2013, Melillo et al. 2014, Zamuda et al. 2018). Higher temperatures and more frequent and severe heat waves, in addition to increased population, are anticipated to amplify demand for cooling energy and lead to stresses in energy provision during peak demand (Melillo et al. 2014, Kinkel et al. 2013, Sathaye et al. 2012, Wilder et al. 2013). The additional pressure placed on already severely stressed water systems as a result of climate change threatens the existing water supply and affects energy infrastructure. Drought could limit the water available for power plant cooling and oil and gas operations (Cook 2013, DOE 2013, Melillo et al. 2014, Sathaye et al. 2012, Zamuda et al. 2018). Reductions in streamflow and shifts in streamflow timing will affect hydropower resources (Aspen Environmental Group and M. Cubed 2005, Cayan et al. 2013, Kunkel et al. 2013, Melillo et al. 2014, Zamuda et al. 2018). Finally, electricity transmission lines are vulnerable to projected increases in wildfires, whereas increased temperatures may reduce the transmission capacity of power lines (DOE 2013, Melillo et al. 2014, Sathaye et al. 2012).

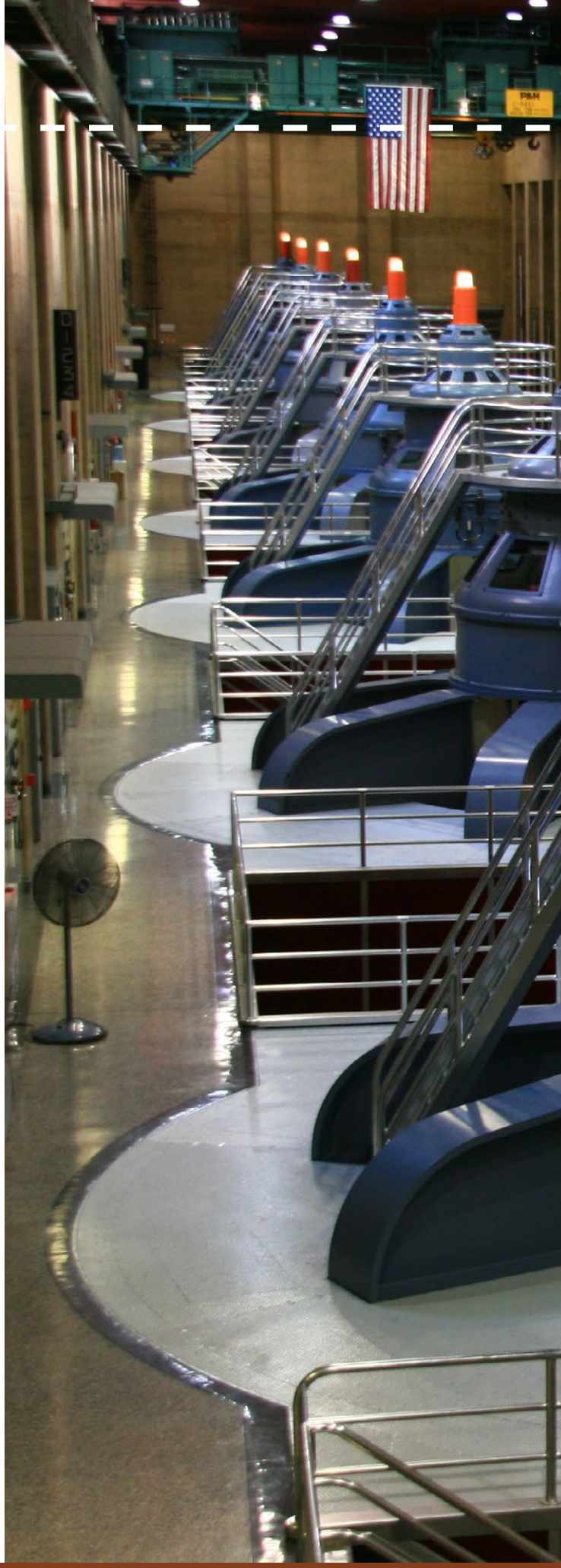
1.5 Energy Efficiency and the Border Region

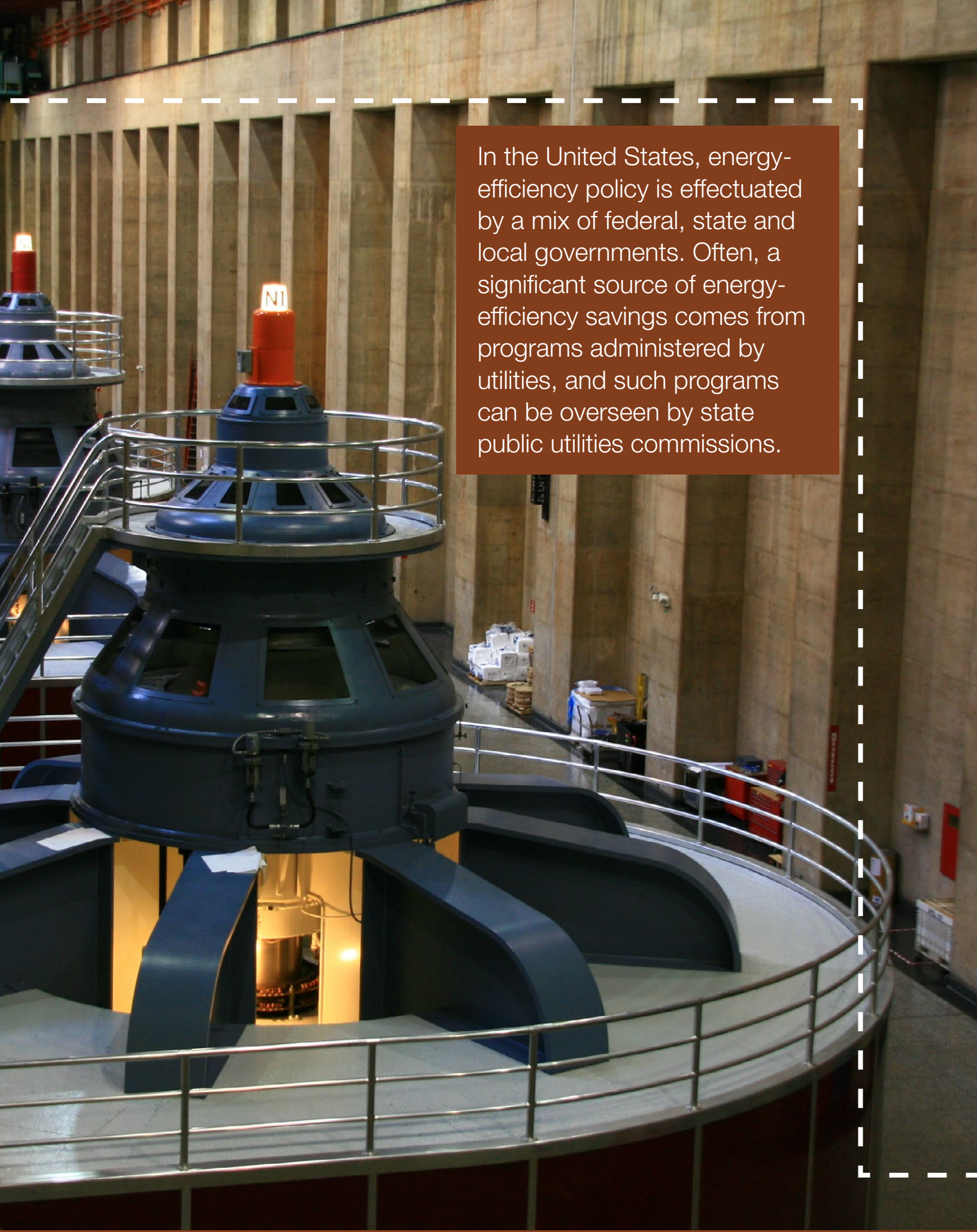
Energy efficiency entails harnessing advancements in technology to use less energy to provide the same or higher level of energy service. In this way, people can receive the benefits of energy services, such as lighting, heating and air conditioning, while using less energy. Energy-efficiency measures are usually designed to be cost-effective. The overall goal is for the energy-efficiency measures to pay for themselves: the sum of the dollar savings from the reduced energy use should be equal to or greater than the cost of installing the measure. In addition to lowering end-users' energy costs, energy efficiency has benefits for the energy grid and society. It is more cost-effective to reduce energy use through energy-efficiency measures than to switch out energy sources (e.g., between electricity or gas), accounting for the cost of energy generation, transmission and distribution. Energy efficiency is particularly helpful to the electricity grid. Because the cost of electricity storage is high, the grid generally needs to be built to serve the highest load of the year. In the border region and other cooling-dominated climates, peak electrical load occurs during the summer. Energy-efficiency measures help to reduce the need for electricity for cooling, thus reducing system peaks and the need for investment in generation, transmission and distribution. Energy-efficiency measures can take the form of government-issued codes and standards for appliances, such as ENERGY STAR®, and for construction of new buildings, such as

Leadership in Energy and Design (commonly known as LEED). Energy-efficiency programs targeting upgrades in existing buildings often are operated by utilities in conjunction with government regulators. Energy-efficiency measures also result in other nonenergy benefits, including enhanced comfort, indoor air quality, health and productivity. Energy-efficiency programs also create jobs, such as those in the construction industry (DOE 2017b).

In the United States, energy-efficiency policy is effectuated by a mix of federal, state and local governments. Often, a significant source of energy-efficiency savings comes from programs administered by utilities, and such programs can be overseen by state public utilities commissions. Federal energy-efficiency policy implementers focus on reviewing and updating national appliance- and equipment-efficiency standards to meet federal technological and economic objectives. The federal appliance standards pertain to a number of product categories. The standards are designed such that the energy savings are equal to or greater than the initial costs of implementing each standard. This federal program yields numerous benefits: cost-effectiveness, technological improvement, reduction in energy waste, economies of scale and streamlined access to product operating-cost knowledge. Since the initial 1987 standards, the United States is expected to reach US$2 trillion in cumulative operating-cost savings by 2030 (DOE 2017b). The border region has benefitted from the more efficient use of energy brought by these standards.

Energy-efficiency policy in Mexico is a mix of federal and local policies. The Comisión Nacional para el Uso Eficiente de la Energía (National Commission for the Efficient Use of Energy), part of the Secretaría de Energía (Ministry of Energy), establishes appliance-efficiency standards that apply nationwide. Mexico does not have a robust system in place to require efficient buildings, although some municipalities have adopted building energy standards.





In the United States, energy-efficiency policy is effectuated by a mix of federal, state and local governments. Often, a significant source of energy-efficiency savings comes from programs administered by utilities, and such programs can be overseen by state public utilities commissions.

1.6 Energy Efficiency in U.S. Border States

Arizona has energy standards for public buildings and encourages the use of energy-savings performance contracts. Building-efficiency standards in Arizona are set at the local level; however, the majority of new construction in Arizona occurs in areas that have adopted the 2012 or 2015 International Energy Conservation Code (IECC) standards. The Arizona Corporation Commission, Arizona's public utilities commission, through its Arizona Energy Efficiency Standards ordered in 2010 that all public utilities were to achieve 1.25 percent annual electricity savings, measured in kilowatt hours, starting in 2011, ramping up to 2 percent beginning in 2013, with the ultimate goal of achieving 22 percent cumulative savings by 2020. At the time, this order was one of the most aggressive energy-efficiency standards in the United States (Haeri and Morris 2012). Appliance standards have been in effect in the state of Arizona since 2012, many of which have subsequently been pre-empted by federal standards, except for standards for pool pumps, pool pump motors and electric spas that became effective in 2012 (American Council for an Energy-Efficient Economy 2019a).

Texas requires public buildings to be energy-efficient and benchmarks energy use in state buildings to this end. Single-family residential new construction must comply with the 2015 International Residential Code efficiency standard. All other new construction must comply with the 2015 IECC efficiency standard. State-funded building construction must comply with ASHRAE Standard 90.1-2013. Texas law requires electric utilities to meet energy-efficiency goals. In 2010, the Public Utilities Commission of Texas established a goal to meet 25 percent of growth in demand in 2012 through energy efficiency and is requiring utilities to meet peak-demand energy-efficiency targets. Utility energy-efficiency program investments and savings in Texas are below the national average (American Council for an Energy-Efficient Economy 2019b).

Residential and commercial buildings in New Mexico must comply with the 2009 IECC efficiency standards. New Mexico requires its investor-owned utilities to acquire cost-effective and achievable energy-efficiency and load-management resources. Electric investor-owned utilities must spend 3 percent of customer bills, whereas gas utilities shall not spend more than 3 percent of total annual revenues. Electric investor-owned utilities have a statutory goal of saving 8 percent of 2005 retail sales through their energy-efficiency programs by calendar year 2020 (American Council for an Energy-Efficient Economy 2019c). The state currently is evaluating upgrading the state's building code to the 2018 IECC for all buildings in the state. Effective on April 15, 2019, New Mexico is implementing Executive Order 2019-003, "On Addressing Climate Change and Energy Waste Prevention," which includes a commitment to develop a regulatory framework to reduce methane emissions in the oil and gas sector and to reduce statewide greenhouse-gas emissions by at least 45 percent by 2030 as compared to 2005 levels (Lujan Grisham 2019, State of New Mexico Office of the Governor 2019).

California offers incentives for energy-efficiency investments to schools, industry, residential consumers and the public sector, as well as through the Property Assessed Clean Energy financing mechanism (DOE 2019c). Like Texas, California requires state buildings to be energy-efficient and also benchmarks energy usage in state buildings to this end. California has a statewide building energy disclosure requirement that applies to large commercial and multifamily residential properties. California first adopted its Building Energy Efficiency Standards in 1978 and updates them on average every 3 years. California's energy code is considered one of the most aggressive and best-enforced energy codes in the United States. California's standards also require field verification and acceptance testing for measures prone to improper installation to ensure that expected energy-efficiency savings are achieved. California will require high-performance attics and walls and onsite photovoltaic installations in low-rise residential new construction as part of its 2019 Energy Standards, effective January 1, 2020. This requirement helps the state meet its goal of having all new residential buildings be zero net energy by 2020.

California's investor-owned utilities efficiency programs are overseen by the California Public Utilities Commission (CPUC) and are considered

some of the most robust in the nation. Investor-owned utilities are decoupled by CPUC order, meaning that the utilities do not earn more money by selling more energy and in turn are compensated for providing energy-efficient programs that reduce ratepayers' energy use. Responding to Senate Bill 350,[10] the California Energy Commission has adopted targets to double energy-efficiency savings in the state by 2030. California was the first state in the country to adopt appliance- and equipment-efficiency standards, effectuated by the Warren-Alquist Act, the foundational legislation of the California Energy Commission, in 1974. Since then, California has adopted standards on more than 50 products, many of which have subsequently become federal standards. California has collaborated with other countries to set harmonized standards for products that have a worldwide market, beginning with external power supplies in 2007. The California Energy Commission has a Modernized Appliance Efficiency Database System that allows manufacturers to certify their products online (American Council for an Energy-Efficient Economy 2019d).

1.7 Resilience

Resilience for this report is defined as the ability of an entity (e.g., asset, organization, community, region) to anticipate, resist, absorb, respond to, adapt to and recover from a disturbance. With respect to the services provided by the energy sector, the objective of resilient energy infrastructure is to protect against economic and social dependencies by providing reliable, affordable energy in an equitable manner—regardless of income, geographic or other issues—while minimizing environmental harm.[11]

During the past 25 years, the world has seen a rise in frequency of natural disasters.[12] Major disaster declarations by the Federal Emergency Management Agency for the United States increased by a factor of five from 1953 through 2013 (Brusentsev and Vroman 2017). Texas ranks highest among U.S. states in terms of variety and frequency of natural disasters (California Institute of Technology 2017). More than ever, people and critical infrastructure are at risk from natural and manmade disasters, with those in developing countries particularly at risk. Because of the interconnectedness of the energy and water infrastructure with other critical infrastructure systems, infrastructure failures can lead to cascading and escalating consequences. These consequences can result in immeasurable losses in terms of lives, livelihoods and damage to a nation's economy. The threat of these consequences has led to a strong policy emphasis on the creation of resilient infrastructure. Superstorm Sandy in 2012, the Northeast Blackout in 2003, and the 2011 Southwest Blackout, which occurred in the Baja California-California-Arizona border region, are examples of critical energy-infrastructure failures.

Failure of the electric power grid can have widespread consequences. For example, the 2011 Southwest Blackout was caused by the accidental shut down of a transmission line in Arizona, triggering 23 distinct events on five separate power grids in a span of 11 minutes that affected portions of southern California, Arizona and Baja California and left 7 million customers without power for about 12 hours (Kucher and Baker 2011). Public schools, universities and federal courts remained closed the following day (Perry et al. 2011). The losses from the discarding of perishable food by grocery stores, restaurants and households were estimated to be up to US$18 million (Jergler 2011). The outage also caused some sewage pumping stations to fail, resulting in contaminated beaches and potentially unsafe water supplies in several areas (KPCC 2011). Because of the failure at the sewage pumping stations, seven diesel generators were installed at five pumping stations at a cost of US$17 million (Ojeda 2012). Had the blackout occurred during a heat wave with a disruption for a longer period, there would have been significant negative health effects on the affected population.

2

Overview of the U.S. Energy Sector

This chapter will briefly discuss the U.S. energy market and U.S. energy and environmental regulation. This chapter also will review the new One Federal Decision program designed to improve the timeliness, predictability and transparency of the federal environmental review and authorization process for covered infrastructure projects, including energy projects.

2.1 U.S. Energy Market

The United States derives most of its energy from oil, natural gas, nuclear and coal (EIA 2019b), although renewables such as solar and wind continue to increase in importance (EIA 2019c). Each of these energy sectors has substantial participation from private companies, with thousands of businesses involved.

2.1.1 Oil and Gas Production

Recently, the United States has witnessed huge growth in oil and natural gas production through increased use of hydraulic fracturing and horizontal drilling (Robert Strauss Center for International Security and Law 2019). Most of the newly booming oil- and gas-producing areas that benefit from these new technologies are in Texas, North Dakota and Pennsylvania.

The increase in oil production has reduced the United States' dependence on imports of petroleum, as net imports of petroleum (including crude oil and petroleum products) have declined substantially in recent years (EIA 2019d).[13] With respect to natural gas, the increase in production and additions to gas reserves—now estimated at 80 years of reserves—have led to a re-orientation of the natural gas industry toward an export-oriented model (EIA 2019e). Taking into account the reduction in net imports of petroleum and the growing exports of natural gas, EIA (2019f) projects that the United States will become a net energy exporter in 2020 for the first time since 1953.

The natural gas industry's new focus on exports has led to the authorization of many new liquefied natural gas export terminals along the East and Gulf Coasts (Zaretskaya 2018)—10 since 2012 (FERC 2019)[14]—

and an expansion of the cross-border gas pipeline network for delivery of natural gas to Mexico (EIA 2018). The pipeline expansion has produced conflict with border communities affected by these large infrastructure projects (Mufson and Oldrunnipa 2019). Gas exports to Mexico have risen from 50 billion cubic feet (1.4 billion cubic meters [m^3]) in 1994 to 1.7 trillion cubic feet (48 billion m^3) in 2018 (Lynch 2019). This has helped play a role in boosting the U.S.-Mexico energy relationship, which already is characterized by its interdependent nature. As an example, although Mexico sends crude oil to the United States, Mexico lacks the refining capacity to turn its oil into fuels—such as gasoline, diesel and jet fuel—for use in Mexico's economy. Therefore, Mexico is dependent on the United States for refined petroleum products even though it is an exporter of crude oil. According to Mexican estimates, the total value of refined petroleum products imported into Mexico for 2016, primarily from the United States, was US$20.7 billion (including US$15.2 billion for gasolines and naphtha and US$4 billion for diesel), whereas the value of Mexican exports of crude oil for that year was only US$15.9 billion (Comisión Nacional de Hidrocarburos 2018).

2.1.2 The Natural Gas Sector

According to the American Gas Association (AGA) (2019a), natural gas comprises more than one-fourth of all primary energy used in the United States. Natural gas service extends to nearly 69 million homes, 5.5 million businesses,185,400 factories and 1,825 electric generating units (AGA 2019a).

The system for delivery of natural gas to end-users has several elements (AGA 2019b):

- The gathering system is the collection of pipelines that carry natural gas from production wellheads to transmission lines or processing plants, with the assistance of field compressors.[15]
- The transmission system is the network of large-diameter steel pipes that move natural gas from the producing regions to local distribution companies, with the assistance of compressors located approximately every 50 to 60 miles along each pipeline.
- Gate stations are receiving points for local distribution companies.
- The distribution system consists of "mains" and "service lines." From the gate station, natural gas moves into "mains" that range from 2 inches to more than 24 inches in diameter. Natural gas then runs from the main into a home or business through "service" lines.

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) provides annual reports on the mileage of each type of natural gas pipeline. PHMSA (2019a,b) reports that as of 2018, there were 17,954 miles of

gathering lines (11,754 miles onshore and 6,201 offshore), 301,562 miles of transmission pipelines (298,390 onshore and 3,172 offshore), 1,307,796 miles of distribution main lines, and an estimated 930,892 miles of distribution service lines, for a total of 2,558,204 miles altogether.

In terms of industry participants, trade associations representing various elements of the natural gas delivery system report as follow:[16]

- The Interstate Natural Gas Association of America states that it "is comprised of 28 members, representing the vast majority of the U.S. interstate natural gas transmission pipeline companies."
- The AGA states that it "represents more than 200 local energy companies that deliver clean natural gas throughout the United States. There are more than 73 million residential, commercial and industrial natural gas customers in the United States, of which 95 percent—over 69 million customers—receive their gas from AGA members."
- The American Public Gas Association represents publicly owned natural gas distribution systems. It states that it has more than "700 members in 37 states. Overall, there are nearly 1,000 municipally owned systems in the United States serving more than 5 million customers."

2.1.3 The Electricity Sector

Thousands of participants in the U.S. electricity sector play a role in the production, transmission, distribution and/or sale of electricity in the country (DOE 2015b, U.S. Department of Homeland Security 2019). According to the U.S. Energy Information Administration's (EIA) electric power sector survey data, almost 3,000 electric utilities were operating in the United States in 2017 (EIA 2019g). EIA classifies utilities into three ownership types: investor-owned utilities, publicly run or managed utilities, and cooperatives. EIA's data show that in 2017, 168 investor-owned utilities served 110 million customers, 1,958 publicly owned utilities served 24 million customers, and 812 cooperatives served 20 million customers (EIA 2019g). Out of this universe of customers, investor-owned utilities served roughly 72 percent, publicly owned utilities served roughly 15 percent, and cooperatives served roughly 13 percent.[17] Other important players in the

electricity sector are non-utility power producers—which accounted for 46.5 percent of installed generating capacity at the end of 2018 as compared to 32 percent accounted for by investor-owned utilities (Edison Electric Institute 2019b)—and retail power marketers, which serve as intermediaries between electricity generators and large consumers (EIA 2018b). The federal government has a role in energy production and distribution, through federal power marketing administrations such as the Western Area Power Administration, that is limited to the sale of wholesale electricity from federal hydropower projects[18] and through the Tennessee Valley Authority (2019), a unique government power company established by an act of Congress in the 1930s. The International Boundary and Water Commission, U.S. and Mexican Sections, maintains hydropower units at Falcon and Amistad dams on the lower Rio Grande River, but they are not operated to maximize power production (IBWC 2019).

With respect to transmission, utilities in each of the categories described above may have their own transmission lines. In addition, regional transmission organizations and independent system operators, described in more detail in Section 2.2.3, play a critical role in the management of transmission systems at the state or, more typically, regional level.

The recent increase in production of natural gas discussed above has caused a steady move toward gas over coal as the most-used energy resource for power generation. EIA (2019h) reports that as of 2018, 35.1 percent of the country's electricity

now comes from natural gas, with 27.4 percent from coal. The decreased price of natural gas and stringent regulations on coal have led to the closure, even premature closure, of many coal-powered plants, once the mainstay of U.S. energy (Marcacci 2017). One example is the Navajo Generating Station on the Navajo Nation Indian reservation in Arizona—once a supplier of critical levels of power to Nevada and Arizona—powered down on November 18, 2019 (Silversmith and Randazzo 2019). America continues to export large amounts of coal, however, with the majority destined for Asia and Europe (EIA 2019i).

Historically, nuclear power plants have played an important role in the U.S. electricity sector, providing about 19 percent of total electricity generation (EIA 2019h), as well as a reliable base load power source, contributing to the reliability of the distribution systems. Arizona's Palo Verde Generating Station and Texas' South Texas Project Electric Generating Station are two of the largest in the country by electricity generated and are located in or near the border region (EIA 2019j). One nuclear plant in the California border region, the San Onofre Nuclear Generating Station, ended operations and began decommissioning in 2013 because of aging equipment, missteps by the operator, and intense public pressure (Wald 2013).

More than half of U.S. states have passed laws or adopted voter-backed initiatives to require certain percentages of the state's electricity deliveries to be derived from renewable sources, and seven aim to have more than half of their electricity generated from renewable sources within the next few decades (Cleveland 2019, National Conference of State Legislatures 2019). This will force many electric power providers to switch their sources to solar, wind, hydro and other renewables in a shift away from fossil fuels. California, the largest border state, is planning to obtain 100 percent of its electricity from decarbonized sources by 2045.[19,20]

Figure 5, prepared by the Edison Electric Institute (2019a) from data provided by EIA, shows the changes in the mix of fuel sources for U.S. power generation during the period from 1998 to 2018.

In recent years, energy-efficiency and load-management programs have become important

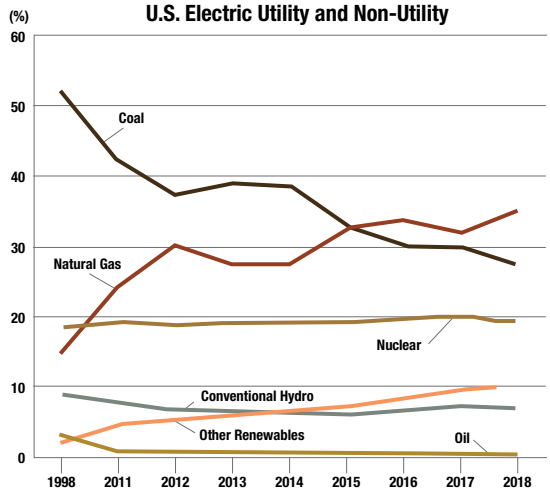


Figure 5. Fuel sources as a percentage of total electric generation, 1998–2018. This chart highlights the rapid decline of coal and the growth in natural gas as fuel sources, as well as the steady growth in "other renewables" (renewables other than conventional hydro) during the 1998–2018 period.
Source: U.S. Energy Information Administration.

elements of utility energy resource portfolios, supplementing the traditional focus on generation. Among other goals, state regulators increasingly promote energy efficiency—obtaining the same or better service from technology for less energy—as a goal of private utilities (e.g., by establishing utility revenue incentives for energy efficiency) (Cleveland et al. 2019). Load management, or "demand response," leverages technology to allow consumers, on a compensated basis, to reduce their individual demand for electricity in lieu of receiving electricity from a power plant. Benefits can include relieving stress on the grid during peak hours and extreme weather events, with a concomitant potential increase in operational complexity for the utility making use of demand response resources. Certain states, including California, require utilities to include demand response resources in long-term procurement and integrated resource plans (Andersen and Cleveland 2019).

2.2 U.S. Energy Regulation

In the United States, the legal and regulatory landscape for energy includes the federal and state laws and regulations applicable to the various energy sectors, as well as other laws and regulations that

affect development of energy infrastructure. This section provides a review of the regulatory framework applicable to the various energy sectors, at both the state and federal levels. The subsequent section will discuss regulation with respect to environmental matters. The regulatory bodies for energy and the environment for each of the border states of California, Arizona, New Mexico and Texas are described in the tables of state energy-related agencies contained in **Appendix 1**.

2.2.1 Oil and Gas Production

Oil and gas in the United States are produced from privately and publicly owned land. Oil and gas rights on privately owned land are governed by state law, which also governs leases and other assignments of oil and gas rights. The law in some states provides legal means for collective exploitation of oil and gas rights, such as pooling agreements and unitization agreements (voluntary and mandatory).[21] Generally, state law and regulations will require an approval permit for drilling of wells.[22] Drilling will be subject to measures for conservation and avoidance of waste such as spacing requirements for wells[23] and in some cases establishment of a "maximum efficient rate" for extraction of oil and gas to prevent damage to a reservoir.[24]

With respect to production of oil and gas from federal lands, there are two separate federal regulatory processes depending on whether drilling will take place onshore or offshore. The U.S. Department of the Interior's (DOI) Bureau of Land Management grants oil and gas leases for onshore lands on a competitive basis under the Minerals Lands Leasing Act.[25] DOI's Bureau of Ocean Energy Management, acting for DOI, is responsible for granting oil and gas leases on federal offshore lands under the Outer Continental Shelf Lands Act.[26] Federal offshore lands consist of the outer continental shelf beyond the jurisdiction of the states,[27] which is generally 3 geographical miles (3.5 miles or 5.6 kilometers [km]) outward from shore at the mean low tide (with different rules for Texas, Louisiana and the west coast of Florida) out to a boundary of 200 miles (322 km) from shore.

A state lands commission or a state's public resources department through a competitive bidding process generally handles oil and gas leases on state publicly owned land.[28]

2.2.2 The Natural Gas Sector

State regulatory bodies supervise and regulate the in-state operations of privately owned gas utilities that sell to the public. The applicable regulatory bodies for the four border states as to regulation of gas utilities are the California Public Utilities Commission (CPUC; www.cpuc.ca.gov); Arizona Corporation Commission, Utilities Division (ACC-Utilities; www.azcc.gov/utilities); New Mexico Public Regulation Commission, Utility Division (NMPRC-Utility; www.nmprc.state.nm.us/utilities/index.html); and Railroad Commission of Texas (www.rrc.state.tx.us/gas-services). State regulation of privately owned gas utilities covers such matters as rates, consumer

protection, safety and reliability of service, and the construction and operation of in-state pipelines.[29] A substantial amount of local gas distribution is carried out by municipal gas utilities, which are generally supervised only by their governing bodies.

With respect to federal regulation, the Federal Energy Regulatory Commission (FERC) has authority under the Natural Gas Act of 1938 to regulate "transportation of natural gas in interstate commerce."[30] FERC's jurisdiction includes interstate natural gas pipelines, gas storage facilities,[31] and facilities for liquefied natural gas that are either onshore or "near shore" (i.e., within the offshore jurisdiction of the states as described above).[32] FERC is charged with ensuring that the rates, terms and conditions of service by interstate natural gas pipelines, storage facilities and liquefied natural gas facilities under its jurisdiction are just and reasonable and not unduly discriminatory.[33] In addition, FERC authorizes construction and operation of such facilities on a finding of public convenience and necessity[34] and must approve abandonment of facilities.[35] Section 3 of the Natural Gas Act authorizes the U.S. Department of Energy to regulate imports and/or exports of natural gas, including liquefied natural gas, from and/or to a foreign country.[36]

In the past, interstate pipeline companies provided both transportation services and sales of natural gas. FERC, however, has taken steps to separate transportation and sales. FERC Order 436, issued in 1985, required that natural gas pipelines provide open access to transportation services, enabling consumers to negotiate prices directly with producers and contract separately for transportation.[37] In 1992, FERC issued Order 636, which mandated unbundling of supply and distribution services from transportation services, providing customers with choices as to providers, who were then forced to compete.[38]

Within the deregulated wholesale natural gas market, gas is supplied and traded by private-sector companies, pursuant to privately negotiated transactions. Pricing and trading take place at locations across the United States, primarily at the intersections of major pipeline systems known as hubs. Although FERC does not set prices in these transactions, it has authority pursuant to the Energy Policy Act of 2005 to issue rules to inhibit market manipulation and facilitate price transparency in natural gas markets.[39]

FERC also has "exclusive authority to approve or deny an application for the siting, construction, expansion, or operation" of a liquefied natural gas terminal within the scope of its jurisdiction."[40] Liquefied natural gas facilities are subject to an exception to the general rule of open access for natural gas facilities. Under a 2002 FERC decision, liquefied natural gas facilities no longer are subject to open access rules, and the facility operator can offer access to customers of its choosing at prices and terms and conditions to be negotiated.[41]

2.2.3 The Electricity Sector

Each U.S. state has a regulatory body that regulates the in-state operations of privately owned electric utilities and is responsible for making siting decisions for electric utility facilities. The applicable regulatory bodies for California, Arizona and New Mexico as to regulation of electric utilities are the same as for regulation of gas utilities (i.e., CPUC, ACC-Utilities and NMPRC-Utility). In the case of Texas, the Public Utilities Commission of Texas has jurisdiction over electric utilities, subject to a role for Texas municipalities in regulating electric utilities within those municipalities.[42] In the case of Arizona, ACC does not have authority over electric service provided by a city, municipality, irrigation district, electric district or utilities operated by tribal authorities. As a general matter, their governing bodies will supervise publicly owned utilities.

Regulation of privately owned utilities covers such matters as rates; adequacy, safety and reliability of service; adequacy of facilities; construction of new facilities; and the generation or procurement of electricity.[43] State regulation also includes authorization for utilities (and other private parties) to construct transmission facilities and distribution lines.[44] As previously discussed, state regulation has come to include mandates for use of renewable energy, programs to foster energy efficiency, programs to incorporate electric vehicles, and mandates to include demand response resources in long-term procurement and integrated resource plans.

The states as a general matter have deregulated the electricity sector so that services are "unbundled"

(American Coalition of Competitive Energy Suppliers 2019, ElectricityPlans.com 2019). For consumers, this means that, subject to various restrictions, they can purchase electricity from non-utility providers at negotiated rates rather than from a single utility, while the local utility still will provide such services as transmission and distribution of electricity. Utilities are permitted to procure electricity and transmission services from third-party providers at negotiated rates, although it may be necessary for state regulators to approve utility procurement contracts for the costs incurred by the utilities under such contracts to be fully recoverable in the rates charged by the utility.[45]

The management of the transmission system at the state or, more typically, regional level and the balancing of generation and load will be through a regional transmission operator or an independent system operator for a region, generally a nonprofit corporation under supervision by both state and federal authorities and/or by electric utilities acting within such utilities' respective territories (EIA 2016).[46] If a regional transmission operator or independent system operator is in place, it also will act as the operator of a wholesale electricity market within the regional transmission operator or independent system operator's territory.[47] The Electric Reliability Council of Texas (ERCOT) and California Independent System Operator operate primarily within the context of one state, which is unique in the national system.

Generally, the federal government does not make siting decisions for electric power lines, except in cases where an electric facility would cross federally managed public lands. Section 368 of the Energy Policy Act of 2005 directs the Secretaries of Agriculture, Commerce, Defense, Energy and the Interior to designate corridors for siting oil, gas and hydrogen pipelines and electricity transmission and distribution facilities on federal lands in 11 contiguous Western states (including Arizona, California and New Mexico).[48] As agency-preferred siting locations, the energy transport corridors ("Section 368 Corridors") are intended to provide industry and the public with greater certainty in energy infrastructure planning and development on federal lands with the least amount of environmental effects.

Federal regulation of electricity in interstate commerce is carried out exclusively by FERC under the Federal Power Act, which grants FERC authority over the "transmission of electric energy in interstate commerce," the "sale of electric energy at wholesale in interstate commerce," and "all facilities for such transmission or sale of electric energy."[49] Under this jurisdiction, FERC regulates the rates, terms and conditions of transmission and wholesale sales of electricity in interstate commerce.[50] In addition, FERC has jurisdiction over the companies that own or operate the facilities subject to FERC jurisdiction.[51]

Where transmission facilities are interconnected and capable of transmitting electric energy across a state boundary, they are deemed to fall within interstate commerce, even if the parties to a transmission contract and the electrical pathway between them are within one state.[52] This gives FERC jurisdiction over almost all transmission systems and transmission system operators (including independent system operators) in the country. One significant exception pertains to Texas, where ERCOT, the independent system operator for most of the state, administers a transmission grid that is located solely within the state of Texas and is not synchronously interconnected to the rest of the United States. El Paso and parts of west Texas, however, are linked to New Mexico and not part of ERCOT. FERC does not have plenary jurisdiction over the ERCOT transmission grid, although it does regulate ERCOT in other respects.[53]

As the U.S. electrical system has become increasingly interconnected, FERC has taken a greater role in guiding that system through its regulation of transmission planning and transmission operators. This is reflected in major initiatives such as the requirement for open, nondiscriminatory access to transmission systems within FERC Order 888[54]; establishment of transmission planning and cost allocation requirements for public utility transmission providers described in FERC Order 1000[55]; establishment of independent system operators and other regional transmission operators within FERC Order 2000[56]; and removal of barriers to the integration and participation in the interstate transmission systems of variable energy (i.e., from renewable energy sources) within FERC Order 764[57] and demand response resources described in FERC Order 745.[58]

Apart from its responsibilities under the Federal Power Act, FERC also is responsible under

provisions of the Energy Policy Act for regulating the reliable operation of the U.S. "bulk power system" (i.e., the interconnected electric grid).[59] FERC appointed the North American Electric Reliability Corporation (NERC) as the electric reliability organization for purposes of the Energy Policy Act (FERC 2006).[60] NERC's area of responsibility includes the continental United States, Canada and the northern portion of Baja California, Mexico (NERC 2019). NERC oversees six regional reliability entities that carry out the standards and has the authority to enforce those standards on power system entities operating in the United States, as well as several provinces in Canada.

2.3 U.S. Environmental Regulation and Programs

Many federal environmental laws and regulations apply to energy production and transportation projects in the United States, including along the U.S.-Mexico border. These federal programs, which are implemented through a combination of federal, state and tribal agencies, regulate a wide range of processes, including air emissions, process water discharges, solid waste disposal and underground injection into wells. Many aspects of these federal programs are well-established under laws passed in the 1960s and 1970s, including the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, National Environmental Policy Act and Safe Drinking Water Act.[61] Some portions of these programs, particularly as they relate to energy projects, continue to evolve as the science and technology associated with energy production and delivery evolves and as more is known about how to monitor and treat for emerging contaminants associated with industrial processes.

A detailed summary of federal laws applicable to oil and gas extraction activities can be found in Chapter VI of *Profile of the Oil and Gas Extraction Industry* (USEPA 2000). Although some regulatory requirements for this sector have changed since the Sector Notebook was last updated in 2000, the summary still is a useful reference point for information about which federal programs apply. Similarly, the *EPA Office of Compliance Sector Notebook Project: Sector Notebook for Fossil Fuel Electric Power Generation* (USEPA 1997) is a reference document for federal programs that govern environmental and public health protections associated with this sector. The Federal Permitting Dashboard (www.permits.performance.gov), discussed further in Section 2.5, is an online tool for federal agencies, project developers and the public to track the government's environmental review and authorization processes for large or complex infrastructure projects, including energy sector infrastructure.

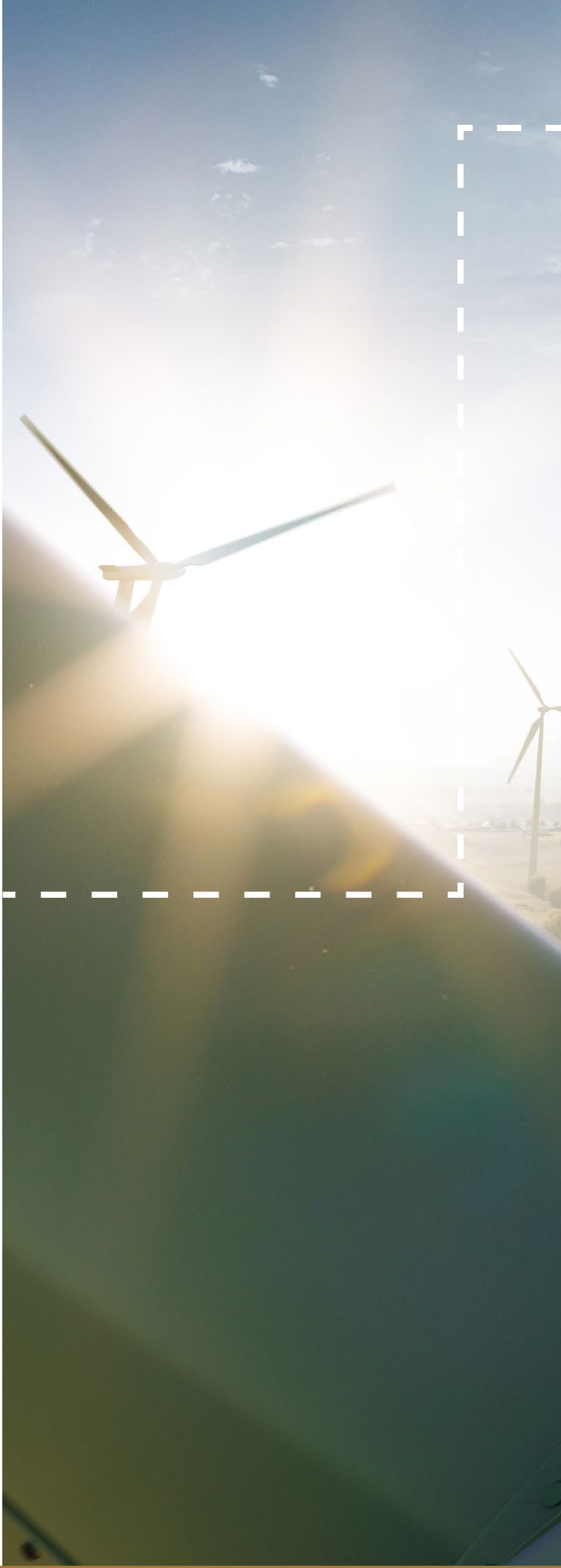
The Environmental Review Toolkit also references Executive Order 13807, *Establishing Discipline and*

Accountability in the Environmental Review and Permitting Process for Infrastructure, which is discussed in further detail in Section 2.5. Executive Order 13807 was signed on August 17, 2017, and was promulgated "to ensure that the federal environmental review and permitting process for infrastructure projects is coordinated, predictable and transparent" to foster "more efficient and effective federal infrastructure decisions" (Trump 2017a). The Environmental Review Toolkit website (www.environment.fhwa.dot.gov) provides quick public access to information about Executive Order 13807 and its implementation, including subsequent agreements, fact sheets, memos and guidance on agency processes.

2.4 Environmental Impacts of Energy on Air, Water and Land

The lands located along the U.S.-Mexico border are home to many flora and fauna, endangered and endemic species, and migrating wildlife that travel along its historic corridors and flyways. In Texas and other border states, as farm income and profitability fluctuate and decline, the risk of these operations converting to nonagricultural use increases, thereby losing those valuable ecosystem services and other benefits derived from ecologically healthy private lands. Large power generation projects may have effects on air quality, water quantity and quality, and the land. Pipeline and electric transmission line construction potentially can destroy native plant communities and cause erosion, affecting water quality and quantity. The individual footprint of solar and wind projects likewise tends to affect large areas of land. Oil and gas extraction projects can disrupt native landscapes with pads for pumping facilities, roads and spills.

The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) implements a number of initiatives and projects to address land-impact issues by the energy industry. Texas and New Mexico have vast open landscapes and a diversity of renewable resources. Both states have massive amounts of energy development potential. Some areas, however, have landscapes and ecosystems that might be affected by energy and other infrastructure



The lands located along the U.S.-Mexico border are home to many flora and fauna, endangered and endemic species, and migrating wildlife that travel along its historic corridors and flyways.

development projects. USDA-NRCS Kika de la Garza Plant Materials Center in Kingsville, Texas, has worked with native plant species in southern Texas to focus on recent efforts in finding, establishing, testing and developing native parent seed crops of native grasses and forbs. This has created a supply of seed sources to allow private industry to sell native seed mixes for re-establishing pipeline, roadways and other disturbed areas associated with wind, oil and gas exploration activities.

Texas and New Mexico have implemented conservation practices, and in some cases suites of practices have been applied to mitigate resource effects caused by the energy industry. Energy companies are teaming up with the National Fish and Wildlife Foundation and USDA-NRCS to fund new habitat conservation and species research for the unique wildlife species found in riparian corridors of the Chihuahuan Desert, which are home to many species found nowhere else in the world.

Some examples of these restoration and conservation efforts include:

- The Luna Energy Facility near Deming, New Mexico, is now eligible for the Conservation Stewardship Program and the Grazing Lands Initiative. The facility originally acquired the land to obtain water rights to cool its gas-powered plant.
- Pad sites and other disturbed areas within the border regions of Texas have been re-seeded with native and introduced vegetation for erosion control purposes.
- Disturbed areas in the Texas border region have been re-vegetated with native trees and shrubs to enhance ocelot habitat.
- The Monarch Butterfly Environmental Quality Incentives Program priority area, created to promote the installation of pollinator habitat, lies within the Eagle Ford Shale area of Texas. This landscape is part of the species' central migration route into Mexico.

Conservation program participation in these regions have yielded results that include:

- Improved and enhanced wildlife habitat from creating an "edge" effect by establishing native and/or improved grass species and creating diversity in the vegetative plant community.
- Increased water quantity and quality from re-seeding previously disturbed areas with native and/or improved grass species.
- Increased ocelot habitat for cover by planting brush and shrub species.
- Improved ecosystem with cleaner water, food and fiber production benefits, and ecological diversity and wildlife habitat benefits.

Over time, energy production companies have become more engaged in re-vegetating disturbed areas in their leases with private landowners by using native seed mixes, which now are more widely available. This increases the chance that native plant communities will become re-established in previously disturbed areas. Evolving corporate policies and state and federal regulations have encouraged these efforts.

USDA-NRCS' field office employees provide private landowners, contractors and/or energy companies' personnel with technical assistance. This expertise is available to assist in finding site-specific seeding recommendations and other conservation practice options to address negative environmental effects and restore and enhance the land and its resources. USDA-NRCS conservation programs are an additional benefit in planning and implementing practices to help improve the landscape and health of natural resources in these regions.

2.5 One Federal Decision

Beginning in 2017, President Donald J. Trump issued several executive orders streamlining the environmental review process for infrastructure projects. The Executive Orders 13766 (Trump 2017b), 13783 (Trump 2017c) and 13807 (Trump 2017a) focus on high-priority infrastructure projects, developing domestic energy sources, and shortening the timeframe for conducting environmental reviews, respectively. These were issued as part of an overall effort by the Trump Administration to reform the infrastructure permitting process. The implementation of these and other administration efforts toward streamlining project review is underway and potentially could affect the construction of cross-border energy infrastructure, including pipelines and transmission lines. One Federal Decision is the name of the policy

established in Executive Order 13807, *Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects*, signed in August 2017. This was an attempt to synchronize environmental reviews and permitting decisions for major infrastructure projects. It builds on Title 41 of the Fixing America's Surface Transportation Act,[62] signed in 2015, which created a new governance structure, set of procedures and funding authorities designed to improve the timeliness, predictability and transparency of the federal environmental review and authorization process for covered infrastructure projects. It also established the Federal Permitting Improvement Steering Council (FPISC, composed of agency representatives from across the federal government).[63] The Office of the Executive Director of FPISC maintains the Federal Environmental Review and Authorization Inventory on the Federal Permitting Dashboard.[64] The inventory is a valuable tool that contains a comprehensive list of federal licenses, permits, approvals, findings, determinations or other administrative decisions issued by a federal agency that should be considered for inclusion in a permitting timetable for major infrastructure projects.

The One Federal Decision framework strives to ensure a coordinated, predictable and transparent environmental review for permitting decisions of major infrastructure projects by streamlining the process and clearly defining federal agencies' roles. Under Executive Order 13807, federal agencies are directed to utilize a One Federal Decision approach to develop an environmental review and authorization decision schedule for a major infrastructure project. For each major infrastructure project, agencies work together to develop a single Permitting Timetable for the necessary environmental review and authorization decisions utilizing the FPISC Permitting Dashboard, prepare a single Environmental Impact Statement, sign a single record of decision, and issue all necessary authorization decisions within 90 days of issuance of the record of decision, subject to limited exceptions. Executive Order 13807 sets a goal for agencies of reducing the time for completing environmental reviews and authorization decisions to an agency average of not more than 2 years from publication of a Notice of Intent to preparation of a Final Environmental Impact Statement.

A memorandum of understanding implementing One Federal Decision was signed by participating departments, councils and commissions on April 9, 2018 (White House 2018). The memorandum establishes concurrence points in the process and a cooperative framework for partner federal agencies to process environmental reviews and authorizations for major infrastructure projects. FPISC works with federal partners to implement the memorandum, maintain the Permitting Dashboard, educate potential project sponsors, and prepare an annual report to Congress assessing agency compliance and best practices. Federal agencies are encouraged to replicate the One Federal Decision model and adopt the best practices to streamline environmental review reported to Congress by FPISC.

3

Overview of the Mexican Energy Sector

3.1 The Mexican Energy Market

The Mexican energy sector, prior to recent reforms, was directly managed and operated by the Mexican federal government, primarily through the Secretaría de Energía (Ministry of Energy, known as SENER); Petróleos Mexicanos (PEMEX), the Mexican national oil and gas company; and the Comisión Federal de Electricidad (Federal Electricity Commission, known as CFE), the Mexican national electricity company. The central role of the federal government in the energy sector was founded on Mexico's radical, nationalist spirit of the 1930s, reflected particularly in the expropriation of foreign-owned oil assets in 1938.

Prior to 1938, foreign capital controlled all extraction, processing and exporting of oil in Mexico. In 1938, however, following labor conflicts between the foreign-owned oil companies and oil workers, and other disputes with the oil companies over whether Mexico was receiving sufficient benefits from its oil resources, the Mexican government under President Lázaro Cárdenas expropriated all oil-related assets in the country and formed PEMEX.[65]

PEMEX became the sole legal producer and supplier of oil, then the most important source of energy and foreign exchange for the country, with a limited supporting role for the private sector. During much of the early- to mid-20th century, Mexico was one of the largest oil exporters in the world, with most of the oil coming from the Bay of Campeche in southern Mexico (EIA 2017a).

The electricity sector in Mexico also developed as a state-owned monopoly in accordance with the same centralizing, nationalistic spirit reflected in the expropriation of foreign-owned oil assets and the formation of PEMEX. CFE was formed in 1934 with the mandate of regulating the private electricity monopolies and also of supplying the areas that the private sector had neglected because they were perceived as unprofitable. During the 1940s

and 1950s, CFE acquired privately owned regional concessions, and then in 1960, the electricity sector was fully nationalized (Bonetto and Storry 2010).

3.1.1 The Lead Up to the Mexican Energy Reform

By the early 2010s, it had become clear that PEMEX and CFE were not performing to the level that Mexico needed. Beginning in 2004, PEMEX suffered a major decline in oil production, dropping from 3.4 million barrels per day in 2004 to 2.5 million barrels per day in 2013, a drop of 26 percent. Indicative of this decline, Mexico's "super-giant" Cantarell oil field in the Bay of Campeche, which was Mexico's largest oil field for many years, saw its daily production decline 81 percent in the 10 years between 2004 and 2014 (McNeece, Save and Hindus 2014).

Similarly, CFE had failed to keep up with Mexico's needs in the power sector by not building new generation capacity and other needed energy infrastructure (e.g., improvements and additions to Mexico's transmission and distribution systems) at a pace adequate to meet Mexico's growing needs. A major reason for this failure was that CFE, as the state-owned power company, was dependent on consistently inadequate federal budget allocations for capital investment. There was only a modest scope for private investment through limited exceptions to CFE's monopoly on generation for (1) independent power producers, (2) self-supply arrangements, (3) cogeneration projects, (4) small power production (≤ 30 megawatts [MW]), and (5) generation for import or export. All electricity produced by these generators and not used for self-supply was sold to CFE. Nevertheless, even with these exceptions supplementing CFE's own generation capacity, CFE could not keep up with demand (Save, Hindus and McNeece 2014).

3.1.2 The Mexican Energy Reform

In response to these challenges, under President Enrique Peña Nieto, who was elected in 2012, Mexico adopted a 2013 amendment to its Constitution to permit a greater role for private parties in hydrocarbons and electricity. It subsequently adopted "secondary," or enabling, legislation in 2014 to implement the constitutional changes. These changes to the constitutional and legal framework for energy in Mexico, known as the "Energy Reform," were dramatic and far-reaching. They effected a major overhaul of the Mexican energy sector.[66]

With respect to hydrocarbons, the Energy Reform opened oil and gas exploration and drilling to private and foreign investors through contracts for profit- or production-sharing to be awarded by auction. International oil and gas companies responded favorably to these changes (Reuters 2014). In addition, the Energy Reform for the first time gave the private

sector the right to participate in the treatment and refining of oil and in the transport, storage and distribution of oil, natural gas, gasoline, diesel and other oil products in Mexico, including ownership of pipelines, storage facilities and gas stations (Embassy of Mexico to the United States 2014).

With respect to electricity, the Energy Reform permitted the private sector to generate power in Mexico for sale in a competitive wholesale electricity market and/or under long-term contracts with marketers of electricity, including CFE, which was restructured as a "state-owned enterprise." The private sector also was permitted to sell electricity directly to specified large-scale consumers in Mexico and enter into contracts with the Mexican state or CFE for the financing, construction and operation of infrastructure needed for the transmission, distribution and generation of electrical power (Save, Hindus and McNeece 2014).

In the electricity sector, CFE stills plays the largest role in power production. Other participants in the power sector include independent power producers, self-supply generators, cogenerators, small power producers, and importers and exporters (i.e., the "exceptions" under the old regime to CFE's monopoly on generation), as well as new generators authorized under the Energy Reform. Figure 6 shows the relative size of each of these participants in power production, in terms of installed capacity.

In terms of the technologies used in generation, natural gas, through combined cycle and turbine gas generation, provides the largest percentage of generation capacity as of December 31, 2018, at 41.1 percent, as shown in Figure 7. Conventional thermal at 17 percent is an older technology and may include the use of fuel oil and diesel as well as natural gas. Clean energy according to Mexican criteria includes wind, solar, geothermal, bioelectricity, hydro, nuclear and efficient cogeneration, and these total 33.2 percent of total capacity.

Natural gas continues to grow in importance within Mexico's overall energy portfolio, as it is cleaner and less expensive than alternative fuels such as fuel oil and diesel. Production of natural gas in Mexico, however, has fallen in recent years, whereas demand has increased substantially. This has resulted in substantial Mexican imports of natural gas from the United States. Mexico's imports of U.S. natural gas averaged 5.2 billion cubic feet (147 million cubic meters [m^3]) per day in 2018, between gas delivered by pipeline and liquefied natural gas delivered by ship, at a total cost to Mexico for the year of US$6.2 billion.[67] It is likely that Mexico's use of natural gas will continue to increase and that U.S. exports to Mexico will grow.

Currently, alternative energy is mandated to make up 35 percent of Mexico's energy production by 2024, according to the 2015 Energy Transition Law (DeFilippe 2018). Clean energy's 33.2 percent of total installed capacity in 2018 reflected in Figure 7 shows that Mexico is well on its way to meeting the 35 percent goal by 2024. President

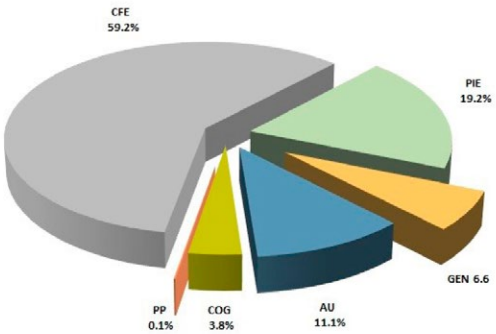


Figure 6. Installed generation capacity by type of permit at December 31, 2018. CFE—Comisión Federal de Electricidad; IPP—independent power producer; GEN—power plants with generator permits; COG–cogenerator; PP—power producer.
Source: Secretaría de Energía (Mexico Ministry of Energy, known as SENER), Figura 5.4, www.gob.mx/cms/uploads/attachment/file/475497/PRODESEN_V.pdf.

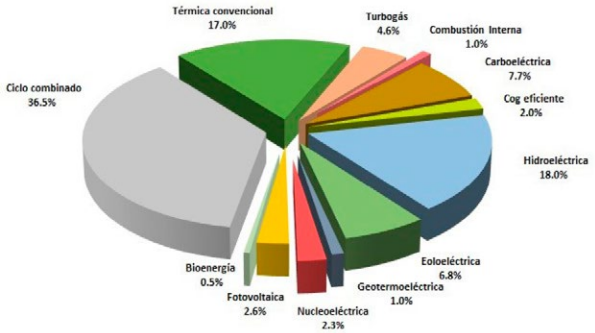


Figure 7. Installed generation capacity by type of technology at December 31, 2018 (70,053 megawatts).
Source: Secretaría de Energía (Mexico Ministry of Energy, known as SENER), Figura 5.3, www.gob.mx/cms/uploads/attachment/file/475497/PRODESEN_V.pdf.

Andrés Manuel López Obrador, however, recently suspended planned auctions for the purchase of clean energy by CFE (Davison 2019). Though the suspension may just be a temporary move as the new administration reviews decisions made in the prior presidency, President López Obrador's aversion to private sector participation in the energy sector could potentially slow down Mexico's move to embrace renewable energy on a larger scale.

3.1.3 President López Obrador's New Energy Policies

Energy sovereignty has been the stated goal of President López Obrador since his inauguration on December 1, 2018, making it clear that significant changes would be in store for Mexican energy policy. President López Obrador has moved to implant his vision of energy and its role in Mexico through a combination of reviewing aspects of the energy reforms of his predecessor and moving in new directions. The administration's actions are not always clear and have increased the level of uncertainty of the business community and called into question plans for investment in Mexico's energy sector. Although there have been pledges to retain the constitutional structure of the energy reform of the previous administration, which led to significant openings for the private sector, strengthening the central role of the longstanding government entities of PEMEX for oil and gas and the CFE for electricity now appears to be the priority. Clearly, Mexico has entered yet another period of energy policy transition, although it is too soon to discern how enduring this shift might be.

President López Obrador appointed Rocio Nahle García, a chemical engineer with a career background in the petrochemical industry at PEMEX plants and in the private sector, as Secretaría de Energia (Secretariat of Energy). She had been elected to the federal Chamber of Deputies in 2015. As head of SENER, Nahle has engaged with the international energy and finance sectors to reassure investors and lead efforts to secure the financial stability of PEMEX. In January 2019, a top-level delegation sent to New York City to meet with key financial institutions was perceived as a failure.

To lead PEMEX, President López Obrador selected Octavio Romero Oropeza, who had been a longtime ally and had worked in a top position for President López Obrador during his term as mayor of Mexico City from 2000 to 2005. Romero Oropeza is from Tabasco, as is President López Obrador, and an agronomist.

Manuel Bartlett Díaz, a veteran politician, former cabinet member and senator, was chosen to head the CFE. He immediately expressed support for increasing the government utility's ability to generate its own power rather than encouraging purchases from the private sector. The CFE had played a central role in the previous administration's energy reform in encouraging the development of privately owned large-scale renewable, combined-cycle gas turbine and cogeneration plants, as well as in the expansion of Mexico's natural gas pipeline infrastructure relying on the private sector.

In further signs that the new administration seeks to defuse the effects of the Energy Reform, it has moved to weaken the regulatory agencies that had received additional staff and authority in the previous administration. Juan Carlos Zepeda, president of the Comisión Nacional de Hidrocarburos (National Hydrocarbons Commission, known as CNH), stepped down from his post early, and two other commissioners resigned before the end of their terms. Similarly, Guillermo García Alcocer, the last remaining head of a federal government institution in the energy sector whose appointment dated to the previous administration, resigned in June as president of the Comisión Reguladora de Energía (Energy Regulatory Commission, known as CRE). He released an open letter noting that the commission's new majority-held views on regulation are incompatible with his. García Alcocer earlier had resisted pressure to step down early from his post.

Following his election, President López Obrador has left much of the Energy Reform intact, but he has cancelled or delayed auctions for oil and gas exploration and development and auctions for the purchase of clean energy while he considers amendments and changes to the original reforms (Chapa 2019a). The overall emphasis of Mexican energy policy is to shift to boosting the sector via

government initiative with the assistance of the private sector. In a move to appease markets, President López Obrador had made special mention of the private sector's role in energy production, particularly in the areas of know-how and cost reduction.

One of President López Obrador's policy priorities has been the stabilization of PEMEX to bring it back to its respected position as the center of and even a model for the rest of the Mexican economy, but this will be a major challenge.[68] In recent years, oil production has continued to decline, down to 1.68 million barrels per day in May 2019 (Robinson 2019). Production of dry natural gas also has declined, from a peak of 5 billion cubic feet (141 million m^3) per day in 2010 (SENER 2018) to 2.6 billion cubic feet (73 million m^3) per day in May 2019 (SENER 2019). Further, PEMEX presently has severe financial and debt issues, which will make it difficult to modernize. In its 2018 annual report filed with the U.S. Securities and Exchange Commission (2019) on April 30, 2019, PEMEX reported as an ongoing concern the substantial doubt as to its ability to continue, citing large net losses for the years 2018, 2017 and 2016; negative equity; negative working capital; substantial debt; and the downgrading of its debt in early 2019 by certain rating agencies. In early June 2019, two credit agencies downgraded Mexico's rating, with Fitch Ratings dropping it to BBB from BBB+ and Moody's Investor Service from A3 to negative. The top concern cited was the continuing increase in the debt of PEMEX, the world's most indebted oil company, with debt exceeding US$100 billion.

Additionally, former PEMEX leaders have been accused of corruption and mismanagement, with Mexico's attorney general recently indicting the chief executive officer of PEMEX from 2012 to 2016 on corruption charges (Reuters 2019). All of this has undermined PEMEX's ability to effect a turnaround in Mexico's oil and gas sector.

President López Obrador has made it clear that he plans to reinvigorate PEMEX and, through PEMEX, Mexico's hydrocarbon sector. This is a key part of his strategy of "energy sovereignty." It will be PEMEX's responsibility to increase production of oil and natural gas. As one of the few energy goals in President López Obrador's (2019) *Plan Nacional de Desarrollo 2019–2024* (National Development Plan 2019–2024), Mexico's domestic production of "primary energy," which includes crude oil and other raw sources of energy prior to transformation, is set to cover 100 percent of national energy consumption by 2024, up from the current level of 70 percent.

With respect to oil, President López Obrador has set a goal of increasing production from the 1.83 million barrels per day recorded for 2018 to 2.697 million barrels per day for 2024 (PEMEX 2019). For dry natural gas (gas in a form ready for consumption), President López Obrador has not set a specific goal. Under his strategy of energy

sovereignty, however, there is an implicit goal for PEMEX to increase production from the 2.6 billion cubic feet (73 million m^3) per day recorded in May 2019 (SENER 2019) to a figure closer to the projected demand in 2024 of 8.9 billion cubic feet (252 million m^3) per day (SENER 2018).

In June 2019, construction began on a refinery at the port of Dos Bocas in the southeastern state of Tabasco—López Obrador's home state—with a planned capacity of 340,000 barrels per day and a budget of 150 billion pesos (US$7.6 billion). "We do not want to be the colony of any foreign nation," President López Obrador stated at the construction's opening ceremony, broadcast in a Webcast event. "This can only be achieved through self-sufficiency." Plans call for refurbishing the six existing refineries that have been operating at well below half capacity; this refurbishing is intended to reduce the need for fuel imports that have come largely from the United States. It is not clear that the investment required to meet ambitious goals to increase production will be available.

A number of specific actions in the initial part of President López Obrador's administration include the following:

- *Cancellation of hydrocarbon auctions.* Auctions of production rights halted (approved and first implemented during the administration of Enrique Peña Nieto) in the border states of Tamaulipas and Nuevo León, as well as the states of Veracruz and Tabasco. The auctions would have included the first areas in Mexico (in this case in Tamaulipas) approved for hydraulic fracturing. That administration also noted that it would review previous auctions to ascertain whether companies were making promised investments. President López Obrador determined that there would be no further auctions until production started on contracts already granted. Outside investors were surprised by this announcement because exploration and development require substantial time after contracts are signed. Under normal timelines, it would be impossible for production to have begun on the contracts signed after initial hydrocarbon auctions.

- *Cancellation of renewable auctions.* Continuing with the emphasis on state control in the energy sector, in early February 2019, the current administration cancelled renewable energy auctions, and President López Obrador noted that the CFE would reclaim a more significant role in the renewable energy sector. This has the potential to directly affect border states that generate significant amounts of renewable energy, such as wind (i.e., Baja California and Tamaulipas) and solar (i.e., Sonora, Chihuahua and Coahuila).
- *Request for renegotiation of existing gas supply/pipeline contracts.* CFE entered into a number of transportation contracts with gas pipeline developers to extend the national natural gas infrastructure and support the construction of pipelines that would bring U.S. natural gas into Mexico. In February 2019, however, the director of CFE, Manuel Bartlett, stated that CFE will seek to renegotiate those contracts. The issue is that the contracts require payments even when the product is not being delivered. The Mexican, Canadian and American companies involved took the position that the contracts were properly granted and should not be revised. At the end of August 2019, President López Obrador announced that an agreement was reached that would save Mexico US$4.5 billion. By early September 2019, the Sur de Texas-Tuxpan pipeline began operations, the first since the agreement was reached (Robinson and Wyeno 2019).

3.1.4 Mexico's Energy Balance of Trade

Mexico's CNH, in a 2018 study, reported that Mexico in 2016 had an energy balance of trade that was substantially negative (i.e., the expenditures for imports exceeded revenues from exports by roughly US$10 billion). The elements of Mexico's 2016 energy balance of trade and their values (in millions of U.S. dollars) are shown in Table 3.

Mexico's negative energy balance of trade is of substantial concern to President López Obrador, and he has announced plans that would reduce this negative balance of trade. These include building a new refinery and rehabilitating six existing refineries, as well as significantly increasing oil and gas production.

3.2 Mexican Energy Regulation

3.2.1 Oil and Gas Production[69]

Under the Mexican Constitution, as amended by the Energy Reform, the Mexican state retains complete ownership of hydrocarbons in the ground.[70] At the same time, the Constitution opens oil and gas exploration and production in Mexico to the private sector through authorization of new contract arrangements with the Mexican state or PEMEX.[71]

Under the reform, PEMEX was initially granted "assignments" of 83 percent of Mexico's "proved and probable" reserves and 31 percent of prospective resources,[72] with the right to enter into "farmouts" in the form of joint ventures with private parties for the development of the assigned rights, subject to an auction process for the granting of farmout contract rights.[73] The reform also provided for auctions for production- and profit-sharing contracts with respect to oil and gas resources identified by SENER, in which both PEMEX and private parties could compete.[74] A few auction rounds for specified Mexican oil and gas resources were carried out, but as previously discussed, those auctions were suspended.

Once contracts are awarded, regulation of oil and gas explorations and production operations in Mexico is carried out by SENER and CNH.[75] The new Agencia de Seguridad, Energía y Ambiente (Agency for Security, Energy and Environment, known as ASEA) is responsible for regulating and supervising industrial safety and environmental protection with respect to the hydrocarbons sector, including exploration and production activities, in accordance with its own governing law. [76]

Overall, Mexico has a robust exploration and production regulatory framework in place under the Energy Reform that permits private participation in oil and gas exploration and production subject to regulation by the state. Under the López Obrador Administration, PEMEX now is the primary actor in exploration and production, but if President López Obrador later decides that Mexico needs the financial and technical resources that the private sector can provide, the regulatory framework now is able to accommodate that.

Table 3. Elements of Mexico's Energy Balance of Trade

IMPORTACIONES	EXPORTACIONES
Carbón $ 503.29	Carbón $ 0.00
Coque de carbón $ 227.94	Coque de carbón $ 0.00
Petróleo crudo $ 0.00	Petróleo crudo $ 15,933.00
Coque de petróleo $ 349.98	Coque de petróleo $ 0.00
Gasolinas y naftas $ 15,169.00	Gasolinas y naftas $ 0.00
Querosenos $ 700.04	Querosenos $ 0.00
Diésel $ 4,046.96	Diésel $ 0.00
Combustóleo $ 413.98	Combustóleo $ 945.98
Gas L.P. $ 1,543.97	Gas L.P. $ 28.00
Gas seco $ 4,059.00	Gas seco $ 2.00
Total $ 27,014.18	Total $ 16,908.99

Source: Comisión Nacional de Hidrocarburos (Mexico's National Hydrocarbons Commission), *El Sector de Gas Natural: Algunas Propuestas para el Desarrollo de la Industria Nacional,* Table 6-6, p. 134, www.gob.mx/cms/uploads/attachment/file/391881/Documento_Tecnico_GasNatural_CNH2018__1_.pdf.

3.2.2 Sale of Gasoline, Diesel and Other Petroleum Products

Under the Energy Reform, the private sector—including foreigners—can transport, distribute and store gasoline, diesel and other petroleum products and sell those products to the Mexican public, subject to receipt of a federal permit from CRE.[77] There is no regulation of the prices for sales of gasoline, diesel and liquefied petroleum gas, which are to be set by the market,[78] nor is there regulation of pricing for distribution of these products if not carried out by pipeline (e.g., in the case of tank trunks that bring gasoline to service stations).[79] CRE, however, approves the maximum rates that may be charged for transportation and distribution of these products via pipeline.[80] U.S. companies have taken advantage of this opening. For example, ExxonMobil announced at the end of 2017 that it planned to open 50 gas stations under the Mobil name by the end of the first quarter of 2018, to be supplied from ExxonMobil's refineries in Texas, as part of ExxonMobil's "long-term commitment to invest US$300 million in fuels logistics, product inventories and marketing in Mexico over the next 10 years" (ExxonMobil 2017).

3.2.3 The Natural Gas Sector

Natural gas transportation, distribution and storage services are open to the private sector, subject to a federal permit granted by the CRE.[81] A number of U.S. companies, through their Mexican affiliates, are now providing these services on a large scale. One example is Sempra Energy, based in California, which operates in Mexico through its IEnova (2019) affiliate. Generally, natural gas transportation and distribution pipelines and storage facilities are required to provide open access without undue discriminatory basis to any shipper that requests the service, provided there is available capacity in the system (e.g., after satisfaction of contract obligations, for reservation of capacity by an anchor shipper).[82]

Permits for transportation by gas pipeline are granted by CRE for a specific "trajectory" (i.e., from one or more points of origin to one or more points of destination and for a specified capacity).[83] Permits for distribution by gas pipeline are granted by CRE for a specific geographic zone, considering the technical and economic characteristics (cost structure) of the project to foster the profitable and efficient development of the distribution network, as well as urban development plans for the area.[84] CRE approves the maximum rates that may be charged for transportation and distribution service.[85] Open-access transportation and distribution permit holders are regulated and supervised by CRE and also by ASEA with respect to safety and environmental issues.[86]

The regulations for natural gas storage are similar to those applicable to transportation and distribution. A permit for storage from CRE will be for a specific installation or set of installations and for a specific capacity.[87] As with gas pipelines, CRE approves the maximum rates that may be charged for storage services.[88]

Mexico does not currently have nationwide management of its natural gas transportation system. Centro Nacional de Control de Gas Natural (National Center for Control of Natural Gas), a government agency, took ownership of the extensive gas pipeline network owned by PEMEX prior to the energy reform and operates those assets as a transportation provider.[89] In a second role, Centro Nacional de Control de Gas Natural also acts as the manager of Sistema de Transporte y Almacenamiento Nacional Integrado de Gas Natural (National Integrated Transportation and Storage System),[90] which is comprised of the former PEMEX pipeline assets and certain private pipelines in Mexico (permitted since 1995) that elected to join the system. Centro Nacional de Control de Gas Natural has announced a proposal to integrate all the pipelines in Mexico under its management (Rodriguez 2019).

Historically, PEMEX was the sole marketer of natural gas in Mexico. Private parties, however, now can engage in gas marketing activities (including wholesale trading and retail transactions) subject to permit and oversight by CRE.[91] CRE will set the maximum prices that can be charged.[92] PEMEX and private marketers are required to report information about their gas-trading transactions on a daily basis through an electronic platform to inform the market and support the eventual creation of a Mexican price index.[93]

3.2.4 The Electricity Sector

CFE is a "productive state enterprise" under the exclusive ownership of the federal government, operating under a new law that specifically governs CFE.[94] Under the Energy Reform, CFE retains its role as the sole provider of electricity for the general public ("basic service"),[95] subject to regulation of its rates and the service provided.[96] Private parties, however, are permitted to generate electricity for sale to "qualified" buyers that have substantial electricity needs, to CFE, and into a newly created wholesale electricity market.[97]

Key objectives of the Energy Reform include promotion of clean energy, diversification of energy sources, and energy security.[98] In accordance with these objectives, SENER established a mechanism for the Centro Nacional de Control de Energía (Mexican National Energy Control Center, known as

CENACE), a government agency, to hold auctions in which private sector bidders could participate. CFE and other load serving entities would acquire clean energy together with clean energy certificates, each representing 1 megawatt hour (MWh) of clean energy generation, as well as capacity. Three rounds of auctions were held, the last in 2017. For the third round, awards were granted for sales of clean energy, clean energy certificates and capacity representing 2,562 MW of new generation and an investment of US$2.37 billion (CENACE 2017). The third round also resulted in record-breaking low prices (i.e., an average price to sellers of US$20.57 per MWh of energy plus the corresponding clean energy certificates, which was 38.5 percent lower than average price of US$33.47/MWh plus clean energy certificates in the previous auction in September 2016) (Newberry 2017). Nevertheless, as previously discussed, once President López Obrador was elected, he suspended further clean energy auctions.

The Mexican state, through CFE, retains its ownership of the transmission and distribution networks.[99] Subject to retention of ownership, however, the Mexican state, directly or through state-owned entities, may form associations or enter into contracts with private parties for the financing, installation, maintenance, management, operation and expansion of infrastructure that provides transmission and distribution services.[100]

CENACE manages the wholesale electricity market and also is the operator of the national electrical system, controlling the dispatch of electrical power and operation of the national transmission grid and general distribution networks for all of Mexico.[101]

CRE is the primary regulator of the electricity industry in Mexico. Among its other responsibilities, it sets rates for CFE's basic service, the tariffs for transmission and distribution services, and the fees for the services provided by CENACE.[102] It also establishes and monitors terms for the operational and functional separation of the various services provided in the electric industry (i.e., generation, transmission, distribution and commercialization) to foster efficient operation of the electrical power industry, without undue aggregation of market power.[103]

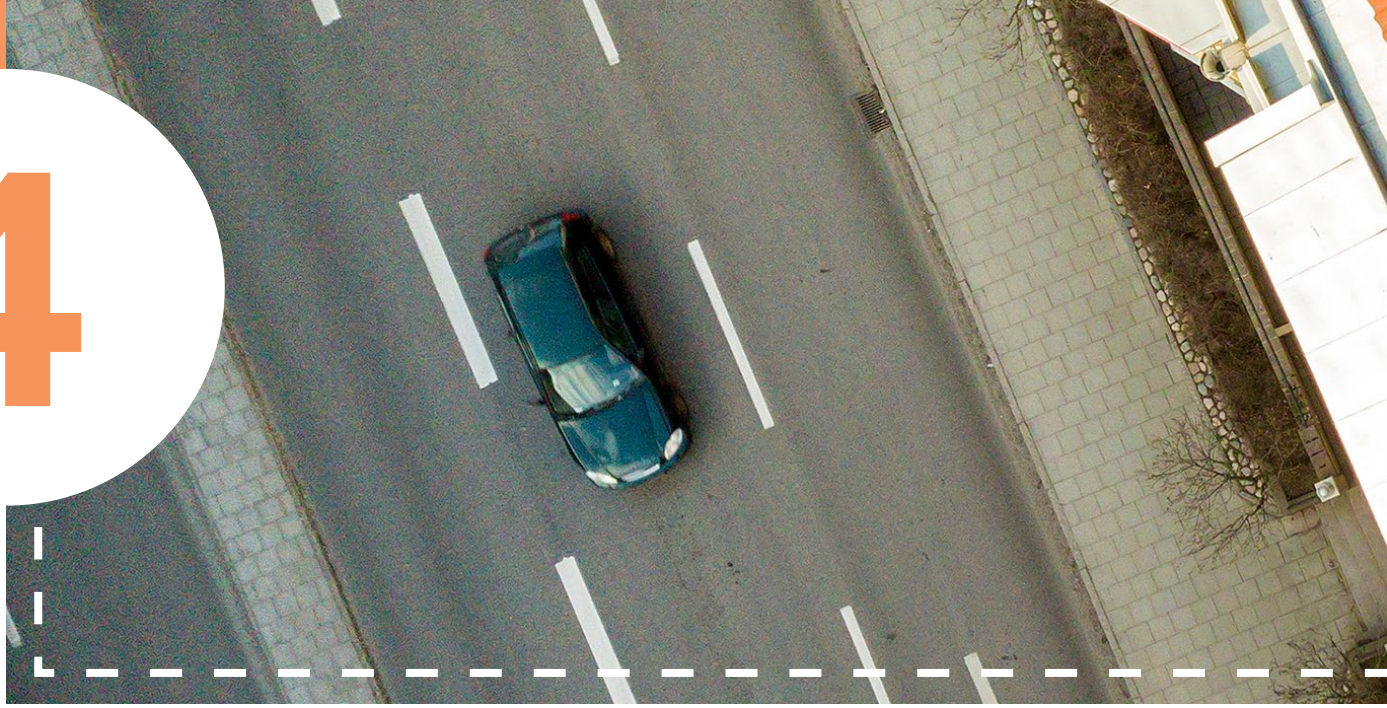
3.3 Energy-Efficiency Efforts

Mexico's existing efforts toward energy efficiency are spearheaded by the Comisión Nacional para el Uso Eficiente de la Energía (the Mexican National Commission for the Efficient Use of Energy, known as CONUEE). CONUEE acts as a regulator, a program operator, a promoter, a provider of technical support for third parties and a planning body. The agency's work is described in the *Roadmap for Building Energy Codes and Standards*, a nonmandatory vision for improving energy efficiency in buildings, with the aim of achieving net zero emissions for all new buildings by 2050. This lofty goal is advanced through Mexico's increasingly stringent building codes, as well as public-private partnerships, such as the Building Efficiency Accelerator (World Resources Institute 2016).

The California Energy Commission has focused its relationship with Mexico on expanding opportunities for collaboration and engagement around energy efficiency. Although Mexico lacks in substantial national-level efforts around energy efficiency—partly as a result of the recent leadership transition—universities, states and cities have demonstrated a continued commitment to advancing energy efficiency through partnerships with U.S. governmental and nongovernmental entities. Though these programs are piecemeal compared to approaches in California and the United States, they represent progress toward realizing the reliability, infrastructure, health and economic benefits conferred by robust energy-efficiency solutions. Mexico ranks 12, immediately following the United States and Canada, in the American Council for an Energy Efficient Economy's 2018 International Energy Efficiency Scorecard, an improvement from its two prior rankings.

The next chapter discusses the legal and institutional framework in the United States and Mexico with respect to cross-border energy relations. Although Chapters 2 and 3 present information about the United States and Mexico separately, this next chapter focuses on a series of specific topics pertaining to cross-border energy relations and in each case discusses the applicable law and institutional arrangements for both the United States and Mexico.

4

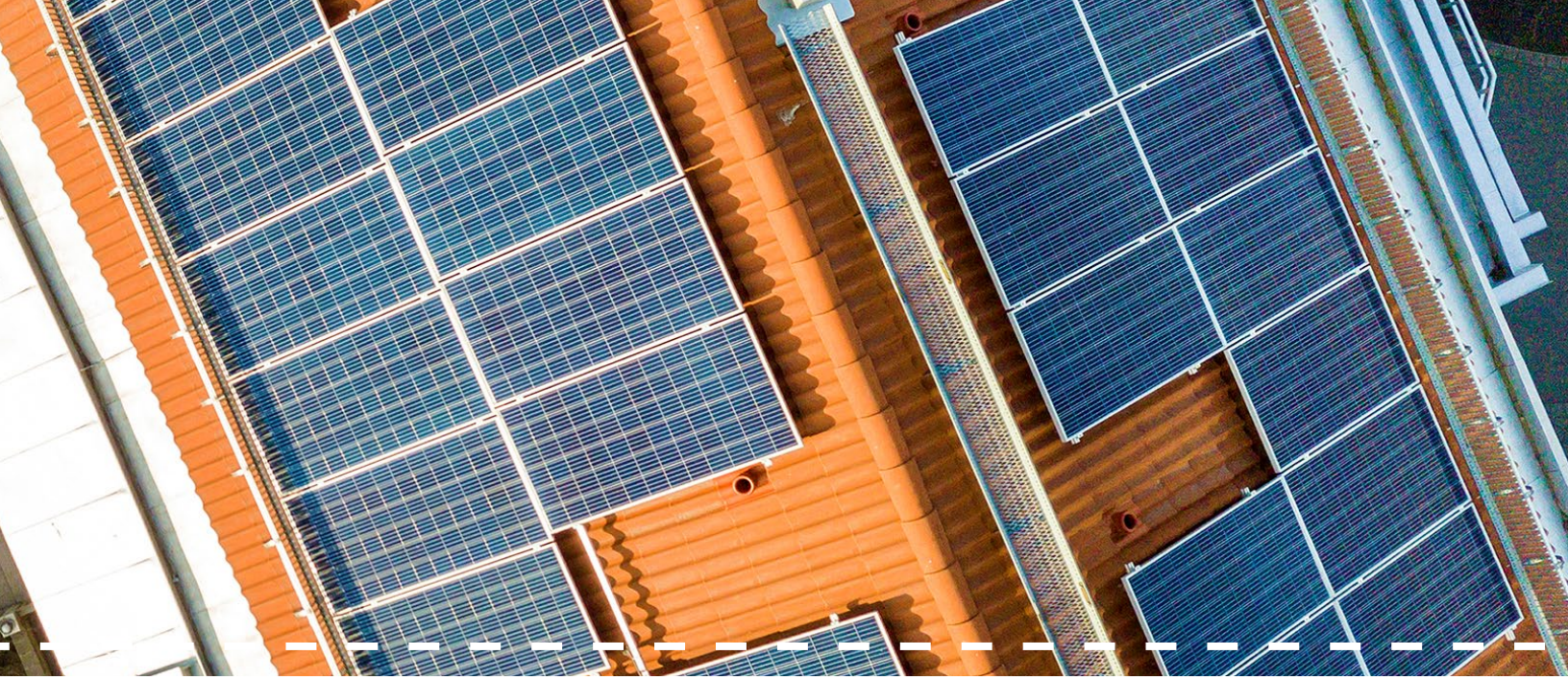


U.S.-Mexico Cross-Border Energy Relations: The Legal and Institutional Framework

4.1 U.S.-Mexico Cooperation for Oil and Gas Production in the Gulf of Mexico

One instance in which the United States and Mexico have directly cooperated to facilitate production of oil and gas involves the *Agreement Between the United States and Mexico Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico* (referred to hereafter as the Agreement), signed on February 20, 2012, and effective July 18, 2014 (U.S. Department of State 2012). According to the Bureau of Ocean Energy Management (2019), which resides within the U.S. Department of the Interior (DOI), the Agreement "establish[es] a framework for the cooperative exploration and exploitation of hydrocarbon resources that cross the United States-Mexico maritime boundary in the Gulf of Mexico (excluding areas under the jurisdiction of Texas)."

Among other things, the Agreement allows leaseholders on the U.S. side of the boundary to cooperate with Petróleos Mexicanos (the Mexican national oil and gas company, known as PEMEX) in the joint exploration and exploitation of hydrocarbon



resources through “unitization” of transboundary reservoirs. In cases where a unitization agreement is not reached, the Agreement allows for unilateral production by each side, up to the amount of hydrocarbons that exist on its side of the boundary. In addition, the Agreement provides a mechanism to resolve disputes regarding the development of specific reservoirs. Finally, it establishes an inspection regime, whereby each side regulates activity on its side of the boundary but also has the ability, under an inspection system to be developed, to inspect activity that takes place under the Agreement on the other side of the boundary (Bureau of Ocean Energy Management 2019).

Notwithstanding these broad terms established by the Agreement, it is fundamentally a framework, with many details, processes and procedures to be devised. Implementation now is underway. In the United States, the Bureau of Safety and Environmental Enforcement and Bureau of Ocean Energy Management, both within DOI, are the relevant agencies. In Mexico, the Agreement will be implemented by the Secretaría de Energía (Ministry of Energy, known as SENER), Comisión Nacional de Hidrocarburos (National Hydrocarbons Commission, known as CNH), and Agencia de Seguridad, Energía y Ambiente (Agency for Security, Energy and Environment, known as ASEA) (Sebastian 2015).

4.2 NADB and Financing of Renewable Energy Generation in the Border Region

The North American Development Bank (NADB) is a binational financial institution established by the United States and Mexico that is capitalized in equal parts by the governments of the United States and Mexico and managed by a 10-member Board of Directors, five of whom are appointed by the U.S. government and five appointed by Mexico’s government (NADB 2019a). According to NADB (2019a), its purposes are “to provide financing to support the development and implementation of infrastructure projects, as well as to provide technical and other assistance for projects and actions that preserve, protect or enhance the environment to advance the well-being of the people of the United States and Mexico.”

Although initially focused on water and wastewater for border communities, NADB has expanded its portfolio to include projects for renewable energy sources and for reducing energy consumption. As with all NADB projects, these must be located in the “border region” (i.e., within 100 kilometers [km] [62 miles] north of the international boundary in the four U.S. states of Texas, New Mexico, Arizona and

Table 4. North American Development Bank Energy Projects

TYPE OF PROJECT	NO. OF PROJECTS	TOTAL MW	NADB FINANCING		STATUS
			Approved	Contracted	
Biofuel	1	--	3.69	3.69	1 in operation
Biogas	2	3.0	5.38	5.38	2 in operation
Efficiency	1	--	50.00	25.00	1 under development
Solar	18	780.0	559.92	559.92	- 16 in operation - 2 under construction
Wind	14	2,091.8	919.33	919.33	- 12 in operation - 2 under construction
Total	36	2,874.8	$1,538.31	$1,513.31	- 31 in operation - 4 under construction - 1 under development

MW—Megawatt
Source: North American Development Bank.

California and within 300 km [186 miles] south of the border in the six Mexican states of Tamaulipas, Nuevo León, Coahuila, Chihuahua, Sonora and Baja California) (NADB 2017). Table 4 shows NADB's energy projects as of June 2019, including the financing committed by NADB.

The 116th U.S. Congress[104] proposed legislation that would recapitalize NADB to address the growing environmental infrastructure deficit in the border region. This effort would support expansion of water and wastewater treatment capacity and replacement of aging infrastructure. It also would increase NADB's ability to finance energy projects for the benefit of border communities, including tribes.

4.3 Cross-Border Infrastructure—Presidential Permits

Generally, the construction, operation and maintenance of facilities that cross the U.S.-Mexico border must be authorized by the U.S. federal government through the issuance of a Presidential Permit in accordance with requirements set forth in a series of executive orders (Vann and Parfomak 2017). The Presidential Permit process involves interagency coordination to ensure that physical interventions of the international border zone are in the national interest of the United States. Three main actors (U.S. Department of State [DoS], U.S. Department of Energy [DOE] and Federal Energy Regulatory Commission [FERC]) drive the process for energy projects, whereas many other agencies interact with the process depending on the type of infrastructure under review. There is no corresponding permit process in Mexico necessary to authorize an international border crossing of energy infrastructure.

Cross-border electricity transmission facility Presidential Permit applications are received by DOE's Office of Electricity.[105] Cross-border natural gas pipeline Presidential Permit applications are received by FERC.[106] For cross-border facilities exporting or importing petroleum, petroleum products, coal or other fuels to or from a foreign country (but not including gas pipelines), applications are received by the Secretary of State.[107] The President is the ultimate decision maker for Presidential Permits issued for oil pipeline crossings at U.S. borders, [108] which President Donald J. Trump authorized on March 29, 2019, in response to the application for a pipeline to import oil from Canada to the United States filed by TransCanada Keystone Pipeline, L.P. (Trump 2019).

Generally, to apply for a Presidential Permit, an energy project proponent (applicant) must include the development of a project description by a specific applicant (a state, county, municipality, public utility or a private-sector entity), a review of impacts from the proposed project to resources in the United States,[109] and completion of necessary studies to determine project feasibility. Following a review and determination of all application materials by the corresponding lead agency, applicants may amend a Presidential Permit application based on feedback from the determination.

Interspersed in a Presidential Permit process are public *Federal Register* notices, review by the public, and review and favorable recommendation by "BOSAS" (bureaus, offices, services, agencies and state/subnational), including the U.S. Section of the International Boundary and Water Commission (USIBWC). The Presidential Permit decision concludes with a determination by the relevant agency that authorization of the subject facility is in service to national (or public) interest[110] and permit issuance by the appropriate executive agency official.

USIBWC also is involved in the permit process for infrastructure that crosses the international boundary. USIBWC is a federal agency whose mission is to provide binational solutions to issues that arise during the application of U.S.-Mexico treaties regarding boundary demarcation, national ownership of waters, sanitation, water quality and flood control in the border region.[111] As part of the mission, the USIBWC, along with its counterpart from Mexico, the Mexican Section of the IBWC, reviews projects that cross the border, whether they are border-crossing infrastructure, pipelines or power. The purpose of the IBWC review is to assure appropriate positioning of the crossing and appropriate construction in areas where the two countries have built levee systems, dams, reservoirs, wastewater treatment facilities and border demarcation monuments.

USIBWC has a license and lease program that tracks projects that affect federal property or cross the international boundary. Under the 1970 Boundary Treaty[112] and the 1944 Water Treaty,[113] USIBWC reviews projects that cross the international reach of the Rio Grande or Colorado Rivers to maintain the international boundary, demarcate the boundary on new structures, and ensure that new infrastructure does not cause any changes to the international boundary or water surface elevation nor deflect additional flows to either country. For the land boundary, USIBWC reviews projects to maintain the boundary and line of sight and ensure that the character of transborder flows is not affected.

For the U.S. review process, USIBWC reviews transborder energy projects during the Environmental Assessment/Environmental Impact Statement process and provides feedback to the project sponsor during this phase through the DOE, DoS or FERC. Following on issuance of a Presidential Permit, project plans are sent for technical review and exchanged with the Mexican counterpart. Plans for the infrastructure to be built in both countries is exchanged and reviewed by the U.S. and Mexican sections of the IBWC. Once the technical review is completed, the IBWC Commissioners exchange letters signifying approval of the project for the U.S. and Mexican infrastructure that makes up the border crossing or facility. Each project sponsor (United States and Mexico) is formally notified of approval of the project and issued a license that is kept on record by USIBWC (Figure 8).

4.4 Cross-Border Infrastructure—Natural Gas Pipelines

In addition to a Presidential Permit, a natural gas pipeline that crosses the U.S.-Mexico border requires a permit under the Natural Gas Act of 1938. In particular, the National Gas Act prohibits natural gas imports or exports to or from the United States without a DOE order.[114] Although this speaks to imports or exports of gas, rather than to the infrastructure carrying the gas, the President by executive order determined that the pipeline itself would also require a DOE permit under the Federal Power Act.[115]

The approval process is different for countries with which the United States has a free trade agreement (FTA) and for countries that have not signed an FTA agreement with the United States ("non-FTA countries"). Under Section 3(a) of the Natural Gas Act,[116]

> "[N]o person shall export any natural gas from the United States to a foreign country or import any natural gas from a foreign country without first having secured an order of the [DOE] authorizing it to do so. The [DOE] shall issue such order on application, unless, after opportunity for hearing, it finds that the proposed exportation… will not be consistent with the public interest."

Section 3(c) of the National Gas Act,[117] however, limits DOE's discretion with respect to countries that are signatories to an FTA with the United States:

> "For purposes of subsection (a), the importation of natural gas… or the exportation of

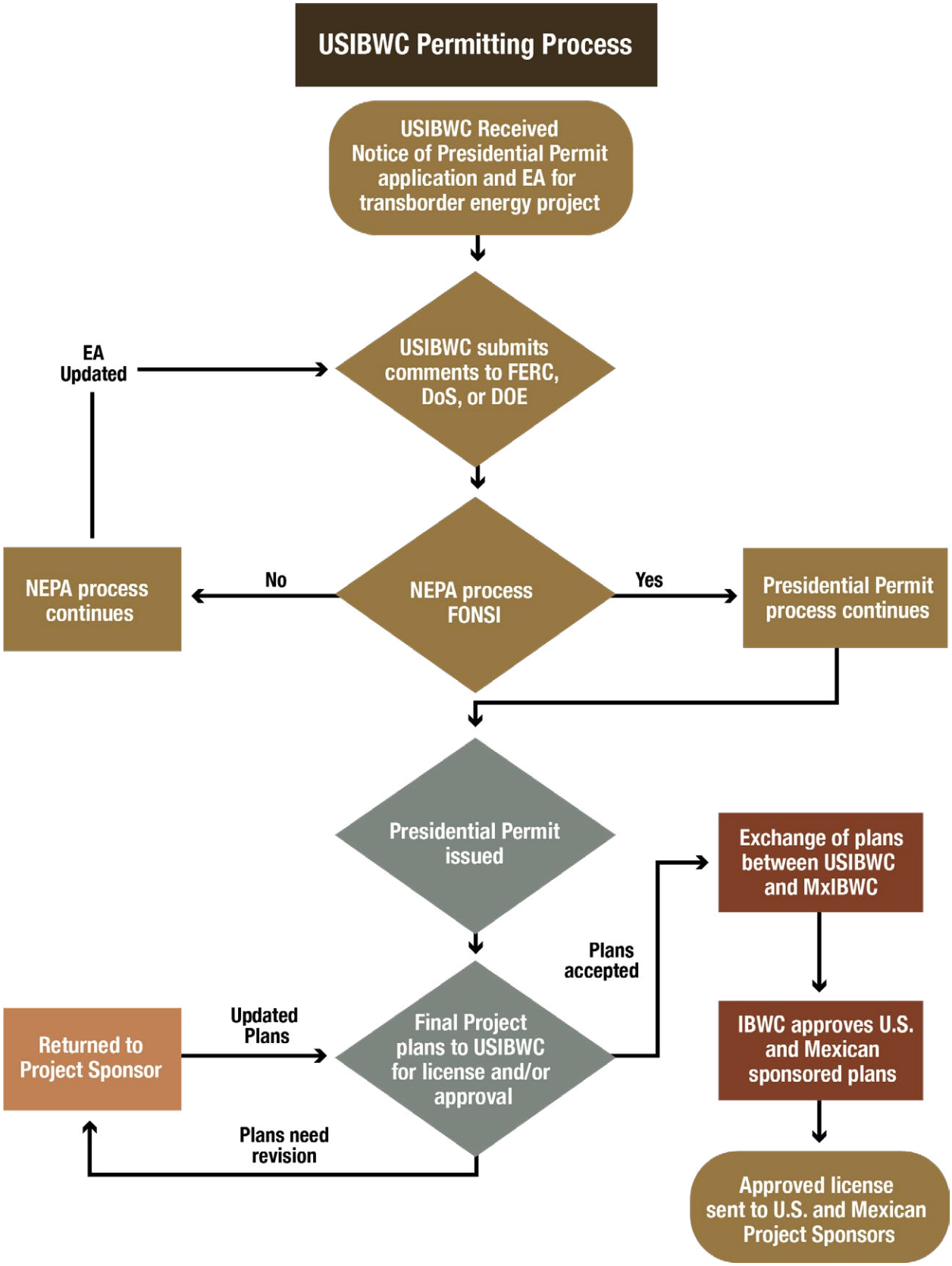


Figure 8. The structure of the U.S. Section of the International Boundary and Water Commission (USIBWC) permitting process.
Source: USIBWC.

> natural gas to a nation with which there is in effect a free trade agreement requiring national treatment for trade in natural gas, shall be deemed to be consistent with the public interest, and applications for such importation or exportation shall be granted without modification or delay."

This means that approval for all imports and approvals for exports to countries with FTA agreements are essentially automatic. Mexico is a signatory to the North American Free Trade Agreement (NAFTA), which has a requirement for national treatment covering natural gas. Mexico therefore is entitled to take advantage of the foregoing language, whereby natural gas exports are deemed to be in the public interest, and the approval for exports of natural gas to Mexico essentially will be automatic.[118]

4.5 Export Infrastructure—The Case of Liquefied Natural Gas Facilities

As previously noted, FERC has "exclusive authority to approve or deny an application for the siting, construction, expansion, or operation" of a liquefied natural gas terminal within the scope of its jurisdiction."[119] Because a liquefied natural gas facility is built specifically for the purpose of exporting or importing natural gas, however, it is subject to a separate permit from the DOE for that export/import activity, as discussed in Section 4.4. Within DOE, the power to grant an export authorization is delegated to the Assistant Secretary for Fossil Energy.[120]

As discussed in Section 4.4, approvals for all imports and approvals for exports to countries with FTA agreements are essentially automatic; however, liquefied natural gas facilities generally seek authority to sell to both non-FTA countries and FTA countries.[121] With respect to non-FTA applications, the application process for export permits is more complicated, allowing a broad inquiry into whether exports of natural gas are in the "public interest." For non-FTA applications, the DOE interprets Section 3(a) as creating a rebuttable presumption that a proposed export of natural gas is in the public interest, unless opponents overcome that presumption by making an affirmative showing of inconsistency with the public interest.[122] DOE historically has reviewed economic factors and environmental factors in evaluating claims that proposed exports to non-FTA countries are *not* in the public interest.

The economic factors pertain to the domestic need for the natural gas proposed to be exported, any potential threat to the security of domestic natural gas supplies, the effects of exports on domestic prices, and the benefits of international trade. With respect to these factors, economic studies commissioned by DOE show that exports do not adversely affect domestic supply, have minor effects on pricing, and are generally beneficial to the economy.[123]

As to environmental factors, DOE (2014) prepared the *Addendum to Environmental Review Documents Concerning Exports of Natural Gas From the United States* (Addendum), which addresses unconventional natural gas production in the nation as a whole and the impact of such production on water quality and quantity, air quality, climate change/greenhouse gas emissions, land use and induced seismicity. Relying on studies of economic factors, environmental studies and the Addendum, DOE has granted a number of non-FTA export permits.[124]

4.6 Cross-Border Trade in Energy

A fundamental point with respect to cross-border trade in energy is that energy products subject to trade (i.e., oil, petroleum products such as gasoline and diesel fuel, natural gas, and electricity) are treated as "goods" for purposes of NAFTA, which sets the tariff rates for trade between the United States and Mexico. Under NAFTA, there are no import duties on any of these energy products. This means that the United States can sell each of these products to Mexico without the buyers paying import duties. This is particularly important with respect to gasoline and diesel fuel, natural gas, and electricity because the United States sells large quantities of these products to Mexico; however, it also is necessary to determine whether other permit requirements exist for the export of these products, as there are for natural gas and electricity.

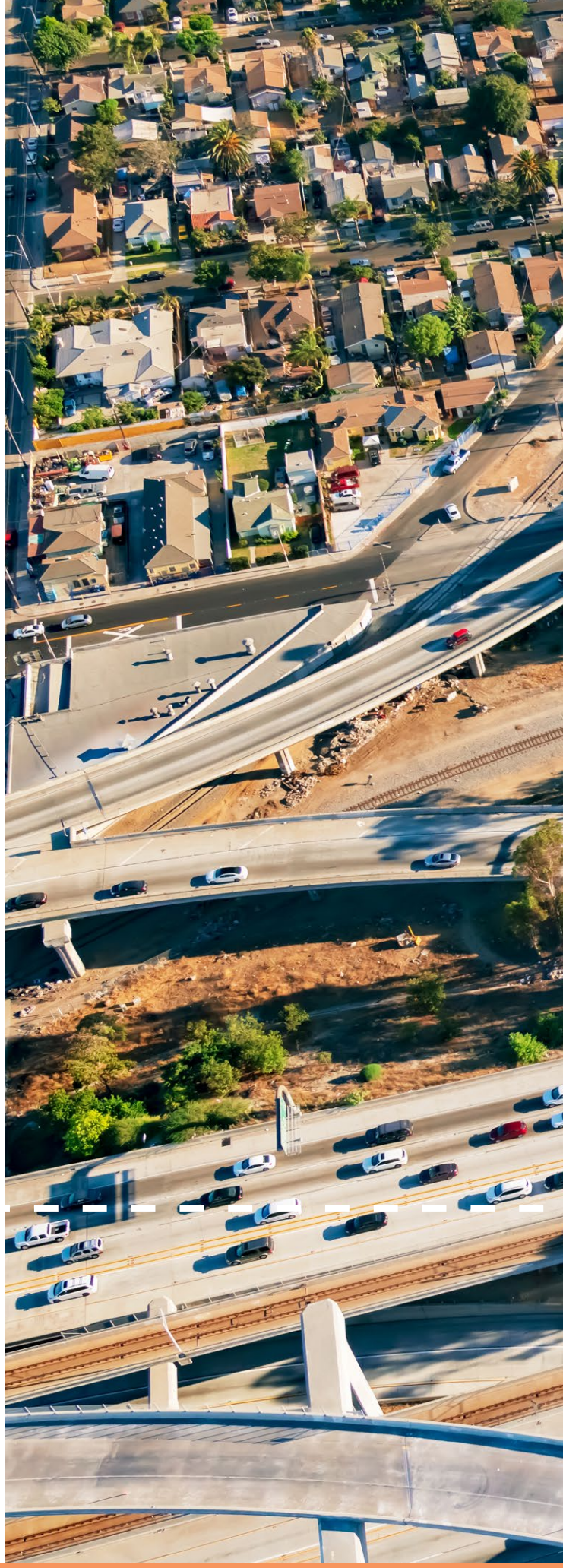
4.6.1 Petroleum Products

In the case of petroleum products, there are no additional permit requirements. As Mexico's production of oil has fallen, so has production of gasoline, diesel and petroleum products. Imports, particularly from the United States, have surged as a result. In 2018, according to the U.S. Energy Administration (EIA), the United States exported to Mexico 440,975 thousand barrels of petroleum products, of which 188,790 thousand were finished motor gasoline, 107,611 thousand were distillate fuel oil with less than 15 parts per million of sulfur (diesel fuel), 51,144 thousand were liquefied petroleum gases, and 47,819 thousand were propane (EIA 2019k). To give a sense of the magnitude of these numbers, the exports of gasoline alone cost Mexico approximately US$15.4 billion for 2018.[125]

4.6.2 Natural Gas Exports and Imports

As previously discussed, the National Gas Act prohibits imports or exports of natural gas to or from the United States without an authorization from DOE. For exports to FTA countries such as Mexico, however, the permit is granted essentially automatically. U.S. exports of natural gas to Mexico averaged 5.2 billion cubic feet (147 million cubic meters) per day in 2018, between gas delivered by pipeline and liquefied natural gas delivered by ship, at a total cost to Mexico of US$6.2 billion for the year.[126] Export of liquefied natural gas by tanker truck to customers in Mexico not served by natural gas pipelines is growing, as liquefied natural gas provides a less expensive alternative to diesel. The Trump Administration has proposed that shipping by rail also be permitted, a practice long banned in the United States because of safety concerns (Chapa 2019b).

Under Mexican law, exporting or importing natural gas requires a permit from SENER.[127] SENER also regulates such exportation and importation in accordance with Mexico's Ley de Comercio Exterior (Foreign Trade Law), with support from the Secretaría de Economía (Mexican Minister of the Economy).[128]



A fundamental point with respect to cross-border trade in energy is that energy products subject to trade are treated as “goods” for purposes of NAFTA, which sets the tariff rates for trade between the United States and Mexico.

4.6.3 Electricity

There is no licensing requirement for imports of electricity into the United States. Exporting electricity to a foreign country, however, requires an export order from DOE under Section 202(e) of the Federal Power Act. This section of the act states that DOE "shall issue such order on application unless, after opportunity for hearing, it finds that the proposed transmission would impair the sufficiency of electric supply within the United States or would impede or tend to impede the coordination in the public interest of facilities subject to the jurisdiction of [DOE]."[129]

DOE has issued numerous orders authorizing electricity exports in accordance with the law and following a determination that certain requirements are met. The first requirement (i.e., no impairment of sufficiency of electric supply) is satisfied where the wholesale electricity market is in place, reliability of delivery is established by an effective regulatory framework, and the applicant is a power marketer and is not obligated to serve a franchised territory. The second requirement—pertaining to the operational reliability and security of the domestic electric transmission system—is satisfied based on (1) existing industry procedures for obtaining capacity on the domestic transmission system and (2) the reliability standards applicable to cross-border power flows and technical studies presented to DOE. In each case, an export order is issued subject to conditions designed to protect the reliability of the domestic transmission systems.[130]

Under the Mexican Ley de la Industria Eléctrica (Law of the Electrical Industry), both importing and exporting electricity require authorization from the CRE.[131] To be connected to Mexico's national grid, imported electricity must be generated by power plants connected exclusively to the Mexican grid[132] (i.e., power plants located in the United States providing power to the Mexican grid can provide power only to the Mexican grid). Electricity exported from Mexico is permitted only where the export is carried out without use of the Mexican transmission grid or distribution networks.[133]

4.7 Cross-Border Trade in Renewable Energy

Each state located along the southern U.S. border has imposed requirements on electric utilities that a certain percentage of the utilities' electricity deliveries come from renewable sources. In the case of California, the law permits renewable resources located in Mexico to satisfy this requirement under specified circumstances.

California has set a target for electricity utilities to generate 20 percent of total retail sales of electricity in California from eligible renewable energy resources by December 31, 2013; 33 percent by December 31, 2020; 50 percent by December 31, 2026; and 60 percent by December 31, 2030.[134] In addition, Senate Bill 100[135] requires a 100 percent carbon-free grid by December 31, 2045. This is known as the "renewables portfolio standard."[136] An electrical generation facility that uses a permitted form of renewable energy need not be in California to be an eligible renewable energy resource, so long as it meets certain criteria. One of those criteria is that it be "near the border of the state with the first point of connection to the transmission network of a balancing authority area primarily located within the state."[137]

This means that if a renewable energy facility in Mexico has its first point of connection to a transmission grid where the grid is managed by a California balancing authority such as the California Independent System Operator, and that first connection point is in California, then that Mexican facility can be an eligible renewable energy resource for purposes of the California renewables portfolio standard.

San Diego Gas & Electric (SDG&E) has taken advantage of these provisions to purchase renewables portfolio standard–eligible electricity from a wind farm located in Baja California that delivers electricity directly to the California grid. In the decision of the California Public Utilities Commission (CPUC) to approve the transaction, CPUC found that the electricity to be purchased by SDG&E under the agreement met the renewables portfolio standard requirements; it also held that the SDG&E expenditures under the agreement would be fully recoverable in rates (2012a, b).

4.8 Cross-Border Cooperation in Energy Regulation—NERC and Mexico

As the energy flows of the United States and Mexico become more integrated, there is a corresponding need to ensure that the regulatory framework is adequate to manage those flows. This is particularly the case with electricity because a failure in the electric grid in one location can cascade and cause failures across a large swath of the grid. This is what occurred in 2003 during the widespread power outage throughout parts of the Northeastern and Midwestern United States and the Canadian province of Ontario (Barron 2003). Of course, the failure can extend across an international border when the grid crosses the border, as occurred with Mexico in the 2011 Southwest Blackout (Kucher and Baker 2011).

As discussed in Chapter 3, the North American Electric Reliability Corporation (NERC) is the organization appointed by FERC as the Electric Reliability Organization (ERO), responsible for overseeing the reliable operation of the U.S. bulk power system (i.e., the interconnected electric grid for the United States).[138] To carry out this responsibility, "NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the bulk power system through system awareness; and educates, trains, and certifies industry personnel" (NERC 2019).

Although NERC is charged specifically with overseeing the bulk power system in the United States, it has established a broader North American strategy in recognition of the increasingly international scope of the grid. In this regard, NERC has incorporated Canada into its efforts. "In Canada, NERC standards are adopted as mandatory and Canadian stakeholders make significant contributions to standards, assessments, and compliance through established collaboration mechanisms" (NERC 2017). NERC also is subject to oversight by governmental authorities in Canada (NERC 2019). Now NERC is placing more focus on integration of Mexico into the NERC process.

In its long-term planning document, *ERO Enterprise Long-Term Strategy: November 2017*, NERC (2017) points out that "[p]roposed increases in cross-border electricity trade and rapid expansion of interconnection ties with Mexico will require increased cooperation in evaluating and addressing reliability and security considerations" (p. 3). To this end, NERC reports that "On March 8, 2017, NERC, the *Comisión Reguladora de Energía*, and the *Centro Nacional de Control de Energía* signed a memorandum of understanding that outlines a framework for a cooperative relationship between NERC and Mexico to further enhance the reliability of the North American BPS [Bulk Power System]. The ERO Enterprise will work with Mexican counterparts to develop and implement the framework outlined in the memorandum with the goal of supporting Mexico in its ongoing efforts to ensure reliability as it reforms and modernizes its electric system" (NERC 2017, p. 3).

According to the NERC long-term planning document, NERC has established "Recommended Strategic Focus Areas," which are "intended to guide operations planning, resource allocation, and annual budgeting to support the ERO Enterprise in both preserving its current progress and achievements and adapting to meet the new challenges" (NERC 2017, p. 12). One of those Recommended Strategic Focus Areas is to "strengthen engagement across North America." With respect to Mexico, "the ERO will complete a full integration of Mexico into the ERO and ensure that Mexico is engaged with NERC and relevant Regional Entity technical committees and initiatives, including:

- Analysis of reliability standards and process development;
- Assessment of reliability performance and risks;
- Identification and assessment of risks related to critical infrastructure protection, cyber and physical security; and
- Sharing of relevant reliability information associated with Mexico's accelerated development of renewable energy resources and transmission infrastructure" (NERC 2017, p. 12).

NERC's North American strategy reflects the necessity of using cross-border cooperation as the means for incorporating Canada and now Mexico into supervisory efforts for the interconnected electric

grid. The United States, Canada and Mexico are sovereign nations and have exclusive jurisdiction over their respective territories, but the grid increasingly crosses the international borders between the United States and Canada and the United States and Mexico. Canada has elected to cooperate with NERC by participating in NERC processes and using NERC standards that it helped to establish, and the Canadian government now plays a supervisory role with respect to NERC. Mexico now participates in NERC with a portion of northern Baja California (NERC 2019). As there is more integration between the U.S. and Mexican grids, it can be expected that NERC will take a greater role in Mexico's reliability strategy for its grid, and Mexico will take a greater role in NERC.

4.9 State and Local Cooperation to Foster Energy Trade and Efficiency

The increased energy integration between the United States and Mexico has effects on trade flows and transportation systems at the local level. It is accordingly prudent for U.S. state and local governments in the border region to account for U.S.-Mexico energy integration in their planning efforts, particularly transportation planning. For U.S. state and local government officials this means, among other things, consulting with their counterparts in Mexico to understand Mexican forecasts of trade flows and the planning efforts taking place on the Mexican side of the border. The growth of liquefied natural gas shipments by truck across the Texas border is a key example. Increasingly, the number of gas pipelines into Mexico to meet long-term demand will have a considerable effect on border communities, and local authorities need to plan for this new infrastructure.

An example of a planning effort that takes account of contemplated U.S.-Mexico energy trade is the *Texas-Mexico Border Transportation Master Plan* (BTMP), which explicitly incorporated consultation with Mexico.[139] According to the Texas Department of Transportation, the BTMP has been defined and supported by the United States-Mexico Joint Working Committee on Transportation Planning and Programming, which includes the following:

- U.S. Department of Transportation;
- *Secretaría de Comunicaciones y Transportes* (the Mexican Secretariat of Communications and Transportation);
- U.S. Department of State;
- *Secretaría de Relaciones Exteriores* (the Mexican Secretariat of Foreign Affairs);
- Four U.S. southern border states, including Texas;
- Six Mexican northern border states, including Chihuahua, Coahuila, Nuevo Leon and Tamaulipas;
- U.S. General Services Administration; and
- U.S. Customs and Border Protection.

Some key elements of the Texas BMTP and the planning process used for its development are as follows:

- One element will be the accommodation of trade flows, which includes energy trade.
- A key consideration will be the anticipated increase of economic activity in Mexico's northern border (especially oil and gas). Among the identified issues and challenges is an increase in wind, shale gas and oil volumes.
- The BTMP will be multimodal and include pipelines.
- Texas is consulting with public officials and the private sector in Mexico to obtain input for development of the BTMP. During a January 2019 visit to Mexico City, members of the BTMP task force met with the Comisión Nacional de Hidrocarburos (Mexico's National Hydrocarbons Commission) and representatives in the Mexican private sector involved in solar energy projects.

The California Energy Commission currently is working with the University of California, Davis and the Mexican state of Jalisco to build a Center of Lighting Technology (Centro de Tecnología de Iluminación) at the Universidad Autónoma de Guadalajara. Its design is based on the California Lighting Technology Center at the University of California, Davis. The Center's mission is to transform the lighting industry in Mexico, directing it toward more efficient, higher quality lighting. The project is funded by SENER (2017) and Consejo Nacional de Ciencia y Tecnología (the Mexican National Council of Science and Technology).

The Lawrence Berkeley National Laboratory's Mexico Energy Initiative has facilitated cross-border partnerships that seek to accelerate Mexico's transition to cleaner energy. Through the Mexico Energy Pathways Initiative, researchers from Lawrence Berkeley National Laboratory work with Mexican policymakers to elevate the profile of energy efficiency, among other energy-related missions. Partner institutions in Mexico include SENER, the Comisión Nacional para el Uso Eficiente de la Energía (the Mexican National Commission for the Efficient Use of Energy), and a range of universities and research organizations. Additionally, former Lawrence Berkeley National Laboratory researcher Claudia Sheinbaum Pardo was elected Mayor of Mexico City in July 2018. During her tenure at Lawrence Berkeley National Laboratory, Sheinbaum Pardo examined energy efficiency in the building, transportation and industry sectors and is likely to bring her nuanced and science-based perspective to managing Mexico City's growing energy needs.

The Mexico Cooling Initiative, which represents a subprogram of the Mexico Energy Initiative, aims to reduce energy demand from cooling by 50 percent and save US$100 billion by 2050 through coordination among the Mexico Energy Initiative's partner organizations and government agencies. The Mexico Cooling Initiative posits a cohesive plan to achieve its lofty goal that includes targets for research and development, program implementation and capacity building, and coordination. Funded by the U.S. Agency for International Development and the Kigali Cooling Efficiency program, the initiative launched in 2018 in the aftermath of the Summit on Space Cooling Research Needs and Opportunities in Mexico.

5

U.S. Border Energy

5.1 California Border Region: San Diego and Imperial Counties

5.1.1 Overview of San Diego

Three large power plants fueled by natural gas account for most of the installed in-region generation of 3,117 megawatts (MW) (Figure 9).

Factors driving energy demand in the California border region, which consists of San Diego and Imperial Counties, are population growth, geology, weather, water availability and environmental issues, particularly air quality. The region is located in the southwestern corner of the United States, far from major electricity supply centers and natural gas sources. A small portion of Arizona, including the cities of Yuma and San Luis, often are included as part of the California border region in terms of energy. The geographical location helps explain the very high electricity rates for San Diego compared to other parts of the country. The region also is vulnerable to the grid impacts of natural disasters such as earthquakes, fires, and other potential energy interruptions. As described in Section 4.7, the

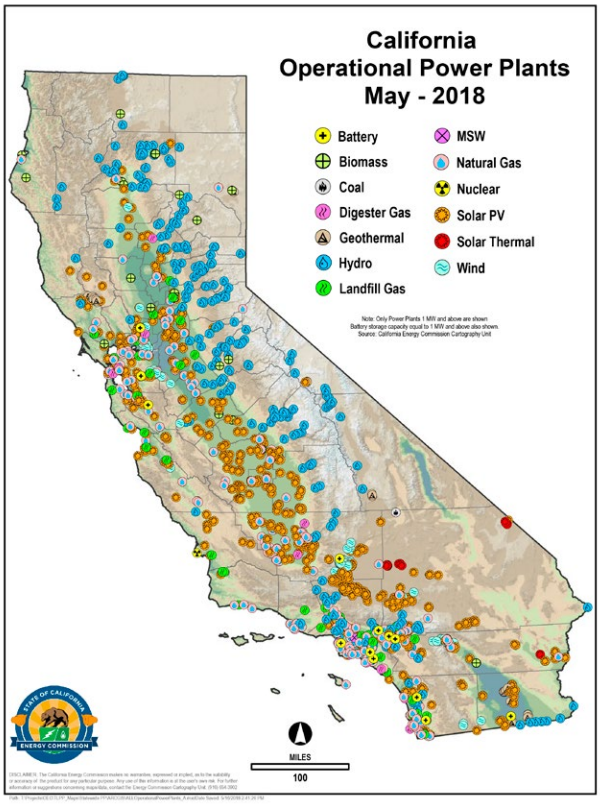


Figure 9. California operational power plants, May 2018.
Source: ww2.energy.ca.gov/maps/powerplants/Power_Plants_Statewide.pdf.

energy future of California is largely framed by state mandates and policy. California's Senate Bill 100[140] calls for utility providers to source 50 percent of their retail sales from renewables portfolio standard–compliant resources by 2026, 60 percent by 2030, and 100 percent from carbon-free resources (including large hydro) by 2045.

As of 2016, San Diego County has 3.33 million residents, and Imperial County has 187,157 (California Department of Finance 2016). Population growth is high in the region, with San Diego County expected to reach 4 million by 2050. In addition to population growth, other factors related to energy use in this region include population shifts to inland regions away from the coast, resulting in greater demand for air conditioning; extreme weather events, especially fires and heat waves; climate change; and air quality issues, especially in the Imperial Valley but also in the coastal region.

For the purposes of this analysis, the California border region is divided into two zones: western (San Diego County) and eastern (Imperial County).

5.1.2 Current Energy Sector in San Diego: Demand and Sources of Energy

The primary sources of energy used for electricity generation in San Diego County are renewable resources and natural gas, which are brought to the region via pipeline from other parts of the United States. According to San Diego Gas & Electric's (SDG&E) publicly available 2017 power content label (Table 5), renewable sources accounted for 44 percent of SDG&E's power mix (primarily wind and solar), and natural gas accounted for 39 percent. "Unspecified sources of power" account for the remaining 17 percent; this category encompasses a mix of resource types that cannot be traced to a specific generator and may include renewables and imported power.

Table 5. San Diego Gas & Electric's 2017 Power Content Label

2017 POWER CONTENT LABEL San Diego Gas & Electric (SDG&E)			
Energy Resources	**2017 SDG&E Mix Power Mix**	**2017 SDG&E EcoChoice Mix**	**2017 CA Power Mix****
Eligible Renewable	**44%**	**100%**	**29%**
Biomass & Biowaste	2%	2%	2%
Geothermal	0%	3%	4%
Eligible Hydroelectric	0%	3%	3%
Solar	21%	100%	10%
Wind	21%	10%	10%
Coal	**0%**	**0%**	**4%**
Large Hydroelectric	**0%**	**0%**	**15%**
Natural Gas	**39%**	**0%**	**34%**
Nuclear	**0%**	**0%**	**9%**
Other	**0%**	**0%**	**<1%**
Unspecified Source of Power*	**17%**	**0%**	**9%**
Total	**100%**	**100%**	**100%**
*"Unspecified sources of power" means electricity from transactions that are not traceable to specific generation sources. **Precetnages are estimated annually by the California Energy Commission based on the electricity sold to California consumers during the identified year.			
For specific information about this electricity product, contact:		**San Diego & Electric 800-411-7343**	
For general information about the Power Content Label, please visit:		**www.energy.ca.gov/pcl/**	
For additional questions, please contact California Energy Commission at:		**844-454-2906**	

Table 6. System Average Rates Associated With Conforming Portfolio (2016US$)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
¢/kWh	21	21	21	21	21	20	20	20	20	20	20	20	20
Rev. Req. SB	3.11	3.14	3.16	3.22	3.15	3.11	3.09	3.06	3.04	3.07	3.10	3.11	3.10

kWh—Kilowatt hour

Thus, for more than half of its electric energy needs, San Diego County is dependent on sources outside of the region (39% natural gas and 17% unspecified). If the target of 50 percent renewables is reached by 2030, because most of these renewables are likely to be located within San Diego and Imperial Counties, dependence on imported sources of energy for power production will likely fall to 50 percent or below. It also is likely that natural gas will remain a major component of power generation in the region for the foreseeable future, at least until 2030. This is because the price of natural gas probably will remain relatively low, and natural gas power plants can support reliability as more renewable resources are integrated into the grid.

The *California Energy Demand 2018–2030 Revised Forecast* (Forecast) predicts a 4 percent decline in electricity sales between 2020 and 2030 in SDG&E's service area, equating to an average annual decline of 0.4 percent. Expected electricity demand in 2020 is 17,984 gigawatt hours (GWh), and 17,321 GWh in 2030. The Forecast predicts stable demand during the same period in the Imperial Irrigation District's (IID) service area, remaining at approximately 3,440 GWh between 2020 and 2030. These projections are based on 2017 data and exclude losses and consumption served by customer generation. Most of the decline in electricity sales is a result of the ramping up of energy-efficiency programs and customer-installed solar rooftop systems (Kavalec et al. 2018).

5.1.3 Cost and Prices of Current Energy Use

According to the U.S. Energy Information Administration (EIA), California's electricity retail rates are the second highest in the United States, and the average residential retail rates are seventh highest. According to SDG&E's 2018 Integrated Resource Plan, system average rates are approximately 21 cents per kilowatt hour (kWh) and are expected to stabilize at 20 cents per kWh by 2030—a calculation based on 2016 dollars and assumptions of revenue requirements for transmission, distribution, demand-side management and generation costs (Table 6) (SDG&E 2018).

A 2016 *San Diego Union-Tribune* article highlights that SDG&E's average residential rates between 2014 and 2018 were notably higher than those of California's other investor-owned utilities, the Pacific Gas and Electric Company and Southern California Edison (Figure 10) (Nikolewski 2018). Utility officials attribute SDG&E's high rates, which are determined through the California Public Utilities Commission's general rate case process every 3 years, to its smaller customer base, costs attributed to wildfires, and maintenance of its underground power lines.

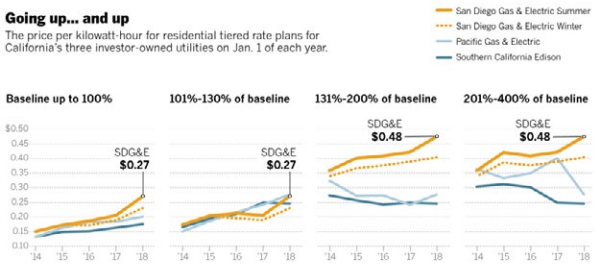


Figure 10. San Diego Gas & Electric's (SDG&E) average residential rates. **Sources:** Public Advocates Office; San Diego Gas & Electric; Southern California Edison; Pacific Gas and Electric Company.

Unbeholden to shareholders as a public agency and lacking a revenue requirement, IID is able to maintain lower average retail rates for its customers. The IID (2015) rate schedule demonstrates the rate structure of its general service, which amounts to a US$12.00 flat monthly charge, and a per-kilowatt hour price that ranges between 11.69 and 12.31 U.S. cents—substantially lower than those of SDG&E.

As both load service providers seek to meet the energy-efficiency targets laid out by Senate Bill 100,[141] they will need to ensure that their efforts to reduce energy demand do not result in substantial rate increases, particularly for any low-income and disadvantaged communities in their customer bases.

5.1.4 Factors Influencing Future Demand

The Southern California region faces unique energy reliability issues. Several factors have combined to create a prolonged period of heightened concern about reliability in the Southern California region, including the outage of two San Onofre Nuclear Generating Station units in 2012, the decision to retire San Onofre in 2013, the massive gas leak discovered in 2015 at the Aliso Canyon natural gas storage facility, the expected compliance-related closure of several Southern California coastal power plants that used ocean water for cooling, and the ongoing natural gas pipeline outages in the Southern California Gas Company system because of maintenance. The factors contributing to concerns about reliability of the Southern California energy system are ongoing (California Energy Commission 2018a).

Factors influencing future electricity demand in San Diego County include:

- *Population shifts*. The population is expected to shift to inland regions where average temperatures are higher than in the coastal zone, resulting in a higher air-conditioning load.
- *Replacement of natural gas with electricity*. As California moves toward a decarbonized energy sector, electricity gradually will replace natural gas in areas such as transportation (electric vehicles), space heating, and water heating and cooking. This will increase the demand for (carbon-free) electricity production.
- *Energy for water-related needs (known by the term "watergy")*. As demand for water increases, especially in the inland and desert areas, reuse and desalination of brackish and sea water likely will increase. Along with this growth in demand for reused and desalinated water will be an associated need for more electricity.

5.1.5 Overview of Imperial County[142]

As described in Section 5.1.1., the population of Imperial County is much smaller than that of San Diego County, and thus its energy usage is considerably lower than San Diego's. The structure of the energy sector in Imperial County also is quite different from that of San Diego County. In contrast to San Diego County's one investor-owned utility (SDG&E), Imperial County's electricity is provided by IID, a community-owned entity. IID supplies both power and water to the Imperial Valley and is governed by a five-member board of directors that is elected by the public, with each director representing one of the five political divisions within the Imperial Valley. IID's service territory covers 6,471 square miles (16,760 square kilometers [km^2]) and includes all of Imperial Valley and parts of Riverside and San Diego Counties.

The sources of electricity for Imperial County in 2017 were natural gas (34%), renewables (29%), coal (15%), large hydroelectric (4%), nuclear (3%) and unspecified (17%), as shown in Table 7.

Table 7. Imperial County 2017 Power Content Label

2017 POWER CONTENT LABEL		
Energy Resources	**Power Mix**	**2017 CA Power Mix†**
Eligible Renewable	29%	29%
Biomass & Biowaste	10%	2%
Eligible Hydroelectric	5%	3%
Solar	11%	10%
Wind	0%	10%
Coal	**15%**	**4%**
Large Hydroelectric	**4%**	**15%**
Natural Gas	**32%**	**34%**
Nuclear	**3%**	**9%**
Other	**0%**	**<1%**
Unspecified Source of Power*	**17%**	**9%**
Total	**100%**	**100%**

*"Unspecified sources of power" means electricity from transactions that are not traceable to specific generation sources.

†Percentages are estimated annually by the California Energy Commission based on the electricity sold to California consumers during the identified year.

For specific information about this electricity product, contact Imperial Irrigation District at 1-800-303-7756.

For general information about the Power Content Label, contact the: California Energy Commission at 1-800-454-2906 or www.energy.ca.gov/pcl/.

Renewable sources of power consist mostly of biomass, solar and wind, but not geothermal energy, which is surprising given that Imperial Valley contains rich geothermal energy sources. Geothermal energy is exported out of the valley.

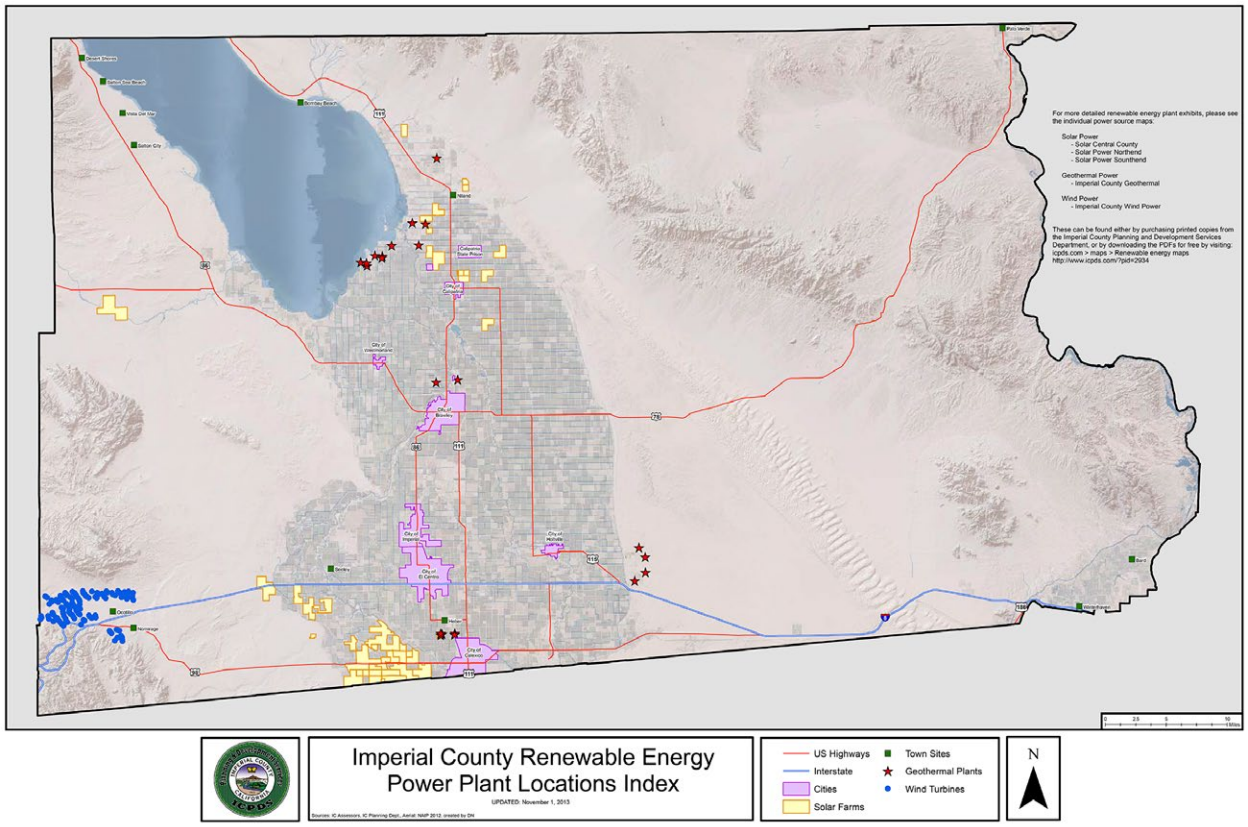


Figure 11. Imperial County renewable energy power plant locations.
Source: Imperial County Planning and Development Services, www.icpds.com/CMS/Media/All-Renewable-Power-Projects-11-1-13.pdf.

Imperial County has solar, wind, geothermal, micro-hydroelectric and thermal power plants (Figure 11). The county has marketed itself as having the potential to generate 42,283 MW from renewable energy sources. In an analysis commissioned by the IID, the *Renewable Energy Feasibility Study Final Report* (Summit Blue Consulting 2008), solar has the greatest potential at 28,600 MW; second is low-speed wind at 9,555 MW, and third is geothermal at 2,488 MW.

Power Transmission

The current power transmission links from Imperial County include the 500 kilovolt (kV) transmission line, called the Sunrise Powerlink, which moves electricity generated in Imperial County by renewables and by two combined cycle plants in Mexicali, Baja California, to San Diego County. This line travels 117 miles (188 kilometers [km]) with a 1,000 MW capacity and went into operation in 2012.

Additionally, the IID's transmission system is linked to the north through the California Independent System Operator (CAISO)/Southern California Edison, to the west through CAISO/SDG&E, and to the east though the Western Area Power Administration/Arizona Public Service. Current proposals seek to develop a new connection to the south to the Comisión Federal de Electricidad (Federal Electricity Commission, known as CFE) in Mexico. In 2018, IID and CAISO settled a lawsuit that claimed that CAISO was seeking a monopoly in the transmission service and operations, which limited the full export rights of IID as a balancing authority area. As part of the agreement, CAISO will upgrade IID's S-Line from the El Centro substation to the SDG&E's Imperial Valley substation. CAISO also agreed to help promote geothermal development around the Salton Sea, and a joint committee was formed to help coordinate issues important to both entities.

IID has developed a Strategic Transmission Expansion Plan that proposes to build a 2,200 MW 230 kV collector system. This system would allow for the export of 1,100 MW to CAISO and another 1,100 MW to the WestConnect Planning Region for

energy. Additional future upgrades to the system will allow for a total export of 4,100 MW. The estimated cost of the build-out of the transmission system is US$431 million to US$1.7 billion.

To better integrate solar power and enhance grid stability, IID in collaboration with General Electric Company, Consolidated Edison, Inc., ZGlobal and Coachella Energy Storage Partners has built a lithium-ion battery storage system that can store 20 MW of power for some time and 30 MW of peak power for very short times. This storage facility is the largest in the western United States, allowing for the startup and synchronization of the El Centro Generating Station, a 128 MW combined cycle natural gas plant. This provides stabilization to the system and can be used in the event of a system blackout. Additional storage capacity still is needed, and this topic is being discussed in the region.

Combined Cycle Natural Gas

IID's El Centro Generating Station replaced a 44 MW plant at the same site in 2012. The natural gas for this system is provided by a Southern California Gas Company pipeline that runs from the Niland regulating station. The annual water consumption for cooling of the facility is approximately 1,125 acre-feet.

Micro Hydroelectric

Imperial County has a 92.5 MW capacity of micro-hydroelectric generation. In 2018, the seven micro-hydroelectric plants had an output of 139,136 megawatt hours (MWh) (Table 8). This reduction of approximately half of what was being produced in 2010 resulted from the Drop 1 plant being taken offline with the lining of the All-American Canal as part of the water transfer agreement with San Diego County. The Drop 4 plant has been down since 2015 for a major refurbishment and should be operational again in 2019.

Solar

A number of new solar projects have been approved and are operating in the Imperial Valley. Examples include:

- The Mount Signal Solar Project, developed by Silver Ridge Power (formally AES Solar) and 8minute Solar Energy. This 206 MW plant went online in 2014, providing power to SDG&E under a 25-year purchase agreement. When the project is completed, it will have the capacity to produce about 800 MW. With the second of its three solar farms having come online in December 2018, the project now produces 1.29 billion kWh of power (8minute Solar Energy 2018).

Table 8. Small Hydroelectricity Production by Imperial Irrigation District, 2010 and 2018

EIA	CEC	Plant Name	Sate	Capacity (MW)	2010		2018	
Plant ID	Plant ID				Gross MWh	Net MWh	Gross MWh	Net MWh
585	H0147	Drop 1	CA	5.9	20,074	20,074	1,791	1,664
385	H0149	Drop 2	CA	10	49,394	49,394	44,107	43,437
386	H0150	Drop 3	CA	9.8	49,065	49,065	42,121	41,903
387	H0151	Drop 4	CA	19.6	99,453	99,453	3,423	3,282
314	H0152	Drop 5	CA	4	14,111	14,111	11,341	11,264
586	H0160	East Highline	CA	2.4	3,706	3,706	4,160	4,047
388	H0385	Pilot Knob	CA	33	25,161	25,161	32,193	31,763
				84.7	260,964	260,964	139,136	137,360

MW—Megawatt; MWh—Megawatt hour.
Source: California Energy Commission, ww2.energy.ca.gov/almanac/renewables_data/hydro/index_cms.php.

- Tenaska Imperial Solar Energy Center West and South are two photovoltaic plants producing 150 MW and 130 MW, respectively. The South plant was built in 2013, and the West plant was built in 2016. These plants cover approximately 2,000 acres and are owned by affiliates of Tenaska Solar Ventures. The electricity generated will be sent to San Diego under 25-year power purchase agreements with SDG&E (Tenaska Solar Ventures 2019).

Rooftop solar projects are promoted by the IID with more than 4,000 systems connected to the local grid (IID 2019).

Wind

A 265 MW wind farm covers 12,346 acres of land administered by the Bureau of Land Management. It came online fully in 2013 and has a purchase power agreement with SDG&E for 20 years.

Geothermal and the Salton Sea

Currently, approximately 600 MW of geothermal energy is generated from 17 sites throughout Imperial County. This region generates the second largest amount of geothermal electrical power in the United States. It has been projected that the region has a total capacity of 2,330 MW (Quintero and Sweedler 2005).

Water transfers to San Diego, Los Angeles and Coachella have led to fallowing and irrigation conservation, which is reducing the amount of water flowing into the Salton Sea. A number of environmental externalities will occur with the exposed lakebed, but the possibility for increased geothermal production exists. Currently, 10 plants around the Salton Sea generate 338 MW. These geothermal plants are owned and managed by CalEnergy (BHE Renewables 2019), a subsidiary of Berkshire Hathaway Energy.

The Salton Sea Restoration and Renewable Energy Initiative has set a goal of 1,700 MW of new geothermal generation in this region. This initiative is sponsored by IID as part of the plan to mitigate the reduced flow of water to the Salton Sea. It currently has California support with the State Water Control Board Revised Order WRO 2002-0013. This order resolved many outstanding issues from the water transfer to San Diego agreement (Quantification Settlement Agreement) of 2001.

No state or federal incentives support the development of new geothermal plants, and lack of funding exists to support projects to mitigate dust and other environmental effects around the Salton Sea resulting from the lower water levels and more exposed lakebed, which could account for the slow progress in the construction of new geothermal plants in the region.

The Bureau of Land Management and the Desert Renewable Energy Conservation Plan[143] recognize the area around the Salton Sea also as having potential for solar energy, and research currently is being conducted into biofuels from algae around the Salton Sea.

"Hell's Kitchen Lithium," a lithium carbonate plant, and "Hell's Kitchen Power," a geothermal plant, are two projects being developed in the Imperial Valley by Controlled Thermal Resources (2019a). The geothermal plant will provide the power for the lithium extraction. The project developer expects the lithium plant to produce its first 15,000 tons of lithium carbonate-equivalent products in 2023. Controlled Thermal Resources (2019b) expects the plant to produce about 75,000 tons of battery-grade lithium carbonate products annually thereafter. The developer reports that the total resource potential for the Hell's Kitchen project is 300,000 tons of lithium carbonate equivalent annually (Controlled Thermal Resources 2019c).

5.1.6 Energy Use

As stated previously, energy sales in IID's service area are expected to remain stable between the years 2020 and 2030 (assuming the mid-demand baseline case and the mid-case for additional achievable energy-efficiency savings). IID's 2018 Integrated Resource Plan demonstrates a less optimistic view of the potential for savings from energy efficiency, as portrayed by IID's Expected Case in Figure 12. Further projections of the system's demand requirements are demonstrated in Figure 13. In total, IID's energy demand forecast projects a 1.2 percent annual average increase in load from 2019 to 2030, which more closely tracks the California Energy Commission's high-demand/low-achievable energy-efficiency and photo-voltaic scenarios.

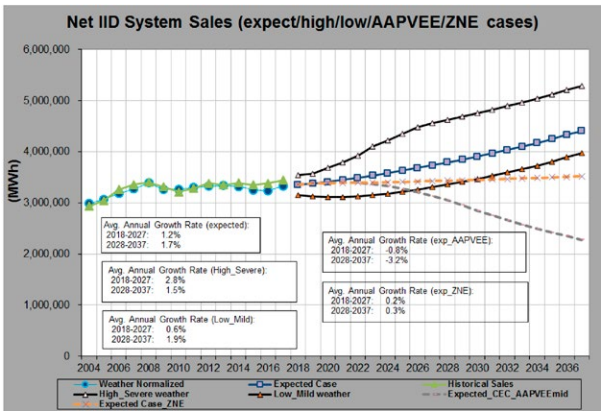


Figure 12. Net Imperial Irrigation District system sales.
Source: Imperial Irrigation District, www.iid.com/Home/ShowDocument?id=17371.

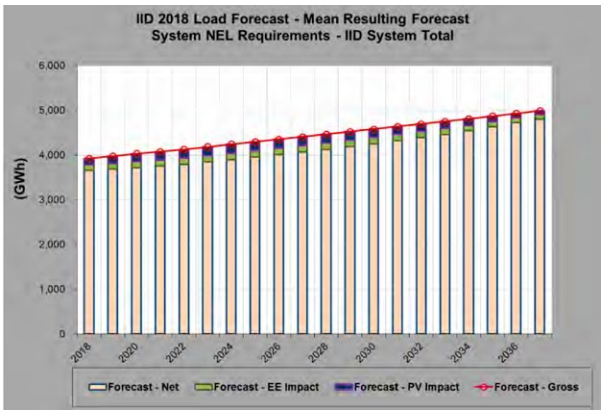


Figure 13. Imperial Irrigation District 2018 load forecast.
Source: Imperial Irrigation District, www.iid.com/Home/ShowDocument?id=17371.

According to 2017 customer data, commercial sales comprise 40 percent of IID's business, whereas residential sales comprise 46 percent. The remaining 14 percent of sales are attributed to agricultural, industrial and other sectors.

5.1.7 Air Quality Issues in Relation to Power Generation

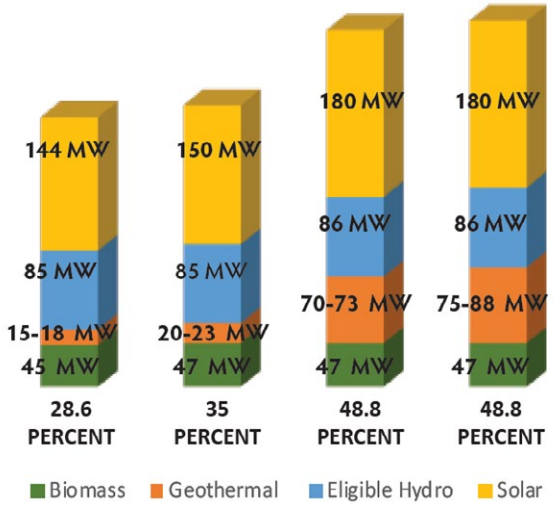
IID's 2017 power content label reveals that natural gas comprises 34 percent of its generation, whereas imported coal power accounts for 15 percent. Additionally, the region experiences high concentrations of particulate matter resulting from agricultural burning and natural events exacerbated by climate change (e.g., high-wind dust events, wildfires).

According to the California Air Resources Board's (2018) *Working Group Draft of the Imperial County—Mexicali Air Quality Work Plan to Improve Air Quality in the Border Region*, "Imperial County's air quality ranks as among the worst in the State of California" because of high levels of large particulate matter (e.g., dust) and fine particulate matter, a more hazardous type of particulate matter that is generated from human sources. The California Air Resources Board's plan to improve air quality at the California-Mexico border focuses on monitoring and regulating agricultural burning practices, reducing emissions from vehicles by tightening Imperial County's smog-check program, and strengthening control over emissions from stationary sources such as buildings and power plants.

5.1.8 Renewable Energy Growth and Role of Wind and Solar

The Imperial Valley has become one of the country's largest sites for renewable generation, especially solar and wind. It is common to see miles of solar arrays and wind turbines on land that was previously used for agriculture or characterized by native vegetation. Much of this renewable energy is exported out of the region, mostly to the Los Angeles, Riverside and San Diego areas. IID plans to increase its use of renewables, as seen in Figure 14.

The renewable resource base is considerable, as can be seen in Table 9. These are very large numbers (the total capacity for California is about 80,000 MW).



MW—Megawatt
Figure 14. Actual/anticipated 2017–2020 renewables mix.
Source: Imperial Irrigation District, www.iid.com/energy/renewable-energy.

Table 9. Resources Untapped in the Imperial Valley

Geothermal	2,488 MW
Solar	28,946 MW
Wind	10,755 MW
Biomass	94 MW
Total Potential Capacity	42,283 MW

MW—Megawatt

Whether these renewable resources ever will be developed depends on state and federal policies, economics (particularly the price of natural gas), and other factors (e.g., carbon tax implementation).

In terms of cross-border energy trading, renewable energy development in the Imperial Valley likely will compete with similar projects in Mexico. If, however, California stays on target to have 100 percent renewable generation by 2045, the demand for wind and solar power will be so great that projects in Imperial County and Mexico could be cost-effective on both sides of the border.

5.1.9 Unique Relationship Between California and Baja California

Baja California is the only state of Mexico that is not connected with Mexico's main national electricity grid nor with oil and natural gas pipelines, but it is interconnected with a U.S. border state, California. The northern part of Baja California has two California grid connections—Otay Mesa and Imperial Valley (both also known as Path 45), but it is not connected to Baja California Sur or the mainland.

Centro Nacional de Control de Energía (Mexico's National Energy Control Center, known as CENACE), a public agency, controls Mexico's electric system and manages the wholesale electricity market as it transitions to a fully competitive market. The grid operator dispatched 68,044 MW of electricity in 2015, using more than 33,000 miles (53,108 km) of high-voltage power transmission lines. CENACE has had a long, productive relationship with the independent system operator, as the two entities coordinate the management of these interconnected electricity grids.

Mexico energy policies mandate a renewables portfolio goal, including hydroelectricity, of 25 percent in 2018, 30 percent in 2021 and 35 percent by 2024 (including hydroelectricity). It should be noted, however, that under the new Mexican administration of President Andrés Manuel López Obrador, energy policy in general and at the border is under review and likely will be quite different than what exists in mid-2019.

5.1.10 Energy Efficiency and Energy Poverty

As discussed earlier in this report, energy efficiency is a key strategy for addressing energy poverty. Investments in the efficiency of housing for low-income groups/communities can reduce energy bills and result in increased comfort, air quality and health. The U.S. Department of Energy (DOE) administers several programs aimed at targeting energy-efficiency measures at low-income individuals, including the Low Income Home Energy Assistance Program, which provides direct assistance to households spending a disproportionately large part of their monthly budgets on energy expenses, and the Weatherization Assistance Program, which supports the installation of energy conservation and efficiency measures in low-income households. The Weatherization Assistance Program, which is a substantial driver of energy efficiency across the United States, disbursed US$223,641,325 to state administrators in 2017. Of that total, approximately US$14 million (about 6% of funds) were allocated to U.S.-Mexico border states (Table 10).

As noted previously, SDG&E's electricity sales through 2030 are expected to decrease by 4 percent despite the growing consumption portrayed by SDG&E's 2016 Electricity Resource Planning Forms. SDG&E forecasts an increase of 1,031 GWh in total

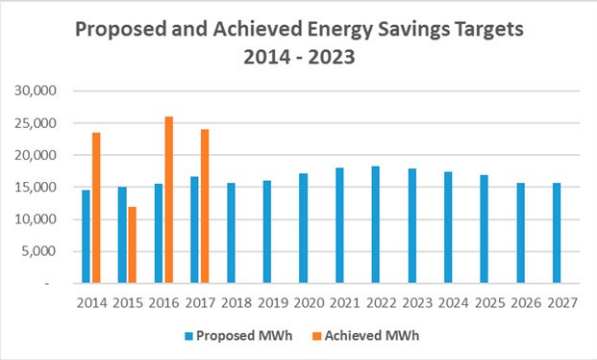
Table 10. Weatherization Assistance Program Border State Distribution Amounts

STATE	2017 ALLOCATION*
California	US$6,215,232
Texas	US$5,480,562
New Mexico	US$1,745,551
Arizona	US$1,268,072
TOTAL	US$14,619,417

*Includes funding for training and technical assistance.
Source: U.S. Department of Energy, www.energy.gov/sites/prod/files/2017/06/f35/wpn-17-2-grantee-final.pdf.

energy consumption between 2020 and 2026 and a concurrent increase of additional achievable energy efficiency of 1,025 GWh during the same time period, resulting in a net increase of only 6 GWh in adjusted demand.

IID's demand forecast is similarly modest, projecting stable demand through 2030 because of anticipated progress toward additional achievable energy-efficiency targets. IID's 2018 Integrated Resource Plan demonstrates its short-term projection of proposed and achieved energy savings targets, which take into account existing buildings and new construction across the residential, commercial and industrial sectors (Figure 15).



MWh—Megawatt hours
Figure 15. Proposed and achieved energy savings targets, 2014–2023.
Source: Imperial Irrigation District, www.iid.com/Home/ShowDocument?id=17371.

Senate Bill 350[144] called on the California Energy Commission to double the state's energy-efficiency savings by 2030 through a variety of mechanisms, including:

- Maintenance of funding for utility-operated energy-efficiency programs,
- Rewards for energy-efficiency programs that facilitate market transformation and attract private investment
- Improvements in code compliance,
- Institutional support for reach codes,
- Improvement of energy-efficiency installations through application of workforce standards,
- Enforcement of regular tracking and reporting of achieved progress, and
- Close analysis of the effects of energy-efficiency targets on disadvantaged and low-income communities (California Energy Commission 2019).

Implementation of the above measures will ensure that electricity demand in SDG&E's service area—and beyond—remains stable and serviceable, even as buildings and appliances shift away from natural gas and toward electricity consumption.

According to the California Energy Commission's (2018c) September 2018 Tracking Progress report on energy efficiency, California is on track to achieve more than 70,000 GWh of electricity savings through building standards, appliance standards and consumer behavior as incentivized by energy-efficiency programs. The Low-Income Barriers Study, which was mandated by Senate Bill 350,[145] provides essential context for the discussion around energy efficiency at the California-Mexico border (California Energy Commission 2016). Of the 30 percent of California households in the low-income category, 19 percent are single-family homes, 7 percent are market-rate multifamily homes, 2 percent are rent-assisted multifamily homes, and 1 percent are mobile homes. Additionally, only 26 percent of low-income households represent owner-occupied homes, whereas the remaining are renters. This demographic information may translate to challenges in meeting the bill's energy-efficiency target in low-income communities, such as:

- Utilities' energy-efficiency programs can be inaccessible or insufficient for renters, particularly those in multifamily homes.
- Renters may lack the property rights to install energy-efficient appliances and upgrades.
- Energy-efficient upgrades may increase property values, resulting in increased rents, causing low-income renters to be priced out of their homes and neighborhoods.

Centering disadvantaged and low-income communities in energy-efficiency efforts requires market transformation and innovative thinking around energy-efficiency project finance. Some of those solutions, which include community solar investments, Pay-As-You-Save programs, and reallocation of California Alternate Rates for Energy (commonly known as CARE) funds, are summarized

in the 2018 Low-Income Barriers Study and may represent appropriate pathways to reducing energy-efficiency costs in the border region.

Looking Forward: Opportunities for Energy Efficiency at the California-Mexico Border

The California-Baja California region represents a particularly compelling opportunity to expand energy efficiency because of its climate and demographic conditions. The area has a growing population (increasing at more than 2% per year) and expanding economy, both of which will represent a strain on the grid absent careful planning (CityPopulation.de 2019). Space cooling needs are expected to grow as a result of rising temperatures in the Baja California-Southern California region. Future temperature projections are illustrated according to high- and low-emissions scenarios in Figure 16.

By expanding on the collaborative efforts illustrated above, California's robust energy-efficiency infrastructure and policy expertise may be leveraged to support similar progress in Baja California. Through robust national and state-to-state partnerships, increased customer adoption, and improvements in cost-effectiveness through strategic policy design and market transformation at the border region, the benefits of energy efficiency may be realized more on the Mexican side of the border.

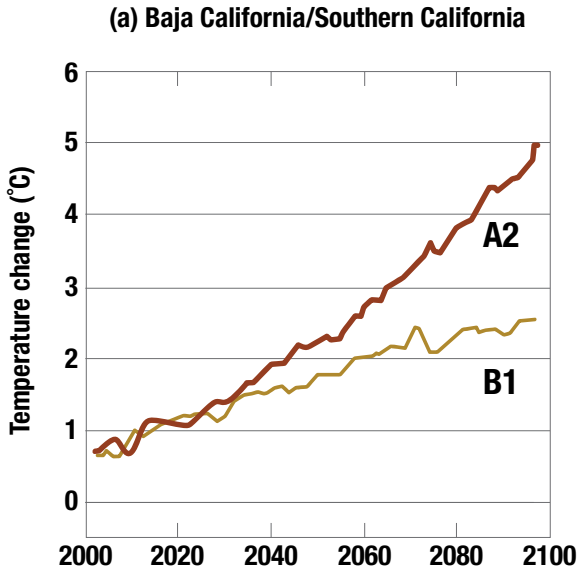


Figure 16. High- and low-emissions scenarios. A2: High-emissions scenario, B1: Low-emissions scenario.
Source: Figure modified from: Cavazos, T., and S. Arriaga-Ramírez. 2012. "Downscaled Climate Change Scenarios for Baja California and the North American Monsoon During the Twenty-First Century." *Journal of Climate* 25: 5904–5915.

5.2 Arizona Border Region

Arizona is one of the few states in the United States that relies on nuclear power for a plurality of its electricity production. Currently, coal, natural gas and nuclear power produce roughly equal thirds of electricity produced in the state, with much smaller amounts coming from hydro and other renewable sources. Arizona is currently a net-exporter of electricity, with most excess electricity flowing to California, Texas and New Mexico (EIA 2019m). Although not home to significant reserves of coal, natural gas or petroleum, Arizona has ideal conditions for renewables such as wind and solar and will need more energy-production capabilities as coal is phased out, and the state population continues to grow (EIA 2019n).

The Palo Verde Generating Station, located west of the Phoenix metropolitan area, is the largest nuclear power plant, the largest net generator of electricity, and the second largest power plant by capacity of any kind in the country (EIA 2019m). It provides close to three-tenths of the electricity produced in the state and provides substantial amounts to neighboring border states as well. Coal produces close to the same amount of electricity in the state; however, this has been in a steep decline 2001, when coal had close to a 50 percent share of electrical production (Popovich 2018). Coal has slowly been edged out in the state by cheaper natural gas and tighter regulations.

The coal-powered Navajo Generating Station, in northern Arizona, was the state's second largest power station, but was closed in November 2019 (Salt River Project 2019, Silversmith and Randazzo 2019). The Central Arizona Project, which supplies most of Arizona's population centers with water pumped from the Colorado River, relied on the Navajo Generating Station for power. One of the challenges for the state will be to find enough sources of power to make up for the loss of the Navajo Generating Station, with the Central Arizona Project pushing to expand solar energy products and find other suppliers in the state (Randazzo 2018). Natural gas is the third largest electricity source in the state and has risen largely since the shale and hydraulic

fracturing boom in other parts of the country reduced the price of natural gas. Most of Arizona's natural gas is imported from Texas and New Mexico through pipelines (EIA 2019n). Hydro and solar make up the rest of the electrical generation in the state, at still comparatively small levels.

The majority of the state's population receives its electricity from four main utility companies: Arizona Electric Power Cooperative, Arizona Public Service, Salt River Project and Tucson Electric Power. Arizona Public Service is by far the largest, serving most of the Phoenix metropolitan area and many urban centers in other parts of the state. Arizona Public Service and Tucson Electric Power are investor-owned utilities, Arizona Electric Power Cooperative is a rural generation and transmission cooperative, and Salt River Project is a community-based not-for-profit water and energy company. These utility companies own most of the electrical transmission and generation capability in the state, with Arizona Public Service owning the Palo Verde Generating Station, Salt River Project owning the Navajo Generating Station, and Arizona Electric Power Cooperative and Tucson Electric Power owning other generating facilities in the state. Recently, the role of Arizona Public Service in state politics has been controversial, with Arizona Public Service spending millions of dollars in political campaigns to help their preferred candidates change net metering arrangements for homeowners with solar systems and influence other policies (Randazzo 2019).

In Arizona, the largest energy consumer among end-use sectors is transportation (Figure 17).

Current state policy aims to have electrical utilities rely more on renewable energy, with a mandate of 15 percent of their total energy sourced from renewable energy sources by 2025. In 2018, a referendum on increasing that mandate to 50 percent renewable electrical sales by 2030 failed to pass, with two-thirds of the state voting against the measure.[146] In addition, certain Corporation Commissioners who set electricity rates and policies have increasingly promoted additional requirements for utilities, such as the Arizona Corporation Commission Energy Modernization Plan, which requires an 80 percent renewables portfolio standard by 2050, among other requirements (Tobin 2018). The Arizona Corporation

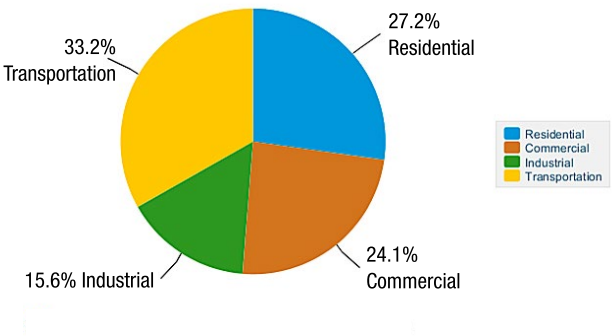


Figure 17. Arizona energy consumption by end-use sector, 2017.
Source: U.S. Energy Information Administration, State Energy Data System.

Commission, however, is planning to increase the renewable mandate from the current 15 percent by 2025. The three primary energy providers plan to significantly increase solar and wind generation during the next 10 years and respond with significant investment in renewable generation. It is likely that battery or other storage technology also will see significant investment to support the increased reliance on renewable resources.

Arizona's sunny weather makes it one of the most promising states for future solar development to meet future electrical needs. In 2017, Arizona ranked second in the country in total solar generation (EIA 2019m). Currently, limited electrical transmission lines, which have limited capacity, run between Arizona and Mexico to deliver power (EIA 2013). Arizona is served most exclusively by the San Juan and Permian gas basins in New Mexico. Natural gas from these sources is transported to Arizona and California through a northern and southern pipeline system from New Mexico. Multiple gas pipelines in the state, however, help to send gas to the Mexican market (DOE 2019e, Kinder Morgan 2019a). One such project brought a new connection from Arizona into Mexico to serve customers with supplies of natural gas (Kinder Morgan 2019b). According to the Federal Energy Regulatory Commission (FERC), the Sierrita Pipeline Expansion Project was developed as a way for Kinder Morgan to increase its gas delivery service to an existing Mexico customer, CFE International LLC, which serves several power plants in Mexico (FERC 2018b). The line was part of a larger project that included a new compressor station, metering and piping. The project was 61 miles (98 km) of 35-inch (89-centimeter)

pipeline that extended from a system in Tucson, Arizona, to the U.S.-Mexico border near Sasabe, Arizona (Kinder Morgan 2019a). The new project was announced in 2016, and the original line was placed into service in 2014 (Kinder Morgan 2016). There was great interest, however, in expanding the capacity of that line, which resulted in CFE International LLC agreeing to enter into a binding bid to secure an increase in expansion capacity. This project provides an interconnect with an existing natural gas pipeline in Mexico owned by IEnova. This project provides Mexico with natural gas to ensure the ability to serve industrial customers.

5.3 New Mexico Border Region

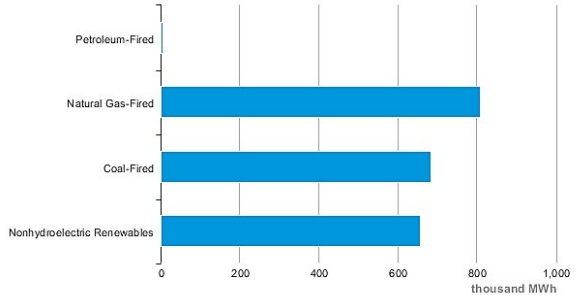
New Mexico is a key supplier of energy to the United States, and the state's economy is highly reliant on the industry. Energy-related jobs are estimated to contribute 6.4 percent of employment in the state and support approximately 14 percent of New Mexico's gross domestic product (GDP). According to the New Mexico Energy, Minerals and Natural Resources Department (NM EMNRD), in 2016 New Mexico was the eighth-largest net supplier of energy nationally, mostly from fossil-based energy sources (NM EMNRD 2019a). New Mexico is among the top 10 natural gas-producing states and has more than 6 percent of U.S. total proved crude oil reserves. In 2017, it became the fifth-largest oil-producing state, accounting for 5 percent of the country's crude oil production, in part due to the Permian Basin, which spans western Texas and southeastern New Mexico and is one of the most prolific petroleum-producing areas nationally and globally (EIA 2019o). In New Mexico, this area is approximately 100 miles (161 km) east of the city of Las Cruces, in Doña Ana County, New Mexico, and 150 miles (241 km) north of Ciudad Juárez, Mexico.

In 2017, the state accounted for 2 percent of U.S. coal production. Coal-fired power plants provide more than half of New Mexico's in-state net electricity generation; natural gas-fired power plants account for more than one-fourth, and renewable resources, primarily wind, provide almost all of the rest. In fact, New Mexico is shifting its electricity sector to a different fuels mix. Renewable energy (geothermal, hydroelectric, biomass, solar and wind) sources created 9 percent of New Mexico's electricity in 2015 and increased to 14 percent in 2017 (EIA 2019o). In 2017, wind energy contributed almost 14 percent of New Mexico's electricity generation with almost 1,800 MW of installed electricity-generating capacity from more than 1,000 wind turbines.

Figures 18 and 19, illustrate New Mexico energy consumption estimates (2017) and net electricity generation by source (2019), respectively (EIA 2019p).

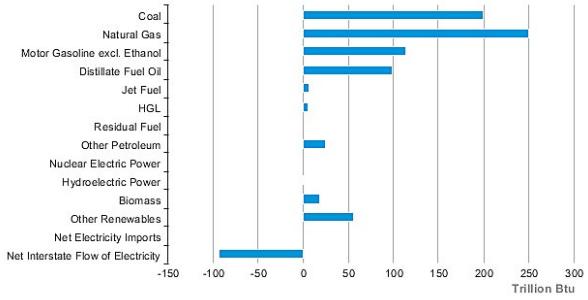
5.3.1 New Mexico at the International Border: Paso del Norte and Doña Ana County

The New Mexico counties that border Mexico (geographically from west to east) are Hidalgo, Luna and Doña Ana. New Mexico has three ports of entry



Source: Energy Information Administration, Electric Power Monthly

MWh—Megawatt hour
Figure 18. New Mexico 2017 energy consumption.
Source: U.S. Energy Information Administration, State Energy Data System.



Source: Energy Information Administration, State Energy Data System

HGL—Hydraulic Grade Line; Btu—British thermal unit
Figure 19. New Mexico net electricity generation by source, March 2019.
Source: U.S. Energy Information Administration, Electric Power Monthly.

into Mexico, overseen by the New Mexico Border Authority (Figure 20).[147] These ports of entry are located at Antelope Wells (Hidalgo County), Columbus (Luna County) and Santa Teresa (Doña Ana County). Santa Teresa and Columbus serve commercial traffic.

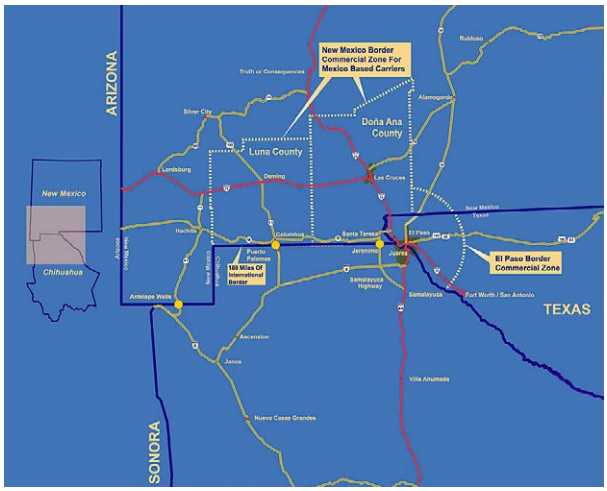


Figure 20. Map of New Mexico's international border.
Source: www.nmborder.com/uploads/Images/Internation-Border-Map.jpg.

The Paso del Norte area[148] is a binational metropolitan area of more than 2.3 million people, encompassing the cities of El Paso, Texas; Cuidad Juarez, Chihuahua, Mexico; and Las Cruces in Doña Ana County, New Mexico (Rooney and McKenzie 2018). The Santa Teresa, New Mexico, Port of Entry industrial area, also known as the "Borderplex," is located 42 miles (68 km) south of Las Cruces (New Mexico's second-largest city), and 20 minutes from downtown El Paso, Texas. From this port of entry, Interstate 10 is 12 miles on the Pete Domenici Highway, the newest Borderplex multilane transportation link. During the last 4 years, Paso del Norte and Borderplex areas in Doña Ana County have experienced high growth, partly because of established logistics parks with rail spurs located in and around Santa Teresa, Interstate 10 (which connects the East and West Coasts of the United States), and increased water and road infrastructure investments.

Doña Ana County, bordered to the south by El Paso, Texas, and Chihuahua, Mexico, encompasses 3,804 square miles (9,852 km^2)—an area larger than the states of Delaware and Rhode Island combined. Doña Ana County has the second-largest population in the state with 217,522 individuals (U.S. Census Bureau 2019a), mostly distributed along the Rio Grande corridor—a narrow band that runs approximately 90 miles (145 km) north to south. Slightly less than one-half of the county population (approximately 90,000 people) reside in 37 *colonias* and the surrounding rural area. *Colonias* are communities on the U.S side of the international border that have been formally designated as lacking critical infrastructure with negative health and quality-of-life impacts on residents. Doña Ana County's 2010–2014 median household income was US$38,426 with a 27.9 percent poverty rate as compared to 19.7 percent for the state (Doña Ana County 2017, U.S. Census Bureau 2019b).

New Mexico Gas Company (2019a) operates and maintains 12,000 miles (19,312 km) of natural gas pipelines throughout the state. Doña Ana County is one of 23 counties in which New Mexico Gas Company oversees gas lines and ensures basic service to residential, commercial and transportation customers.

Local business interests have cited a need to upgrade electrical service in the Sunland Park and Santa Teresa areas in Doña Ana County. These businesses say that without service upgrades, commercial development requiring reliable supplies of "clean" electrical output cannot proceed (Camino Real Regional Consortium 2015).

Doña Ana County is a U.S. Foreign Trade Zone administered by U.S. Customs and Border Protection, and in 2016 the southern part of the county and most of Luna County were designated as Opportunity Zones. Therefore, tax incentives may provide for leveraging opportunities for energy infrastructure. The New Mexico Economic Development Department (2019) administers the FUND IT program, providing a process for a community to present its energy infrastructure needs and receive input about potential funding sources from a wide range of state and federal agencies at one time. It also serves as a platform for community planning, including a webinar series for the funding agencies to learn more about how to leverage their programs with other resources and community planning.

5.3.2 Energy Sector in New Mexico's Border Region

The Paso del Norte region is developing its renewable energy resources. Doña Ana County lies in the major solar resource area in the country for flat-plate and concentrating solar collectors, and Las Cruces is home to the Southwest Technology Development Institute, a renewable energy research and development center located at New Mexico State University (Mesilla Valley Economic Development Alliance 2015). In addition to solar power plants, the border region of New Mexico includes several natural gas power plants, one geothermal resource area and one biomass power plant (EIA 2019o, Open Energy Information 2015). Both Las Cruces and Radium Springs, in Doña Ana County, were identified as sites that potentially could utilize geothermal energy for district heating and other applications. Wood burning continues to be widely used across New Mexico, and Las Cruces is using anaerobic digestion of sludge to generate methane gas for production of electricity and heat to power its wastewater facilities (Mesilla Valley Economic Development Alliance 2015).

As a result of activities in the Permian Basin (Delaware Basin), New Mexico oil production has increased by 400 percent in the past 10 years, making New Mexico the third-highest oil-producing state behind Texas and North Dakota (Figure 21). The Wolfcamp Shale and Bonesprings Formation together potentially contain 46.3 billion barrels of oil and 281 trillion cubic feet (8 trillion cubic meters [m^3]) of natural gas, and 20 billion barrels of natural gas liquids. Gross value of oil production now exceeds US$1.5 billion each month, and oil and gas production provided an approximately US$1.2 billion state-budget surplus for 2019 (NM EMNRD 2019b). Technology has made production of these "unconventional" resources possible through lateral drilling and hydraulic fracturing. The domestic extraction of natural gas and oil has increased dramatically, and prices have fallen as a result.

Energy markets are significantly altering the traditional ways in which fuels are transported, including in the border region, with railroads seeing significant growth of unit train movement of petrochemicals, even as several pipeline routes are being evaluated. The railroad industry has been able to respond to growth in the energy sector more quickly as compared to the pipeline industry (NM EMNRD 2019a).

Figure 21. Monthly crude oil production in New Mexico since 1981. **Source:** New Mexico Energy, Minerals and Natural Resources Department's Oil Conservation Division (OCD). See also www.emnrd.state.nm.us/EnergyPolicy/newmexicoenergy.html.

With these and other sector expansions, however, it is not certain that border area roads and infrastructure are ready for growth in truck traffic; many of these roads are owned or maintained by counties and will eventually require repair and replacement as overweight truck volumes increase.

The state's new and planned electricity-generating capacity will use renewable energy or natural gas. New Mexico has recognized an economic interest in selling more electricity to other states, particularly electricity generated from its renewable resources (NM EMNRD 2015, p. 28). Projects underway to move those electricity supplies include new transmission lines that take advantage of the state's location at the edge of the three U.S. electrical grids—the Eastern, Western and Texas Interconnections—and of the Four Corners power trading hub, located at the Four Corners coal complex in northwestern New Mexico (EIA 2019o).

5.3.3 Cost and Prices of Current Energy Use

Natural gas prices in New Mexico are lower than the national average, as are electricity rates for residential, commercial and industrial users (Table 11). In terms of overall energy consumption, New Mexicans use more than the national average, primarily because of driving, and by contrast, they consume less residential electricity and natural gas than the country at large (NM EMNRD 2019a).

5.3.4 Environmental Impacts of the Energy Sector

Environmental issues associated with energy production primarily include emissions, water quality and solid-waste management. New Mexico's energy industry generates by-products, including sulfur dioxide, hydrogen sulfide, oxides of nitrogen, fine and coarse particulate matter, air toxics, hazardous air pollutants, and greenhouse gases, including carbon dioxide and methane. Half of the state's overall carbon dioxide emissions originate in the conversion of coal and natural gas into electricity. The state has achieved a 17 percent reduction in the state's energy-related carbon dioxide emissions between the years 2000 and 2016 (NM EMNRD 2019a). More information is available in Section 5.3.7.

According to the New Mexico Environment Department (NMED), Doña Ana County currently has two air nonattainment areas as a result of particulate matter and ozone pollution: Anthony, New Mexico, which lies on the border of Texas and New Mexico, and a portion of Sunland Park. NMED currently is developing an Emissions Inventory for the nonattainment area to be submitted to the U.S. Environmental Protection Agency by August 3, 2020. In addition, NMED must review its nonattainment permitting rules and adopt revisions if required to comply with federal law by August 3, 2021 (NMED 2019).

Table 11. Average Energy Cost and Price Per Energy Sector

Petroleum	New Mexico	U.S. Average	Period
Domestic Crude Oil First Purchase	US$41.85/barrel	US$47.85/barrel	Jan-19
Natural Gas	**New Mexico**	**U.S. Average**	**Period**
City Gate	US$3.45/thousand cu ft	US$4.09/thousand cu ft	Jan-19
Residential	US$6.48/thousand cu ft	US$9.43/thousand cu ft	Jan-19
Coal	**New Mexico**	**U.S. Average**	**Period**
Average Sales Price	US$34.72/short ton	US$33.72/short ton	2017
Delivered to Electric Power Sector	US$2.67/million Btu	US$2.10/million Btu	Jan-19
Electricity	**New Mexico**	**U.S. Average**	**Period**
Residential	12.21 U.S. cents/kWh	12.47 U.S. cents/kWh	Jan-19
Commercial	9.54 U.S. cents/kWh	10.29 U.S. cents/kWh	Jan-19
Industrial	5.21 U.S. cents/kWh	6.58 U.S. cents/kWh	Jan-19

The average energy cost and price per energy sector (data as of January 2019) in New Mexico. Except for coal, all prices are less than U.S. averages.
Btu—British thermal unit; cu ft—cubic foot; kWh—kilowatt hour.
Source: U.S. Energy Information Agency, www.eia.gov/state/print.php?sid=NM, May 8, 2019.

In addition to sulfur dioxide and nitrogen oxide, New Mexico's energy enterprise was estimated to have generated 48 million metric tons of carbon dioxide in 2016—half coming from the conversion of coal and natural gas to produce electricity (NM EMNRD 2019). Transportation contributes most of the rest of the carbon dioxide emissions. The transportation sector contributes 14 million metric tons, the residential and commercial sectors each contribute 2 million metric tons, and the industrial sector contributes just more than 7 million metric tons (NM EMNRD 2019).

In 2015, New Mexico was ranked 37th nationally in terms of carbon dioxide emissions. The coal and natural gas conversion process (for producing electricity) generated 7,000 metric tons (7,716 U.S. tons) of sulfur dioxide and 35,000 metric tons (38,581 U.S. tons) of nitrogen oxide in 2016, both numbers representing decreases of 36 percent and 17 percent, respectively, from 2014 levels. The state achieved a 17 percent reduction in the state's energy-related carbon dioxide emissions between the years 2000 and 2016, and 2016's emissions decreased from the 2014 and 2015 levels (NM EMNRD 2019).[149]

This year, New Mexico Governor Michelle Lujan Grisham signed into law the New Mexico Energy Transition Act of 2019, which requires the New Mexico Environmental Improvement Board[150] to limit carbon dioxide emissions of certain electric generating facilities.[151] It is anticipated that regulations will soon be proposed to implement the new law.

Water is required to extract, produce and deliver energy. Surface and groundwater are used for oil and gas production, and these processes generate produced water, which must be managed to protect fresh water supplies, public health and ecosystems. Groundwater contamination is a concern with energy or mineral extraction (NM EMNRD 2019a). In New Mexico, including the border region, the relationship between energy production and water quality protections is regulated under state and federal laws that are administered by EPA, NM EMNRD and NMED. Produced water in New Mexico is estimated at 900 million barrels in 2017 alone (NM EMNRD 2019a). Much state and national attention has been devoted to reusing produced water in oil and gas activities and to treating produced water for other purposes, including agriculture, dust control and other industrial processes, such as manufacturing or electric utilities. In 2019, EMNRD and NMED began to implement a new state law, the Produced Water Act (House Bill 546),[152] that encourages the oil and natural gas industry to favor reuse, recycling and treatment options over the reliance on New Mexico's limited fresh water resources and directs the state to establish regulations for the use of treated produced water, treated product, or any byproduct of the produced water.

5.3.5 Future Demand for Energy

In New Mexico, energy demand has remained relatively flat because of slow population growth and increases in energy efficiency. National fuel economy and appliance standards account for these efficiency gains, along with the New Mexico Efficient Use of Energy Act of 2005. For southeastern New Mexico, unprecedented growth in the Permian Basin has tested the local economy (e.g., housing, workforce, education, roads, wastewater infrastructure, the environment) (NM EMNRD 2015).

5.3.6 Structure of New Mexico's Energy Sector

The state is located at the intersection of three of the North American Electric Reliability Corporation (NERC) regional entities and three electricity market organizations (NM EMNRD 2019a). Regional transmission organizations and independent system operators coordinate electricity delivery and generation functions. New Mexico's location complicates the number of interfaces required by electricity providers who operate in the region. The absence of federally regulated power lines (transmission) in the eastern and west central areas of the state is both a challenge and an opportunity. One critical transmission path includes pairs of high-voltage (345 kV) transmission lines originating at the San Juan and Four Corners generating stations in the northwest corner of the state. These lines serve the central part of New Mexico. Additional lines run east and south. Several transmission expansion projects with New Mexico connections have been proposed or are in some stage of development (as of August 2018) (NM EMNRD 2019a). In the border region, El Paso Electric

supplies electric services to southern Doña Ana County and West Texas; New Mexico Gas Company and Zia Natural Gas Company supply natural gas. In 2012, the City of Sunland Park (2018) and Doña Ana County combined to form the Camino Real Regional Utility Authority via a Joint Powers Agreement and share planning and zoning authority.

The electricity sector also uses large quantities of water for cooling of thermal (coal and natural gas) and nuclear generation facilities. Although there are no nuclear generating facilities in New Mexico, Public Service Company of New Mexico (2019a) owns and purchases power from Palo Verde, a nuclear generating station in Arizona. Natural gas steam turbine plants (generally peaking power plants) consume the most gallons per MWh of electricity generated, with nuclear and coal-fired electricity generating stations being the second and third largest consumers. Solar and wind technologies do not require any water for operation.

Passed and signed in 2019, House Bill 546, which includes the Produced Water Act,[153] combined two pieces of legislation—one to establish an administrative enforcement process for NM EMNRD's Oil Conservation Division and the other to clarify the regulation of produced water, including the emerging efforts to recycle and treat produced water for potential reuse in and outside of the oil patch.[154] The act clarified that if produced water is recycled and reused in the oil patch, then that is the Oil Conservation Division's jurisdiction; however, if treated for use outside of the oil and gas well site, then it is NMED's jurisdiction.

5.3.7 Energy Use by Sector

The industrial and transportation sectors account for more than 65 percent of energy consumed in New Mexico, as shown in Figure 22.

5.3.8 Renewable Energy

The following facts detail renewable energy in New Mexico from the Solar Energy Industries Association (2019a):

- Solar installed: 792.0 MW (94.6 MW in 2018), enough to power 203,000 homes.
- National ranking: 16th (21st in 2018).
- Percentage of state's electricity from solar: 4.72 percent.
- Solar jobs and ranking: 2,168 jobs, ranked 29th in 2018.
- Solar companies in state: 107 companies total, including 15 manufacturers.
- Total solar investment: US$1.75 billion (US$144.18 million in 2018).
- Price declines: 47 percent during the previous 5 years.
- Growth projections and ranking: 950 MW during the next 5 years (ranks 18th).

Below are some notable projects in the state:

- Alta Luna Solar Farm, in Luna County, has the capacity to generate 28.1 MW of electricity—enough to power more than 7,035 homes in the state (Solar Energy Industries Association 2019b).
- At 70 MW, Chaves Solar in Roswell is among the largest solar installations in New Mexico. Completed in 2016, this photovoltaic project has enough electric capacity to power more than 17,525 homes (Solar Energy Industries Association 2019b).
- Eubank Landfill Solar is one of the first major corporations to go solar in New Mexico with its 2-MW project in Albuquerque (Solar Energy Industries Association 2019a).

By the passage of the New Mexico Energy Transition Act of 2019, New Mexico anticipates doubling renewable energy use in the state by 2025, requiring 50 percent renewable energy by 2030, and 100 percent carbon-free electricity generation by 2045.[155] The Act provides for "…new requirements

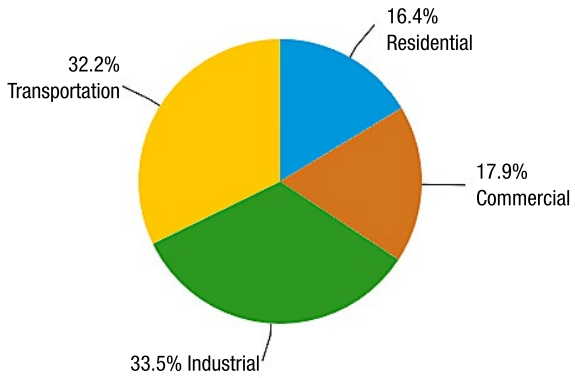


Figure 22. New Mexico energy consumption by end-use sector, 2017.
Source: U.S. Energy Information Administration, State Energy Data System.

and targets for the renewable portfolio standard for rural electric cooperatives and public utilities."[156] New Mexico, through the growth of its portfolio of renewables and the local expertise of its engineering and science public universities and national laboratories, also has the capacity to become a national leader in energy innovation and a center for next-generation electrical-system technologies and grid-modernization efforts. Energy storage is one prospect, with the laboratories running several pilot projects in the state. New Mexico has the opportunity to lead the development, integration and growth of this energy technology by creating a robust, in-state energy-storage industry and incorporating its use into legislation. The main challenge for the state in taking full advantage of renewable energy resources is infrastructure (Center for Strategic and International Studies 2018). New Mexico Executive Order 2019-003, which addresses climate change and energy waste prevention, expressly identifies renewable energy transmission in Directive III.5.d: "Collaboration with Renewable Energy Transmission Authority to identify transmission corridors needed to transport the state's renewable energy to market" (Lujan Grisham 2019).

5.3.9 Energy Efficiency

In 2005, the State of New Mexico instituted the Efficient Use of Energy Act, which established energy savings requirements for investor-owned electric utilities of 5 percent of 2005 total retail kWh sales by 2014 and 8 percent of 2005 total retail kWh sales by 2020. In 2013, the Efficient Use of Energy Act was revised to establish a fixed budget level of 3 percent of annual revenues for energy-efficiency programs (customer's demand-side management surcharge is capped at US$75,000 per year).[157] The Efficient Use of Energy Act was amended in 2019, as discussed below.

Electricity Demand-Side Management. The state's three investor-owned electric utilities, Public Service Company of New Mexico, Xcel Energy (Southwestern Public Service Company) and El Paso Electric offer their customers a wide range of energy-efficiency programs. State legislation adopted in 2008 establishes energy-savings requirements for the electric utilities and amendments that the legislature adopted in 2013 direct utilities to spend 3 percent of their retail sales revenues on demand-side management programs. Total spending on electric utility energy-efficiency and load-management programs was US$36 million in 2015 (Public Service Company of New Mexico 2019b). The electricity conservation potential, as well as impacts, of the state are shown in Table 12.

Table 12. Electricity Conservation Potential and Impacts in New Mexico

Savings Potential in 2020	24%
Avoided New Power Capacity	970 MW
Net Dollar Savings (2010–2030)	$1.7 B
Increases in Jobs by 2020	2,330
Water Savings by 2020	4.6 B gallons/year

MW—Megawatt; B—Billion
Source: www.swenergy.org/Data/Sites/1/media/documents/publications/factsheets/nm-factsheet.pdf.

Natural Gas Demand-Side Management. The New Mexico Gas Company (2019b) implements some natural gas energy-efficiency programs for its customers. The utility's energy-efficiency budget was about US$4 million as of 2015.

State Building Energy Codes. New Mexico adopted a statewide energy code, the 2009 International Energy Conservation Code (IECC). DOE (2018) estimates that homeowners of new homes built in New Mexico complying with the 2009 IECC rather than the 2006 version will save US$216–251 per year on energy costs.

Recent Legislation. On April 3, 2019, Governor Lujan Grisham signed changes to the Efficient Use of Energy Act to establish decoupling. Under decoupling, utilities are able to recover only the costs that they set along with a set amount for profit, but nothing beyond that, which will incentivize them to drive more efficiency in their customers' energy usage.[158] The aim is to remove the disincentive for utilities to conserve energy, as well as boost energy-efficiency funding by 67 percent. The legislation is the continuation of a 2005 law allowing electric and gas utilities to implement energy-efficiency programming (Morehouse 2019).[159] Although Public Service Company of New Mexico is the largest utility in the state, Xcel Energy and El Paso Electric also operate in New Mexico, and their combined programming has reduced electricity demand by 7 percent since the projects' launches in 2008 to 2017. Although this bill is not under the umbrella of a January 2019 executive order by Governor Lujan

Grisham, which tackled a wide sweep of climate change initiatives, including building energy-efficiency standards, it is part of a broader package for New Mexico's energy future. The state in 2019 became the third in the country to commit to 100 percent carbon-free energy. The bill followed Governor Lujan Grisham's January 2019 Executive Order 2019-003, which commits New Mexico to the U.S. terms under the Paris Climate Agreement and directs state agencies to set emissions standards for vehicles and power plants, as well as to identify transmission infrastructure needed for renewable energy growth.[160]

5.4 Texas Border Region

5.4.1 Electric Reliability Council of Texas—ERCOT

Texas is the only state in the United States with an intrastate electricity grid. The independent system operator, the Electric Reliability Council of Texas (ERCOT), manages and operates the grid for the Texas side of the border with Mexico, except in El Paso County and Hudspeth County, which is part of the Western Interconnection (Figure 23). ERCOT falls under the governance of the Public Utility Commission of Texas and the Texas Legislature, and it complies with NERC standards (ERCOT 2019a). Under the U.S. Federal Power Act, ERCOT does not fall under federal jurisdiction because there is no transmission of electricity across state lines (FERC 2018a). ERCOT serves approximately 90 percent of Texas, or 25 million customers (ERCOT 2019b). The majority of Texas customers live in competitive markets for electricity, so customers

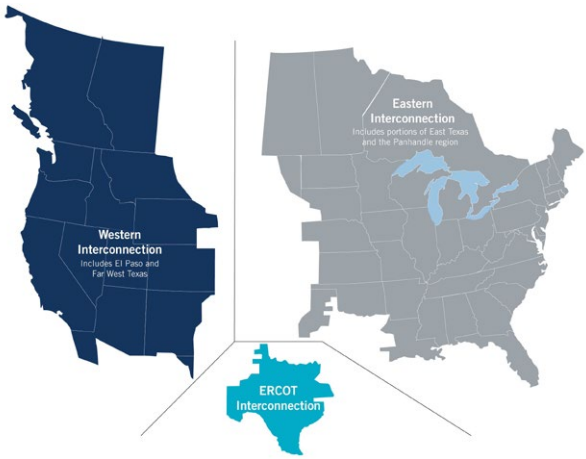


Figure 23. Electric Reliability Council of Texas interconnection maps.
Source: Electric Reliability Council of Texas, www.ercot.com/news/mediakit/maps.

Hatch Solar Energy Center

Energy Projects in Rural Communities—An Economic Development Case Study

The Hatch Solar Energy Center is an example of a renewable energy project that is generating revenue for the small rural community of Hatch (with a population of 1,648) in Doña Ana County (U.S. Census Bureau 2019c). The Hatch Solar Energy Center is a 5-megawatt solar energy plant using concentrating photovoltaic systems (Hilliard Energy 2019), constructed on 41 acres of village-owned property (Village of Hatch 2019). Operated by a subsidiary of NextEra Energy Resources, the facility has a 25-year purchase power agreement to sell the energy produced to El Paso Electric, a major electricity provider in southern New Mexico and west Texas (El Paso Electric Company 2019b).

The Village of Hatch receives yearly lease payments as part of the solar park's 30-year lease with the Village. The Village authorized an Industrial Revenue Bond for the project, abating the property taxes but establishing a payment in lieu of taxes to be made yearly for the life of the lease. Combined payments total more than US$40,000 per year.

Projects such as these present opportunities for rural border communities to participate in economic opportunities generated by growth in the renewable energy sector. Although solar parks are not large job-generating projects, utilizing vacant municipal-owned land for energy projects can produce a reliable income stream for rural border communities as long as transmission lines are available.

purchase from a market of available retailers. Fifteen percent of Texans purchase electricity from public- or investor-owned utilities or cooperatives, which have received permission from the Public Utility Commission of Texas to exclude retailer competition (ElectricityPlans.com 2017). ERCOT maintains reliability for more than 46,500 miles (74,834 km) of high-voltage transmission lines. Record peak demand for electricity consumption within ERCOT comes from a variety of sources, led by natural gas. Following is a summary of consumption, which totaled just more than 73.4 GW in 2018, by source:

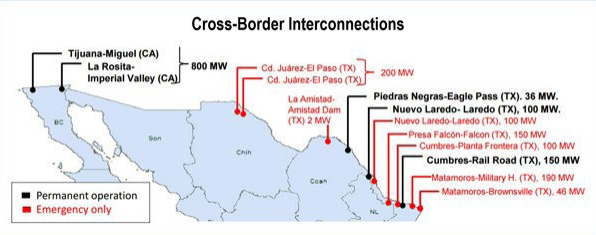
- 44.4 percent natural gas power
- 24.8 percent coal
- 18.6 percent wind
- 10.9 percent nuclear
- 1.3 percent from other sources such as landfill gas, biomass and hydropower (ERCOT 2019a)

5.4.2 The El Paso Exception

El Paso County and Hudspeth County are part of the Western Interconnection of the electricity grid. Historically, far West Texas was separate from ERCOT because of transmission costs and utility territories that crossed into New Mexico (Galbraith 2011). Electricity customers may be served by utilities such as the Rio Grande Electric Cooperative (2019), which has the "largest service territory of any electric cooperative in the contiguous United States, serving 18 counties in Texas, and 2 counties in New Mexico," or El Paso Electric Company. El Paso Electric Company (2019a) serves more than 415,000 customers in a 10,000 square mile (25,900 km^2) service territory. Utilities in far West Texas fall under the governance of the Public Utility Commission of Texas as well as the Texas legislature, but may also be subject to regulations from New Mexico Public Regulation Commission, the New Mexico legislature and FERC.

5.4.3 Cross-Border Electrical Grid Interconnections

Cross-border interconnections exist between ERCOT and the CFE grid in northern Mexico. These include transmission line asynchronous interconnections of American Electric Power Texas to CFE in the Texas cities of Eagle Pass, Laredo and Mission, which are part of ERCOT. An interconnection also exists between El Paso Electric, not part of ERCOT, and CFE's Norte region (Rosales, Sarmiento and Rodriguez 2011). AEP Texas, part of the American Electric Power system, submitted a request to FERC and received permission in 2018 from DOE to transmit power between Texas and Mexico using its connections (Kleckner 2018). FERC did not suggest that ERCOT would fall under its jurisdiction as a result of the cross-border electricity flows (Sanders 2018). Using interconnections in the Rio Grande Valley and Tamaulipas, a combined cycle gas powered plant in Mission, Texas, has been selling all of the power it generates to industrial consumers in Mexico since 2015. The plant must, however, make its power supply available to ERCOT customers in an emergency (ERCOT 2014, Matalon 2019, Mexico News Daily 2015). In its Quadrennial Energy Review, DOE (2017a) found that "The Electric Reliability Council of Texas could benefit from greater integration with Mexico, through access to enhanced imports or as a business opportunity for power exporters." Eight interconnections along the Texas-Mexico border exist for emergency and reliability purposes (Figure 24) (Kleckner 2018).



MW—Megawatt
Figure 24. Cross-border interconnections.
Source: RTO Insider, rtoinsider.com/ferc-aep-ercot-mexico-dc-tie-connections-97152.

5.4.4 Oil and Natural Gas Production From the Eagle Ford Shale Formation in South Texas

The Eagle Ford Shale extends northeast from the Texas-Mexico border in Webb County, north of Laredo toward East Texas. The geological formation is approximately 50 miles (80 km) wide and 400 miles (644 km) long (Railroad Commission of Texas 2019d). Oil and natural gas production in the Eagle Ford Shale grew rapidly with the decreasing

costs of hydraulic fracturing in the 2010s. The Railroad Commission of Texas (2019e), the state regulatory agency for oil and gas drilling, issued its highest number of permits in the Eagle Ford Shale in 2014, at 5,613 permits (Figure 25). In 2015, oil production in the Eagle Ford Shale hit its peak at 1,196,974 barrels per day (Railroad Commission of Texas 2019f). The highest gas production in the Eagle Ford Shale also hit its peak in 2015, at 6.1 billion cubic feet (172 million m^3) per day (Railroad Commission of Texas 2019g). Since then, production in the Eagle Ford Shale has averaged close to 900,000 barrels per day of oil and 5.4 billion cubic feet (153 million m^3) of natural gas per day (Railroad Commission of Texas 2019g).

5.4.5 Oil and Natural Gas Production From the Permian Basin Shale Formations in West Texas

The Permian Basin Shale extends from roughly 40 miles (64 km) north of the Texas-Mexico border in Terrell, Val Verde, and Edwards Counties north toward the Panhandle and west into New Mexico. A dozen geological formations in the Permian Basin cover an area 250 miles (402 km) wide and 300 miles (483 km) long (Railroad Commission of Texas 2019a). The Railroad Commission of Texas (2019b) issued its highest number of drilling permits in the Texas Permian Basin in 2014 at 10,966 permits (Figure 26). Natural gas production in the Texas Permian Basin has increased every year since 2012. In 2018, it produced 8.5 billion cubic feet (240 million m^3) of natural gas per day. In February 2019, the production in the Texas Permian was 8.4 billion cubic feet (238 million m^3) per day (Railroad Commission of Texas 2019c). Total natural gas production for the Permian Region was 14.2 billion cubic feet (402 million m^3) per day as of May 2019 (EIA 2019q). As a result of reduced costs and technological advancements in hydraulic fracturing and directional drilling, the Permian Basin continues to produce from oil fields previously thought to be unrecoverable. In December 2018, the U.S. Geological Survey announced that the Wolfcamp Shale and Bone Spring Formation in the Permian Basin have the largest unconventional oil and gas resource potential ever assessed (U.S. Department of the Interior 2018).

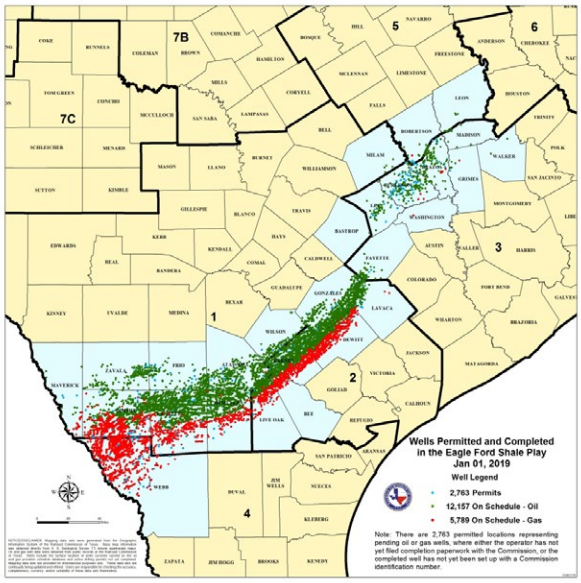


Figure 25. Wells permitted and completed in the Eagle Ford Shale Play as of January 1, 2019.
Source: Railroad Commission of Texas, www.rrc.state.tx.us/media/49772/eaglefordshaleplay2019-01-lg.jpg.

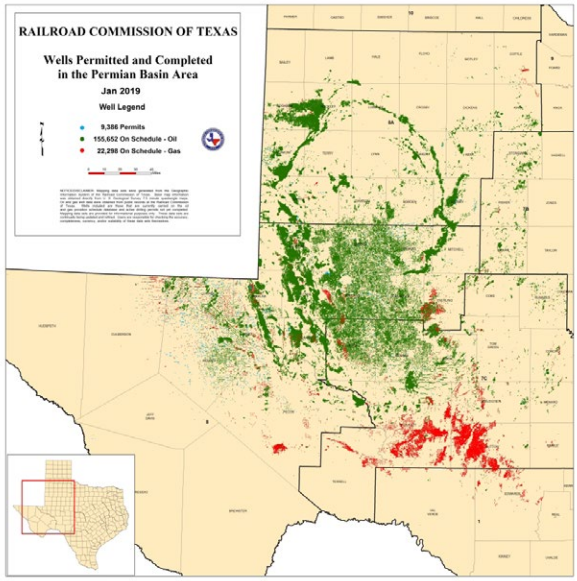
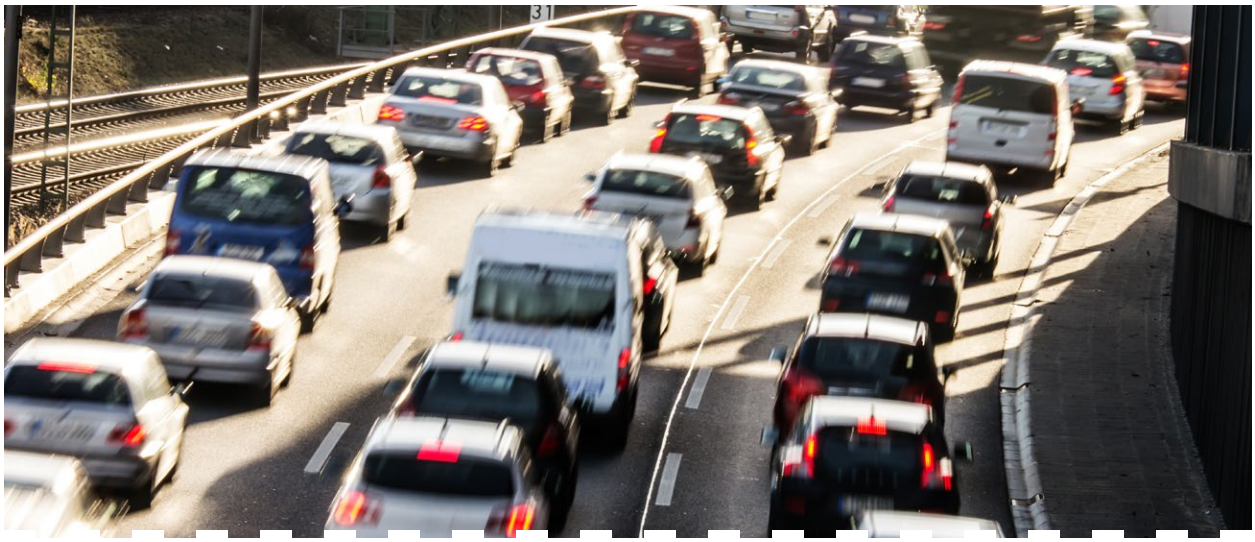


Figure 26. Wells permitted and completed in the Permian Basin area as of January 2019.
Source: Railroad Commission of Texas, www.rrc.state.tx.us/media/49783/pb-area-201901-lg.jpg.

5.4.6 Wind and Solar Energy

Texas is one of the leading states in renewable energy generation. In 1999, Texas legislators created renewable portfolio standards to mandate the production of 10,000 MW of renewable energy by 2025, which the state was able to accomplish early—in 2009 (Sixel 2019). In 2007, Texas invested



US$7 billion to construct transmission lines to connect wind farms in West Texas to the state electricity grid. The construction of the lines was completed in January 2014 (Malewitz 2019). In 2018, the cumulative installed wind generating capacity in Texas was 24,895 MW (DOE 2019d). 5,322 MW of additional capacity is under construction on pace with the 10,000 MW of capacity that ERCOT forecast to be installed in 2018–2019 (ERCOT 2017). According to the U.S. Geological Survey (2019), several clusters of wind turbines are installed near the South Texas border with Mexico near the Texas cities of Del Rio and Laredo and the Rio Grande Valley. Texas generates nearly 20 percent of its electricity from wind and solar energy (Fares 2018).

Texas is one of nine southwestern and western states with the greatest potential for solar photovoltaic-generated electricity in the country (USEPA 2019). In 2017, the solar power generated in Texas more than doubled, from 96 GWh to 199 GWh (Graves and Wright 2018). At this time, solar energy accounted for just 1 percent of electricity generation in Texas (ERCOT 2019a). In January 2019, the ERCOT grid had 1,500 MW of installed utility-scale solar capacity, with more than 4,300 MW of capacity expected to be in service by 2020 (ERCOT 2019c). The Texas border with Mexico has the highest solar resource potential in the state, especially along the Texas-Chihuahua border (National Renewable Energy Laboratory 2017). Declining costs of solar technology, as well as streamlined permitting processes, continue to expand solar power generation in Texas (Graves and Wright 2018). ERCOT estimates that up to 20 GW of utility-scale solar power could be added to the grid by 2032 (Golnas 2018).

5.4.7 Cross-Border Natural Gas Pipelines

Texas exports more natural gas to Mexico than any other state. Gas exports go through the "Rio Grande/Roma" point of exit in the Rio Grande Valley. Exports from the Permian Basin in West Texas have dramatically increased in the past few years with its production boom, new gas-fired power plants in Mexico, and pipeline expansions in South Texas. Between 2017 and 2018, natural gas exports to Mexico from the United States via pipeline increased by 1 billion cubic feet (28 million m^3) per day (Figure 27) (EIA 2019r). New gas pipeline construction for export to Mexico has been met with concerns and opposition by some local Texas communities and landowners.[161] Federal, state and local governments, as well as energy companies, need to do a better job of proactively informing and providing information to local stakeholders who might be affected by these large infrastructure projects.

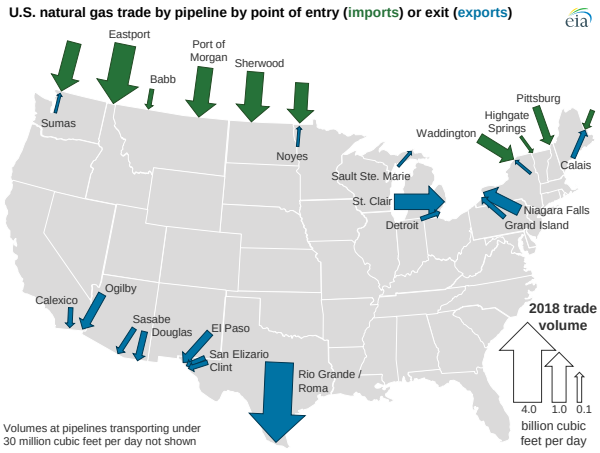


Figure 27. U.S. natural gas trade by pipeline by port of entry (imports; green arrows) or exit (exports; blue arrows).
Source: U.S. Energy Information Administration, www.eia.gov/todayinenergy/detail.php?id=39312.

Although liquefied natural gas exports are forecast to rise, pipeline exports of natural gas to Mexico, mainly through Texas, currently make up the largest share of U.S. natural gas exports globally (EIA 2019r). Liquefied natural gas also is exported to Mexico by truck to areas not served by Mexican pipelines, and this export has increased dramatically from 2016 (Figure 28) (EIA 2019s). The increase in liquefied natural gas trucks transiting through U.S. border communities presents risks to local residents.

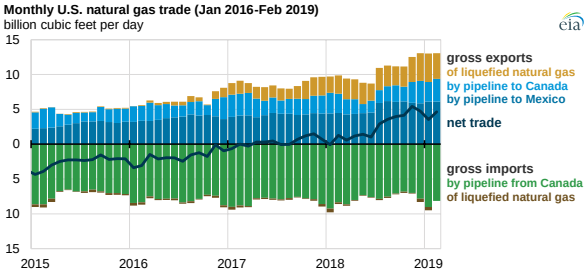


Figure 28. Monthly U.S. natural gas trade (January 2016 through February 2019) in billion cubic feet per day.
Source: U.S. Energy Information Administration, www.eia.gov/todayinenergy/detail.php?id=39312.

5.4.8 Energy Efficiency: Property Assessed Clean Energy Program in the Border Region

The Texas legislature created the Property Assessed Clean Energy Program in 2003 to incentivize Texas' property owners to finance energy-efficiency improvements, such as insulation and air sealing, cool roofs, and water-efficiency products at a low fixed interest rate. Through this program, property owners, including owners of multifamily residential properties of five units or more, gain access to private, affordable, long-term financing (typically 10 to 20 years) that is not available through traditional funding avenues. The Texas PACE Authority administers the program on behalf of local governments.

The Texas PACE Authority completed the Plaza Hotel Property Assessed Clean Energy project in downtown El Paso in April 2019. The Plaza Hotel is a 5,308 square foot historic hotel built in 1930 that has been out of service since the 1990s. The rehabilitation and energy-efficiency upgrades transformed the hotel into the first 4.5-star luxury hotel in El Paso and preserved the hotel's Pueblo Deco (which fuses elements of Art Deco and Pueblo Revival design) by acclaimed architect Henry Trost. All of the building systems were updated as part of the building rehabilitation, including HVAC, elevator, lighting and plumbing. An investment of US$9,200,353 funded these improvements.

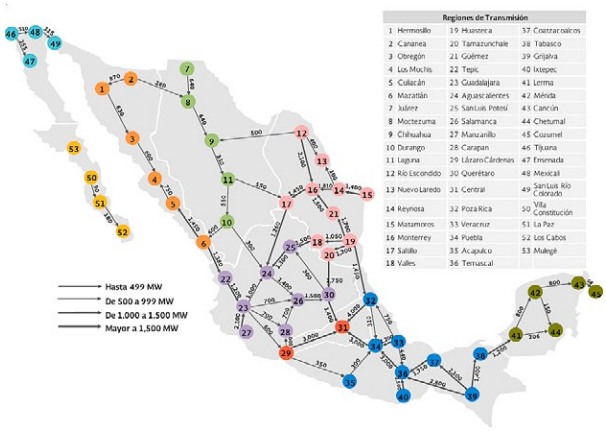
6

Mexican Border Energy

6.1 Baja California

6.1.1 Current Energy Infrastructure and Use

The Sistema Eléctrico Nacional (National Electric System of Mexico) is comprised of four isolated electric systems: (1) Sistema Interconectado Nacional (National Interconnected System), (2) Sistema Interconectado Baja California (Baja California Interconnected System), (3) Sistema Interconectado Baja California Sur (Baja California Sur Interconnected System), and (4) Sistema Eléctrico Mulegé (Mulegé Electric System). The Baja California Interconnected System is the system that covers all of the cities in Baja California (Ensenada, Tijuana, Tecate, Mexicali and Rosarito) and also includes San Luis Río Colorado in Sonora. This system is isolated from the other three that exist in Mexico, but interconnected with the Western Electricity Coordinating Council in the United States. The Baja California Interconnected System has interconnections with different capacities; the Tijuana-Ensenada interconnection has a capacity of 255 megawatts (MW) and Tijuana-Mexicali of 520 MW, whereas the interconnection between Mexicali-San Luis Rio Colorado is 315 MW (Figure 29).



MW—Megawatt

Figure 29. Capacity of the interconnections in the 53 regions of the National Electric System.

Source: Secretaría de Energía (Ministry of Energy, known as SENER), Map 2.2, www.gob.mx/cms/uploads/attachment/file/236866/Electricity_Sector_Outlook_2016-2030_P.compressed.pdf.

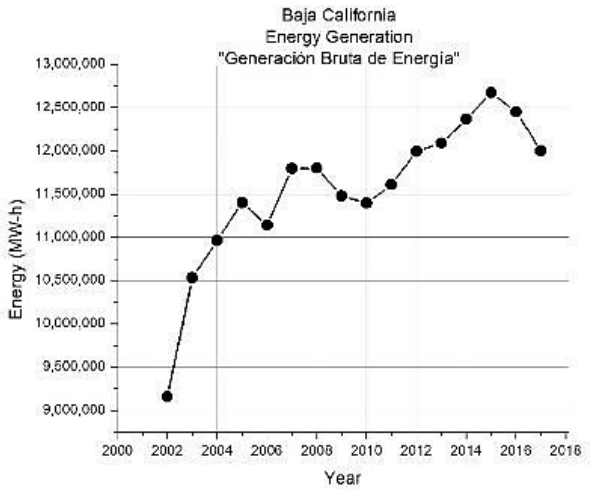
In an effort to connect the Baja California electrical system to the Mexican national grid, an open call for tenders ("licitación pública") was issued in 2018 for the management and operation of a direct-current, 500 kilovolt (kV), 1,500 MW transmission line. The line would cover a distance of 700 kilometers (km) (435 miles). This project, however, was cancelled in March 2019 by the new Mexican administration (Proyectos México 2019).

Baja California's energy infrastructure is divided into two zones: Zona Costa, which is formed by the cities of Tijuana, Ensenada, Tecate and Rosarito; and Zona Valle, which includes Mexicali. By 2017, the Baja California Interconnected System had 35 generation units distributed by various types of technology as follows: nine combined cycle, one thermoelectric, four turbo gas, 12 internal combustion, two wind, four geothermal, two photovoltaic solar and one cogeneration. All large power plants in Baja California now burn natural gas, an improvement in terms of air pollution compared to the former fuel oil. The natural gas used in the power sector is imported from the United States. This is a good example of how cross-border energy trading can be a win-win case in that Baja California has access to relatively less polluting natural gas from the United States (compared to heavy fuel oil). The main power plants in Baja California are described in Figure 30.

For 2017, the approximate totals of electrical generation and installed capacity were 20,234 gigawatt hours (GWh) and 4,641 MW respectively, approximately 6.1 percent of the overall values in the country in both generation and capacity (SENER 2018). Between the years 2013 to 2017, Baja California generated on average 12.3 million megawatt hours of energy per year, or 4.8 percent of the national generation (Figure 31).

Nombre	Tecnología	Propietario	Capacidad MW	Ubicación	Cliente
El Cedros	CI	CFE	1	Ensenada	CFE-SSB
Cerro Prieto Solar	FV	CFE	5	Mexicali	CFE-SSB
Parque Eólico Rumorosa	E	Gobierno del Estado	10	Tecate	Autoabastecimiento : Municipio Mexicali
FAPSA	CO	Fabrica de Papel San Francisco	23	Mexicali	FAPSA
Turbo gas Cipriés	TG	CFE	28	Ensenada	CFE-SSB
Rumorosa Solar	FV	IEnova	41	Tecate	CFE-SSB
Turbo gas Mexicali	TG	CFE	62	Mexicali	CFE-SSB
EAX – AA	CC	SAAVI	80	Mexicali	Autoabastecimiento : Industria
Energía Sierra de Juárez	E	IEnova	157	Tecate	Exportación
EAX – Gen	CC	SAAVI	165	Mexicali	CFE-SSB
La Rosita II	CC	SAAVI	320	Mexicali	Exportación
Baja California III	CC	Iberdrola	324	Ensenada	CFE-SSB / Generación Industria
Cerro Prieto	Geo	CFE	340	Mexicali	CFE-SSB
Turbo gas Tijuana	TG	CFE	345	Tijuana	CFE-SSB
La Rosita	CC	SAAVI	489	Mexicali	CFE-SSB
Termoeléctrica de Mexicali	CC	IEnova	625	Mexicali	Exportación
Presidente Juárez	CC	CFE	1063	Rosarito	CFE-SSB

Figure 30. Main Power Plants in Baja California, Mexico
Source: David Muñoz, Diurna Energy.



MWh—Megawatt hours
Figure 31. Historic production of energy in Baja California.
Data source: Sistema de Información Energética (Mexico's Energy Information System).

Table 13. Electricity Sales Volume in Baja California, 2012–2016

Sector	Sales Volume GWh (2012)	Sales Volume GWh (2013)	Sales Volume GWh (2014)	Sales Volume GWh (2015)	Sales Volume GWh (2016)
Total	9,657	9,403	9,791	9,987	10,432
Domestic	3,166	3,088	3,173	3,264	3,430
Street Lighting	1,201	101	949	103	94
Bombeo of Drinking Water and Sewage	46	45	48	52	56
Agricultural	252	259	306	313	323
Industrial and Services	6,073	5,910	6,169	6,254	6,528

GWh—Gigawatt hours
Bombeo is the pumping of drinking water and sewage.
Source: Instituto Nacional de Estadística y Geografía (Mexico's National Institute of Statistics and Geography).

6.1.2 Energy Resources

Baja California is a region with an abundance of indigenous solar, wind, geothermal, bioenergy and ocean-related energy resources that have not been fully exploited. Baja California is home to the largest geothermal plant in Mexico: Cerro Prieto, near Mexicali, with an installed capacity of 570 MW and generating 3,709 GWh in 2016. The geothermal fields at Cerro Prieto have been declining over the years from a peak capacity of 820 MW. Wind generation continues to grow, with new projects developed by Sempra Energy (IEnova in Mexico) in the Sierra de Juárez mountain range and existing projects in the town of La Rumorosa. The Sierra San Pedro Mártir mountain range is believed to have significant wind resources as well. Energy and power resources of 400 GWh per year and 166 MW, respectively, were in place in 2016.

Baja California has a high level of solar insolation, especially in the state's capital, Mexicali, where summer temperatures are very high, and electricity demand from the use of air conditioning is significant. There has been a relatively slow growth of solar projects, however, compared to the resource, with one large project of 41 MW developed by IEnova.

Bioenergy is a potential energy source because of the large quantities of waste generated in Baja California, as well as agricultural and animal wastes. An example of biogas generation is the dairy company Pasteurizadora Jersey del Noroeste, located near the Transpeninsular Highway, which implemented technologies for the generation of biogas from animal waste as its main energy resource (Muñoz et al 2012).

Baja California does not have indigenous natural gas and imports natural gas via pipelines from the United States. The state potentially can utilize natural gas from the large liquefied natural gas facility just north of Ensenada, known as Energía Costa Azul (2019), and owned by IEnova.

During the past few years, several global companies associated with the manufacture of photovoltaic cells have been established in the region (e.g., Sunpower), creating an opportunity for low-cost solar system components in the local market and the formation of small regional companies for the installation of solar systems. It also creates demand for a well-trained labor force and technicians in the field.

6.1.3 Cost and Prices of Energy in Baja California

The pricing of electricity in Baja California is complex, with many different categories of service. The largest sector is the industrial and services sector, which in 2017 used 63 percent of generated electricity. This was followed by the domestic sector at 33 percent. These numbers reflect the underlying economy of Baja California, which has a growing industrial sector primarily centered in the cities of Mexicali and Tijuana. The sales volume in Baja California from 2012 to 2016 is shown in Table 13.

The prices for electricity vary by region and sector. In general, electricity is expensive in Baja California, especially in the eastern section of the state, where summer temperatures are very high, and air conditioning loads are significant. Prices also are high in California in the San Diego Gas & Electric territory, although lower in Imperial County, and energy costs for power generally are not a major

Table 14. Atmospheric Emissions of Thermoelectric Plants Located in Baja California

Plant Name	Location	Carbon Dioxide (Ton)	Sulfur Dioxide	Oxides of Nitrogen	Coarse Particulate Matter	Fine Particulate Matter
Presidente Juárez	Rosarito	1,925,417.15	6,952.11	5,118.06	730.67	648.67
Termoeléctrica Mexicali	Mexicali	1,095,489.82	5.48	3,822.99	364.05	364.05
Energía Azteca X	Mexicali	915,235.91	4.58	3,193.94	304.15	536.62
Energía de Baja California	Ensenada	560,296.41	2.8	1,955.29	186.2	186.2
CTG Mexicali	Mexicali	6,131.67	0.06	25.94	2.27	2.27
CTG Ciprés	Ensenada	2,225.66	0.02	9.42	0.82	0.82

Data source: Commission for Environmental Cooperation, www.cec.org/sites/default/napp/en/country-profiles/mexico/view-emissions-data.php.

factor in decisions regarding location of industrial facilities on either side of the border.

6.1.4 Environmental Impacts of the Energy Sector

The biggest environmental impacts resulting from power generation are associated with fossil fuels and treatment of brines that are part of geothermal production in the Mexicali Valley. The main power plants in the state are located in Rosarito and Cerro Prieto, near Mexicali. The Rosarito plant uses natural gas as a fuel, and Cerro Prieto exploits the geothermal fields in the region. Two other natural gas-fueled (thermoelectric) plants exist near Mexicali. Emissions from these plants are shown in Table 14.

6.1.5 Future Energy Demand

Projections of future demand in Mexico—from 2018 through 2032—were developed by the Secretaría de Energía (Ministry of Energy, known as SENER) (SENER 2018). The analysis showed that an additional capacity of 66,912 MW would be needed by 2032. The analysis concluded that 45 percent would be supplied by conventional resources and the remaining 55 percent by renewable energies. In Table 15, the additional capacity for Baja California can be seen by type of technology; conventional technologies will contribute 80.55 percent, whereas renewables account for the remaining 19.44 percent. Baja California's future expansion of the electrical power is heavily weighted toward natural gas-burning facilities, with wind energy next. Surprisingly, little consideration is given to solar energy generation, despite the very good solar resource available in the region.

6.1.6 Potential for Renewables

Baja California has significant potential for the development of both solar- and wind-generated electricity. Qualitatively, it is clear that both of these resources hold major potential to become a large factor in Baja California's energy mix.

Table 15. Additional Gross Capacity by Technology in Baja California

Year	Municipality	Technology	Capacity (MW)
2019	Mexicali	Solar	41
2020	San Luis Rio Colorado	Turbogas	340
2022	Tijuana	Bioenergy	4
2022	Ensenada	Combined Cycle	565
2023	Mexicali	Combined Cycle	337
2023	San Luis Rio Colorado	Combined Cycle	1,186
2025	Mexicali	Combined Cycle	516
2026	Tijuana	Hydroelectric	11
2027	Mexicali	Combined Cycle	130
2028	Tijuana	Hydroelectric	17
2028	Tijuana	Bioenergy	3
2028	Tijuana	Bioenergy	16
2028	Ensenada	Bioenergy	5
2028	Mexicali	Bioenergy	11
2028	San Luis Rio Colorado	Combined Cycle	290
2029	Ensenada	Eolic	400
2030	Tijuana	Eolic	58
2030	Tijuana	Eolic	46
2030	Tijuana	Eolic	100
2030	Tijuana	Eolic	100
		Total	**4,176**

MW—Megawatt

Source: Secretaría de Energía (Ministry of Energy, known as SENER), base.energia.gob.mx/Prospectivas18-32/PSE_18_32_F.pdf.

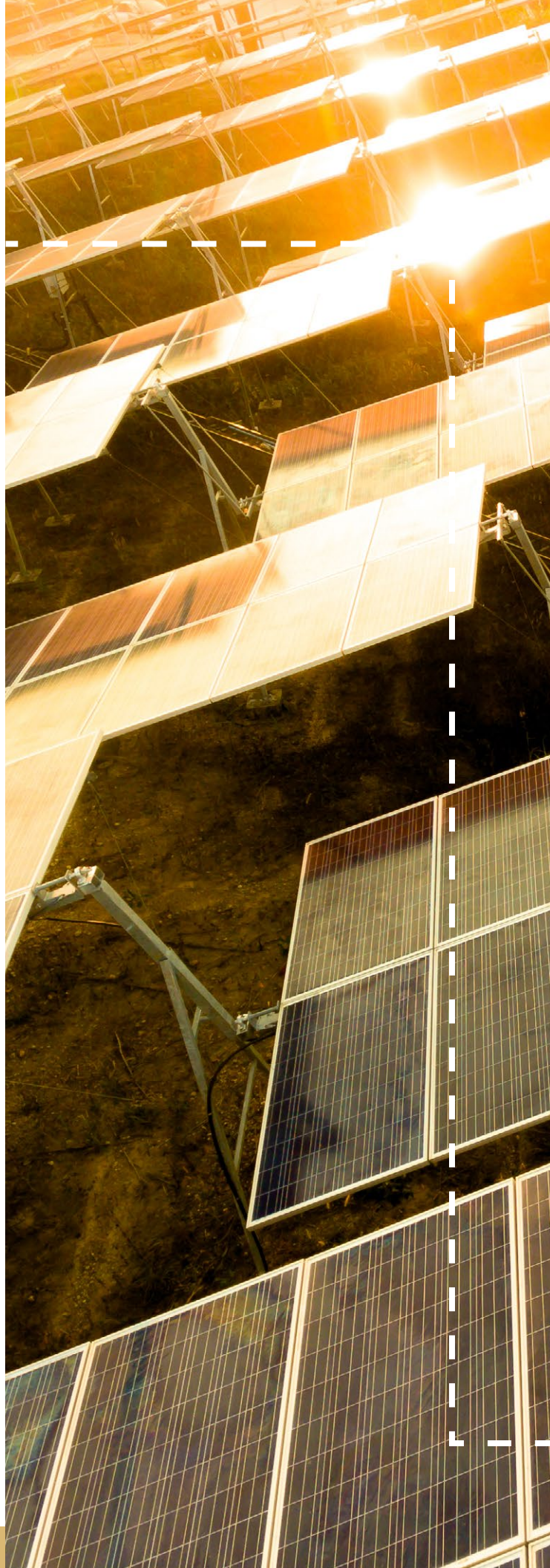
6.1.7 Energy Needs for Water

Contemporary civilization depends on water and energy for survival. Baja California has two critical issues related to the water-energy nexus: the lack of sufficient water resources to meet social needs, and depletion and salinization of aquifers in food-producing areas (in Mexico, agriculture represents around the 70% of water consumption).

The San Quintín Valley, located about 225 km (140 miles) south of the border, is the main producer of tomato and berries in the state, most for export. It has an annual average rainfall of 200 millimeters (7.9 inches), and there are no permanent rivers. Of the eight aquifers, three are overexploited, and another three are salinized. In 2017, at least 67 desalination plants are operating and registered with the Comisión Nacional del Agua (Mexico's national water authority), and all use water from the salinized aquifers because it is cheaper to process than seawater. It is difficult to determine the total water extraction capacity of the region because desalination plants are private and are installed, operated and maintained by individual ranches and farms.

The exact amount of energy needed to operate the desalination plants in San Quintín valley is unknown, but demand for electric power is assumed to be very large. All facilities are connected to the regional power grid because the federal government subsidizes more than 90 percent of the cost of energy used for agricultural purposes. The Special Energy Program for Agricultural Use states that "…if the regular cost of energy is 7.24 pesos per kWh, and the farmer signs the agreement, the daytime cost will be 0.62 pesos per kWh and the nighttime cost will be 0.31 pesos per kWh" (Azuz and Arreola 2019).

Because of water availability restrictions, from 2003 to 2017 the planted area in the San Quintín Valley experienced a decrease of 30 percent, going from roughly 9,000 to 7,000 hectares (22,239 to 17,297 acres). Despite this, the value of production tripled, especially in the case of strawberry crops. For this crop, recent studies estimate that the total water demand for one agricultural cycle (between 5.2 and 6.8 months) is 19 million cubic meters (m^3) (670 million cubic feet) and the energy need for desalination is 122 MW (Azuz and Arreola 2019).



Baja California has significant potential for the development of both solar- and wind-generated electricity.

6.1.8 Binational Desalination Initiatives

Binational desalination provides opportunities to augment water supply in the U.S.-Mexico border region but has challenges, such as the need for additional energy, which would increase greenhouse gas emissions, and difficulties with sustainable discharge of millions of gallons of brine concentrate daily. A desalination plant co-located with the Rosarito Thermoelectric Plant at Playas de Rosarito, Baja California, some 19 km (12 miles) south of the international border, has been under discussion for many years. The plant, if built, would produce about 378 million liters (100 million gallons) per day, which would be twice the output of the currently operating plant located in San Diego County at Carlsbad, California.

For many, desalination is an attractive option to obtain water in Baja California or even southern California, Arizona and elsewhere along the border. Given its high energy use, high cost and environmental effects, however, many believe that other options should be implemented first, such as increasing water treatment and reuse. For example, 20 percent of Tijuana's water is not treated. Of the water that is treated, only 4 percent is reused; the rest is discharged into the ocean.

6.1.9 Cross-Border Energy Trading

Baja California and California share two interconnection electrical transmission lines. These lines are managed by the Sistema Eléctrico Nacional through the Comisión Federal de Electricidad (Federal Electricity Commission, known as CFE) in Mexico and by the Western Electricity Coordinating Council through the California Independent System Operator in the United States. One connection is between Tijuana-Otay Mesa, and the other is between Mexicali (La Rosita)-Imperial Valley. The interconnections between both systems in Baja California have a capacity of 800 MW for both lines with a voltage of 230 kV (SENER 2015).

In 2011, San Diego Gas & Electric signed a 20-year contract to receive power from wind farms operated by Sempra Energy's wind farms in Baja California. The farm has 47 turbines with a capacity of 155 MW of wind power. The energy is 100 percent generated in Mexico and connected to San Diego's substation system (Sempra International 2016).

Baja California and California share three natural gas pipelines with a capacity of 23.5 billion m^3 (829 billion cubic feet) per day. The first interconnection is located at the port of entry east of Mexicali and feeds the residential and industrial sectors. The second, the Baja Norte pipeline, covers Tijuana and Rosarito and provides energy to the Rosarito Electric Plant and San Diego Gas & Electric. The third connection is in Los Algodones at Valle de Mexicali, which supplies energy generation plants in the area (Muñoz et al 2012).

6.2 Sonora

Sonora is the second largest state in terms of land mass in Mexico, and despite being sparsely populated, it is home to important mining, farming and manufacturing centers for the Mexican economy. The state has some hydroelectric and solar power stations but mainly relies on gas imported from the United States and oil from other Mexican states for most of its electrical supply. Around 5 percent of the state's electrical needs come from renewable sources, with the rest from natural gas and other fossil fuels (Comisión de Energía del Estado de Sonora 2019). The transportation sector continues to be the main destination for energy usage in the state and one of the most important uses of oil in the state (Comisión De Energía del Estado de Sonora 2010). Currently, one of Latin America's largest solar power plants (Puerto Libertad Photovoltaic Plant) is under development in Puerto Libertad, Sonora, and should be producing electricity for the state sometime in the next few years (Power Technology 2019b). Thirteen solar power projects currently are under construction, and the government of Sonora has made it a priority to expand production of solar and wind electricity generating plants in the state, especially because so much of the state is suitable for solar energy production (Comisión de Energía del Estado de Sonora 2019). Solar likely will see large amounts of growth in the state's energy portfolio as the state invests in new programs and plants. The government has and will likely continue to expand and upgrade electrical transmission lines between Arizona and Sonora (Wichner 2017).

Thirty percent of the state's electrical consumption takes place in the capital of Hermosillo (SENER 2016). Electricity distributed in the state still is managed by the federal government of Mexico, with state-level policy focusing on development of new sources and encouraging the growth of renewables and cross-border trade (Comisión De Energía del Estado de Sonora 2009). The state's Comisión de Energía helps formulate policy and encourage development in the state, working with CFE. The federal government manages energy prices depending on multiple factors, including the region of the country, its climate, and its usage level. Last year, the governors of Sonora, Arizona and New Mexico signed an accord to import natural gas to plants in Mexico before transporting the finished liquefied natural gas onward to Asian customers (Vanguardia 2018). The majority of the natural gas coming into the state through the U.S.-Mexican border goes to Sonora and its more populous neighbor state, Chihuahua.

6.3 Chihuahua

Although the oil- and gas-producing geological formations in the Permian Basin do not extend into Chihuahua, manufacturers in the state have benefitted from the West Texas production boom. In 2016, a group of 40 companies formed the Chihuahua Energy Initiative to spearhead investment in energy industry activities, such as supplying tanks and well controls (McEwen 2016). CFE also has commissioned combined cycle gas-fired power plants to take advantage of low-cost gas imports in Chihuahua to generate electricity for industrial and residential electricity needs (Buchanan 2017, Power Technology 2019a). Mexico's former President Enrique Peña Nieto promoted Ojinaga, Chihuahua, as a possible location to build a manufacturing and transportation hub to transport oil and gas from the Permian Basin via pipeline to export markets (Marfa Public Radio 2014).

In 2018, four solar energy plants in Chihuahua came online—in Jiménez, Ojinaga/Camargo, Ascensión and Galeana (Gobierno de Chihuahua 2019). The largest plant is operating in Galeana, at 170 MW. Both plants in Jimenez and Ojinaga/Camargo are operating at 30 MW, and the solar plant in Ascension produces 60 MW. Three additional solar projects with a combined capacity of 365 MW are under construction in Ahumada and Delicias (Gobierno de Chihuahua 2019). The renewable energy sector in Chihuahua received US$725 million in foreign direct investment in 2018 (Gobierno de Chihuahua 2019).

6.4 Coahuila

Coahuila is one of Mexico's most energy-abundant states. In addition to high wind speeds, solar radiation and shale gas, Coahuila has 95 percent of Mexico's coal reserves; 7.3 million metric tons (8 million U.S. tons) of coal were mined in Coahuila in 2017 for steel and electricity production, and that amount is increasing (Gobierno de Coahuila 2019c).

6.4.1 Shale Gas Reserves

The Burgos Basin is a shale-rich basin that covers an area of approximately 62,678 square kilometers (24,200 square miles) onshore in Coahuila and also extends offshore toward the continental shelf of the Gulf of Mexico for additional area (EIA 2017b). In July 2017, SENER opened the onshore portion of the Burgos Basin for natural gas exploration and development by private companies (EIA 2017b). This is the first time that nonstate entities were offered access to the Burgos Basin for development since the creation of the national oil company Petróleos Mexicanos (PEMEX) in 1938 (EIA 2017b). SENER hopes that private investment will help to reverse the decline in natural gas production and offset decreasing PEMEX investment in the region. Production from the Burgos Basin accounted for 15 percent of natural gas production in Mexico in 2016, and the basin holds the largest undeveloped shale resources in the country (EIA 2017b).

The Burgos Basin is the southern extension of Texas' Western Gulf Basin, which encompasses the Eagle Ford Shale (EIA 2017b). PEMEX initiated exploration activities in the Burgos Basin in 1942, and it has discovered some 227 fields, mostly rich in natural gas. The basin currently has more than 3,500 active natural gas wells in nonshale formations (EIA 2017b).

6.4.2 Coahuila Energy Cluster

The Coahuila Energy Cluster is a nonprofit association that was formed through a network of businesspersons, universities, research centers and authorities at the state and municipal levels, with the goal of preparing the oil and gas stakeholders in the state of Coahuila. Seventeen municipalities, nine national and international universities, and approximately 50 corporations have the capacity or potential to provide services or participate as suppliers within the sector. The cluster comprises six committees (Infrastructure, Human Resources, Supply, Superficial Rights, Technological Innovation and Environment), which address important issues related to the development of the energy sector in Coahuila. The overall objectives for the cluster are to build business networks and develop skills in the oil, mining, manufacturing and business sectors to enhance competition. Initiatives and services that the cluster facilitates include supply chain integration, capital investment, mediation and infrastructure development (Consejo Nacional de Ciencia y Tecnología 2015).

6.4.3 Solar and Wind Energy Resources

Approximately 12 percent of Mexico's national wind power potential and 8 percent of its national solar energy potential come from Coahuila (Gobierno de Coahuila 2019b). Ten wind energy and 24 solar energy projects currently are authorized in the state (Gobierno de Coahuila 2019b). Governor Miguel Ángel Riquelme Solís is a vocal proponent of reducing air emissions from energy production and attracting foreign investment for renewable energy in Coahuila, including US$500 million to install more than 500 MW of solar capacity in the southeast portion of the state (Gobierno de Coahuila 2019a).

6.4.4 Energy Audit of the Piedras Negras Water Treatment Facility

Municipalities in Coahuila have highlighted the water-energy nexus by participating in energy-efficiency projects with support from the North American Development Bank (NADB), as well as the U.S. Environmental Protection Agency's Border 2012 and Border 2020 Programs. Electricity costs are the highest operating costs for wastewater treatment facilities along the border. To reduce costs, the local water utility in Piedras Negras (Sistema Municipal de Aguas y Saneamiento) conducted an energy audit for its wastewater treatment plant from 2013 to 2014 in coordination with the Comisión Nacional del Agua (Border Environment Cooperation Commission 2013). Sistema Municipal de Aguas y Saneamiento's Piedras Negras Manager Arturo Garza stated that the audit identified energy-saving measures that resulted in 6.5 million pesos saved during an 8-month period. Since then, Sistema Municipal de Aguas y Saneamiento has participated in training workshops with other water utilities in

Coahuila as part of a statewide Energy Efficiency Learning Network in Coahuila (Border Environment Cooperation Commission 2016).

6.5 Nuevo León

Approximately 2.85 percent of Mexico's installed electricity generating capacity at the national level is located in Nuevo León. This does not account for intrastate sales of electricity, which Nuevo León generates at the second highest level in the country. SENER anticipates that industrial energy consumption will continue to grow the energy sector in Nuevo León. Because Nuevo León has the second-most highly educated workforce of any Mexican state, second only to the Distrito Federal, the 2014 Energy Sector Plan anticipates continued growth in energy contribution to gross domestic product. Universities such as the Tecnológico de Monterrey and the Universidad Autónoma de Nuevo León contribute degree programs, resources and expertise to support the state's energy sector (Border Environment Cooperation Commission 2016).

PEMEX operates a refinery for crude oil in Cadereyta, Nuevo León, which accounts for 16.2 percent of national production. Its products include asphalt, lubricants and oils, polymers, gasoline, and coke. Nuevo León produces 13 percent of Mexico's asphalt at the Cadereyta refinery (Border Environment Cooperation Commission 2016).

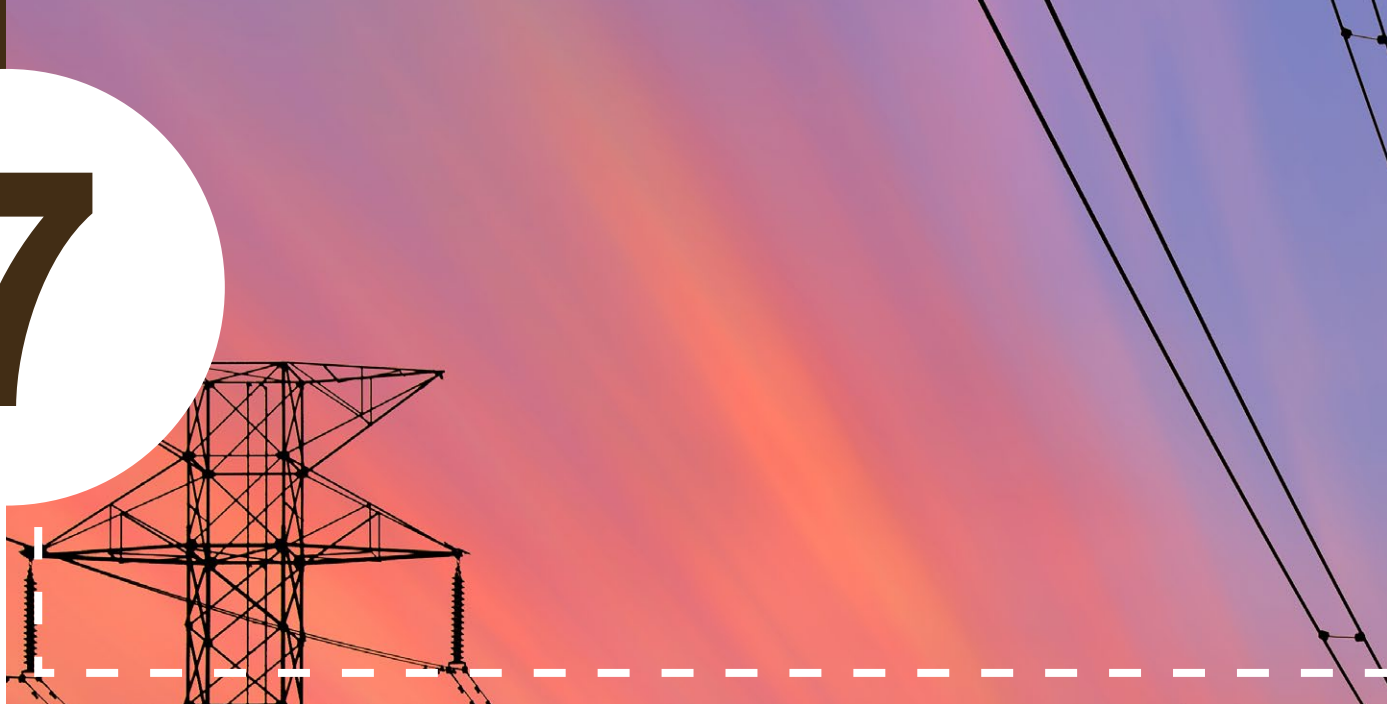
6.6 Tamaulipas

In 2017, Tamaulipas created a state energy commission, the Comisión de Energía de Tamaulipas, to establish policies and strategies to develop both renewable and nonrenewable energy resources in the state (Gobierno de Tamaulipas 2019a). In 2018, the Comisión de Energía de Tamaulipas organized the first International ENERTAM Expo, which brought 10,000 participants from Mexico's global energy sector and interested companies together to Tamaulipas to network and exchange ideas (Gobierno de Tamaulipas 2019b).

6.6.1 Wind Energy Projects

Zuma Energía, a Mexico City–based wind and solar farm developer, secured US$600 million in financing in 2018 to build the largest wind farm in Reynosa. The project will consist of 123 wind turbines that will generate 424 MW of electricity for 900,000 residents. Renewable energy companies have built more than six wind farms in Tamaulipas (Chapa 2018). Wind projects are under construction in the state, such as a US$119-million project built by Engie that is expected to start operations in 2020 and a 100 MW wind farm built by Enel Green Power that was expected to begin operations in June 2019 (Mexico News Daily 2018).

NADB has financed more than US$125 million for the construction of three wind farms in Tamaulipas (Chapa 2018). The Victoria Wind Energy Project in Güémez, Tamaulipas, was certified by NADB (2019c) in 2015. The project consists of the installation of 15 wind turbines and the construction of one substation and a transmission line. The project produces approximately 184 GWh of electricity per year, which is equivalent to the annual energy consumption of 25,733 households. In 2017, NADB (2019b) certified the Vicente Guerrero Wind Energy Project in Güémez, Tamaulipas. The project consisted of the construction and operation of a 117.3 MW wind energy farm. It generates approximately 452 GWh of electricity per year.



7

The USMCA and Energy Trade and Investment in the Border Region

On November 20, 2018, the United States, Mexico and Canada signed a new trade agreement, known as the United States-Mexico-Canada Agreement (USMCA), which is intended to take the place of the North American Free Trade Agreement (NAFTA). The USMCA will become effective on its ratification by the three parties in accordance with their respective domestic procedures. Once it is effective, the USMCA will replace NAFTA, subject to certain transitional provisions. This chapter reviews the USMCA provisions that potentially affect energy trade in the cross-border region.

7.1 Energy Import Duties Under the USMCA

Under the USMCA, there are no import duties for electricity, natural gas, oil, gasoline or diesel fuel for either the United States or Mexico. Under Article 2.4 of the Agreement, "originating goods" of a party (i.e., goods that originate in the respective signatory countries in accordance with the rules of origin set forth in Chapter 4 of the USMCA) are subject to duties in accordance with the parties' respective Schedules to Annex 2-B (Tariff Commitments). For the United States and Mexico, their Schedules show zero duties for each of the following originating goods (references are to Harmonized Tariff Schedule of the United States numbers in the United States and to fracciones arancelarias TIGIE in Mexico):

- Electricity (United States 27160000; Mexico 2716.00.01)
- Natural gas (United States 27112100 [in gaseous state] and 27111100[LNG]; Mexico 2711.21.01)
- Crude oil (United States 27090010 [< 25 degrees American Petroleum Institute gravity] and 27090020 [≥ 25 degrees American Petroleum Institute gravity; Mexico 2709.00.02 -.99)

- Gasoline (United States 27101215; Mexico 2710.12.08 -.91)
- Diesel fuel (United States 27101911; Mexico 2710.19.09 -.91)

More broadly, all goods under Chapter 27 of the harmonized tariff system pertaining to mineral fuels for the United States and Mexico has a zero tariff. This would include such goods as liquid petroleum gas, kerosene and jet fuel in addition to the energy goods listed above.

7.2 Limitations on Import and Export Restrictions; Exception for Mexico Hydrocarbons

Article 2.11, clause 1 of the USMCA incorporates by reference Article XI of the General Agreement on Tariffs and Trade (GATT) 1994 (a part of the World Trade Organization Agreement),[162] which provides in part as follows:

> "No prohibitions or restrictions other than duties, taxes or other charges, whether made effective through quotas, import or export licenses or other measures, shall be instituted or maintained by any contracting party on the importation of any product of the territory of any other contracting party or on the exportation or sale for export of any product destined for the territory of any other contracting party."

In Article 2.11 clause 2, the USMCA Parties state their understanding that Article 2.11 prohibits the following:

> A voluntary export restraint inconsistent with World Trade Organization provisions permitting measures in response to unfair trade practices (i.e., antidumping and countervailing duty measures), in accordance with World Trade Organization treaties;
>
> An export or import price requirement, except as permitted in enforcement of antidumping and countervailing duty orders or price undertakings; or
>
> Import licensing conditioned on the fulfilment of a performance requirement.

Among other things, Article 2.11 would forbid restrictions on the export of energy goods (i.e., the United States cutting off or placing export quotas on exports of electricity, gasoline or natural gas to gain a competitive or political advantage or Mexico doing the same with respect to crude oil).[163] An example of such restrictions is shown in a World Trade Organization report that found that China had improperly imposed export duties and quotas on

rare earths, tungsten and molybdenum in violation of GATT Article XI and had unreasonably administered licensing requirements to enforce these trade restrictions, while favoring domestic entities over foreign competition.[164]

One major exception to the Article 2.11 limitations is an exception taken by Mexico with respect to crude oil, natural gas, gasoline, diesel fuel and certain other hydrocarbon products.[165] This means that the Article 2.11 limitations are not applicable to Mexico with respect to the identified hydrocarbon products. The United States did not take an energy exception, so Article 2.11 applies to all U.S. energy products.

7.2.1 Export Licensing

Article 2.14 of the USMCA requires transparency in export licensing and by implication permits such licensing. This is a USMCA exception to the general rule set forth in GATT 1994 Article XI, which prohibits export licensing as a restriction on the export of goods. This may affect the U.S. export license regime for natural gas, which would otherwise potentially be subject to attack under GATT 1994 Article XI.

7.2.2 Export Duties, Taxes or Other Charges

Article 2.15 of the USMCA provides as follows: "No Party shall adopt or maintain any duty, tax, or other charge on the export of any good to the territory of another Party, unless the duty, tax, or charge is also applied to the good if destined for domestic consumption." For the United States, this supplements the existing restriction on export duties or taxes as set forth in the U.S. Constitution, which provides at Article I, Section 9, that "No tax or duty shall be laid on Articles exported from any State." As an example of the impact of these provisions, the United States could not place an export duty on exports of electricity, gasoline or natural gas. Similarly, Mexico could not place export duties or taxes on the export of crude oil.

7.3 USMCA Chapter 8 Specifically Recognizes the Mexican State's Ownership of Hydrocarbons in the Ground

As discussed in Section 3.1.3, the concept of "energy sovereignty" is one that occurs at various key times over the course of Mexico's history. It is a concept with both nationalistic and budgetary impacts. The Mexican Constitution of 1917 established the Mexican federal government's dominion over subsoil rights throughout the country. Oil Expropriation Day (*Día Nacional de la Expropriación*), March 18, is a national holiday in Mexico that marks the anniversary of President Lazaro Cárdenas' decision to expropriate the oil industry in Mexico in 1938, a watershed event that was followed by a nationwide effort to pay off debts to foreign oil companies that involved even citizens.

Although the relative utility of a state-owned oil company has been fiercely debated in Mexico for decades, and two recent Administrations have sought—with varying levels of success—to open the sector up to foreign investment, the concept has survived not only these efforts but also the free trade era in Mexico that began in earnest in the 1980s. The USMCA contains a pointed reference to this political and policy reality. Chapter 8 of the USMCA is titled "Recognition of the United Mexican States' Direct, Inalienable and Imprescriptible Ownership of Hydrocarbons." The second clause of article 8.1 notes that:

> 2. In the case of Mexico, and without prejudice to their rights and remedies available under this Agreement, the United States and Canada recognize that: (a) Mexico reserves its sovereign right to reform its Constitution and its domestic legislation; and (b) Mexico has the direct, inalienable, and imprescriptible ownership of all hydrocarbons in the subsoil of the national territory, including the continental shelf and the exclusive economic zone located outside the territorial sea and adjacent thereto, in strata or deposits, regardless of their physical conditions pursuant to Mexico's Constitution (*Constitución Política de los Estados Unidos Mexicanos*).

7.4 Special Investor Dispute Resolution Mechanism Under USMCA Annex 14-E

One of the U.S. objectives in the negotiation of the USMCA was to revise the NAFTA Chapter 11 investor-state dispute settlement mechanism to limit the rights of the investors of one NAFTA country to make direct claims through a binding arbitration process against the government of another NAFTA country. The ultimate outcome of the negotiations was that under the USMCA, investor-state dispute settlements no longer will be available for claims against Canada or by Canadian investors, other than certain "legacy" claims, and there are significant limitations on investor-state dispute settlements between the United States and Mexico. For United States or Mexican investors in oil and gas or electricity, or certain other "covered sectors," with claims

against Mexico or the United States, respectively, there was a less of a "cut-back" of investor protections than for investors in other business sectors, however.

Under NAFTA Chapter 11, a private investor from one NAFTA country is permitted to seek damages through binding arbitration based on another NAFTA country's failure to comply with its treaty commitment, including obligations to treat investors fairly, not to discriminate against them or their investments, and not to expropriate investments or take measures amounting to expropriation without paying adequate compensation, as outlined in NAFTA Article 1116 (claim by an investor on its own behalf) and Article 1117 (claim by an investor on behalf of an enterprise).

The NAFTA investor-state dispute settlement mechanism is terminated under the USMCA, except that with respect to "legacy" investments, an investor of a NAFTA country still can use the NAFTA investor-state dispute settlement mechanism against another NAFTA country, so long as the claim is made within 3 years after the termination of NAFTA, per USMCA Annex 14-C. In this regard, a "legacy investment" is one established or acquired between January 1, 1994, and the date of termination of NAFTA, and in existence on the date of entry into force of the USMCA.[166]

The USMCA has a new investor-state dispute settlement mechanism between the United States and Mexico as set forth in USMCA Annex 14-D. The investor-state dispute settlement mechanism under Annex 14-D is less protective of United States and Mexican investors than under NAFTA in two major respects:

- Annex 14-D ISDS is available only for claims of discrimination (i.e., violation of national treatment and most-favored-nation obligations) and for claims of direct expropriation, per Article 14-D-3. This means that claims of unfair treatment, in violation the duty of fair and equitable treatment under international law, and claims of indirect expropriation (e.g., as a result of environmental or other regulatory proscriptions) are not permitted under Annex 14-D. These latter claims were the most prevalent claims in NAFTA investor-state dispute settlement proceedings, so this cutback is a major reduction in investor protections.
- Under Annex 14-D, a claimant must first litigate the challenged measure "before a competent court or administrative tribunal of the respondent." The claimant must then pursue litigation until it receives a "final decision from a court of last resort" or 30 months have passed from the date the local proceedings were initiated, as outlined in Article 14.D.5, clause 1(a) and (b). The only way that these requirements toward pursuit of domestic remedies can be avoided is if they are "obviously futile," per Article 14.D.5 footnote 25. There is a 4-year statute of limitations for claims under Annex 14-D, and there is no tolling of the statute of limitation while the domestic remedies proceed, except that the claimant can move to

an investor-state dispute settlement if there is no final decision within 30 months from the date the domestic proceeding was initiated.

The investor-state dispute settlement mechanism set forth in Annex 14-D for U.S.-Mexico investment disputes is modified under Annex 14-E for certain "covered government contracts," pertaining to investments in "covered sectors," including "activities with respect to oil and natural gas that a national authority of [the United States or Mexico] controls, such as exploration, extraction, refining, transportation, distribution, or sale," and "the supply of power generation services to the public on behalf of [the United States and Mexico]."

For U.S. or Mexican investors in the "covered sectors," Annex 14-E negates the two Annex 14-D cutbacks on investor protections described above. In particular, Annex 14-E permits claims based on *any* breach of USMCA Chapter 14, which would include claims of unfair treatment and claims of indirect nationalization or expropriation, per Annex 14-E, section 2. Further, Annex 14-E *does not* require pursuit of domestic remedies (i.e., judicial or administrative proceedings, before proceeding to ISDS arbitration),[167] as detailed in Annex 14-D, section 5 and footnote 32.

As a result, a U.S. investor who had either—

- an investment in exploration, extraction, refining, transportation, distribution, or sale of oil and gas in Mexico, which is under the control of Mexican authorities, or
- an investment in the supply of power generation services to the public on behalf of the Mexican government,

would be permitted under Annex 14-E to move directly to investor-state dispute settlement arbitration against Mexico under the procedures set forth in Annex 14-D based on claims of unfair treatment, discrimination, or direct or indirect expropriation.

Annex 14-E contains some unusual provisions. In particular, Annex 14-E provides that it can be modified or eliminated in the future by agreement of the United States and Mexico, per Annex 14-E, Section 5. Furthermore, Annex 14-E no longer will be operative if the respondent state is no longer "a party to another international trade or investment agreement that permits investors to initiate dispute settlement procedures to resolve an investment dispute with a government," per Annex 14-E, clause 2.(a)(i)(B) and clause 2(b)(i)(B). Therefore, if Mexico was no longer party to another treaty or investment agreement with investor-state dispute settlement arbitration provisions (apart from the USMCA), then the expanded scope of arbitration for "covered government contracts" under Annex 14-E would no longer apply to Mexico.

8. Recommendations

GNEB identified research and incentives, regional sustainability planning, and binational collaboration as key principles that federal agencies and Congress should apply to direct federal resources toward building a sustainable new border energy economy.

Research and Incentives

To enhance resilience and support economic development needs specific to the U.S.-Mexico border region, federal agencies and Congress should provide for research and program incentives that are informed by known research gaps and regional vulnerabilities.

1. Support research on energy topics on the U.S.-Mexico border, such as where energy needs are most acute, quantifying economic costs and benefits, and identifying opportunities. For example, the Texas border area is unique as compared to other parts of the state. Border-specific original research is lacking.

2. Support research especially related to *colonias* and tribal areas, which lack adequate energy-related infrastructure. The absence of recent research on *colonias* makes it a challenge to form policy solutions. For example, research support could be valuable to answer such questions as how effective microgrids could be to extend electricity to *colonias* or how to finance infrastructure.

3. Promote incentives and funding for transmission line and microgrid projects, in conjunction with regional energy sustainability plans (described below), that create resilient border communities by locating energy investments in the border region that benefit those communities.

4. Establish the U.S. Environmental Protection Agency (EPA) as the lead agency, in coordination with other federal agencies—including but not limited to the U.S. Department of Energy (DOE), U.S. Army Corps of Engineers, Bureau of Reclamation and the U.S. Section of the International Boundary Water Commission—to conduct research and develop new programs, policies and incentives to promote water conservation and reuse in energy production throughout the U.S.-Mexico border region, much of which is arid and drought-prone. EPA and other agencies should leverage partners and action items in the Water Reuse Action Plan, scheduled to be finalized and released in 2020. For more information on EPA's development of the Water Reuse Action Plan, see www.epa.gov/waterreuse/water-reuse-action-plan.

5. Support sustained and strategic research barriers to energy efficiency, particularly in existing buildings, in the U.S.-Mexico border region. Support incentives to promote efficient cooling and lighting technologies in areas and building types with the greatest potential for increasing energy efficiency.

Regional Sustainability Planning

To provide for a more resilient future energy supply for communities along the border, there must be federal leadership *to promote policies and programs that support development and implementation of regional energy sustainability plans that liaise with Mexican communities.*

6. Establish a regional energy sustainability planning process for federal agencies to collaborate and communicate with local, state and tribal governments to increase resiliency, provide for strategic economic development, and advance energy-efficiency projects that improve communities. Regional energy sustainability planning requires effective transborder communication and cooperation.

7. DOE should be the lead agency in multiagency projects that evaluate existing frameworks for sustainable energy planning at the regional scale, adopt a framework after input from the public and the regulated community, and then integrate the planning framework into how energy production projects demonstrate eligibility for federal funding and how projects meet regulatory requirements for permits and other approvals.

8. Integrate the following into the new framework for development and implementation of regional energy sustainability plans:

(a) Delineate border communities (U.S. and Mexico) and benefits/costs of energy development and trade and identify infrastructure planning that considers sensitive and rural populations along the border, including tribal communities, to aid in regional planning and the most efficient use of governmental assistance.

(b) Invest in and support the successor program to the U.S.-Mexico Border 2020 Program, which has proven valuable to California, Arizona, New Mexico, Texas and the six neighboring Mexico states. Congress, EPA and other executive branch agencies should encourage improvements to the program based on stakeholder input.

(c) Continue and expand support for the binational NADB, an important source of water and energy infrastructure investment and economic development along the U.S.-Mexico border. Grants and loans to border communities continue to be valuable to binational goals in water quality, air quality and protection of the shared border environment, which enhance the quality of life of border residents.

(d) Actively coordinate with the Border 2020 Program managed by EPA and its Mexican counterpart agency when federal agencies (federal contractors) are developing and implementing policies that affect energy production and transportation along the U.S.-Mexico border, especially as they relate to energy. Actively leverage resources, projects and expertise toward addressing vulnerable populations associated with environmental and public health challenges in the energy sector.

(e) Encourage rational provision of energy and energy-efficiency services for border communities. Locate energy projects in border communities, including tribal areas, when it makes economic and environmental sense.

(f) Require federal agencies to consider household energy vulnerability ("energy poverty") and low-income status for receipt of federal programmatic funding.

(g) Promote the use of NADB funds to support energy transmission and generation in areas with little existing infrastructure, especially rural communities and tribal areas.

Binational Collaboration

To provide for greater marketability and prosperity, projects must be binational, bi-state and broadcast on a national level.

9. Support export of petroleum products to Mexico and monitor Mexico's efforts to expand its own refining capacity.

10. Support export of natural gas to Mexico and support private sector efforts to complete cross-border pipelines that will support such exports. Evaluate the safety and effects on border communities resulting from increased exports of liquefied natural gas by rail and tank trucks on regional highways.

11. Foster the development of renewable energy, particularly solar and wind, in border states.

12. Actively support development of U.S. electricity-generation projects built for the purpose of making cross-border deliveries of electricity to Mexico.

13. Increase efforts by NERC to include Mexico within NERC and also increase NERC's efforts to incorporate cross-border flows to protect and improve the reliability of the bulk electrical system throughout North America.

14. Support binational projects that increase the reliability and efficiency of the shared grid.

15. Promote the promulgation of efficient cooling and lighting technology in the border region. Support binational projects that promote energy-efficient building standards compliance, data collection (monitoring, reporting and verification), demand-side management, and the introduction of reach codes for high-energy-use areas and buildings.

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Appendix 1

State Regulatory Agencies

State Regulatory Agency Responsibilities

CALIFORNIA		
Agency/Entity (Commonly Known Acronym)	**Responsibilities**	**Energy-Related Areas of Responsibility**
California Department of Conservation, Division of Oil, Gas and Geothermal Resources (DOGGR)	Oversees the oil, gas and geothermal industries in the state.	The Idle Well Program administers the plugging and abandoning of wells left unused for 2 or more years. The Underground Injection Control Program administers state regulations for injection wells. The Underground Gas Storage Program ensures that natural gas storage operations are conducted safely. The Pipeline and Facilities Unit regulates surface equipment.
California Public Utilities Commission (CPUC)	Regulates investor-owned companies (services and utilities) providing electric, natural gas, telecommunication, water, railroad, rail transit and passenger transportation services.	The Energy Division establishes service standards and safety rules for the investor-owned energy utilities. The division plays a role in the administration of the state's Renewable Portfolio Standard, overseeing investor-owned utility compliance, and also oversees these utilities' energy efficiency programs. The Public Advocates Office protects consumers in utility rate and policy proceedings. The Office of the Safety Advocate addresses utility safety concerns.
California Independent System Operator (CAISO)	Responsible for maintaining the reliability of the state's electric grid.	This private 501(c)(3) nonprofit organization regulates the wholesale electric power market through the Western Energy Imbalance Market, balances electricity supply and demand, oversees transmission line operation, and plans for grid integration, expansion or improvement.
California Energy Commission (CEC)	Oversees energy policy and planning for the state.	The commission forecasts the state's energy needs, promotes energy efficiency through appliance and building standards, and supports deployment of renewable energy technologies. The agency plays a role in administering the state's Renewable Portfolio Standard, overseeing compliance for all energy producers outside the investor-owned utilities. It licenses new power plants and regulates existing plants. It provides funding for energy research and technology development and also supports planning for grid reliability in a post-disaster context.
California Environmental Protection Agency (CalEPA)	Develops, implements and enforces environmental laws that regulate air, water and soil quality; pesticide use; and waste recycling and reduction.	The agency regulates air, water and soil quality, as well as pesticide use and waste management. Under this agency, the Air Resources Board regulates emissions for compliance with air pollutant and greenhouse gas limits. Also, the State Water Resources Control Board balances the state's water resources, including managing allocations of water to hydroelectric power plants, and regulates discharges associated with polluting activities that affect water quality (including energy projects). Currently, Jared Blumenfeld, California Secretary for Environmental Protection, chairs the California-Mexico Border Relations Council, California's central organizing body for coordination and collaboration on border issues, including energy projects.
California Coastal Commission (CCC)	Protects the state's coast through planning and regulation.	Has authority over all development activities in the coastal zone as established by the California Coastal Act of 1976. This includes offshore oil and gas exploration, including power plants, marine terminals, refineries, and pipelines.
California State Lands Commission	Manages the state's Public Trust lands and protects state waters; ensures public access to navigable waterways and the coast.	Manages leasing of on-shore and off-shore state lands, including for oil and gas development and other energy projects.
California Department of Community Services and Development (CSD)	Administers services using state and federal funds to support low-income Californians.	Administers the federal Low-Income Home Energy Assistance Program. Also administers the U.S. Department of Energy Weatherization Assistance Program and California's Low-Income Weatherization Program, a California Climate Investment.

ARIZONA		
Agency/Entity (Commonly Known Acronym)	**Responsibilities**	**Energy-Related Areas of Responsibility**
Arizona Department of Environmental Quality (ADEQ)	Administers and enforces the state's environmental laws and delegated federal programs to prevent air, water, and land pollution and ensure cleanup; responsibilities include waste, underground storage tanks, and remediation.	The department ensures that energy producers and consumers are in compliance with environmental regulations.
Arizona Corporation Commission (ACC)	Regulates public utilities and business incorporation in the state, and five elected commissioners oversee proceedings regarding rates and services for water, electricity, telephone, natural gas resources, securities, pipelines and railroads.	The commission has jurisdiction over the quality of service and rates charged by public utilities and inspects gas pipelines for safety.
Arizona Power Authority	Allocates hydroelectric power from Hoover Dam to 39 power customers in Arizona, consisting of cities, towns, irrigation and electrical districts, and the Central Arizona Water Conservation District.	This government administration company works with public and private-owned utilities to make hydropower available to all major load centers in Arizona.
Arizona-Mexico Commission (AMC)	Serves as the principal mechanism for the management of the state's relationship with Mexico.	This public/private 501(c)(4) nonprofit organization has sixteen public/private bilateral committees including Agribusiness and Wildfire, Economic Development, Energy, Environment and Water, and Mining. The Energy Committee promotes renewable energy projects. The Environment and Water Committee focuses on water management planning and environmental quality in the Arizona-Sonora region.
Arizona Department of Economic Security (DES)	Uses state and federal funds to administer services to low-income and vulnerable Arizonans, including the Supplemental Nutrition Assistance Program, Temporary Assistance for Needy Families, In-Home Support Services, and Workforce Innovation and Opportunity Act.	The Utility Assistance Division contracts with local Community Action Agencies that provide Arizonans access to the federal Low-Income Home Energy Assistance Program.
Arizona Department of Water Resources (ADWR)	Administers all state water laws outside those relating to water quality, implements the Groundwater Code, supports the adjudication of water rights, implements surface water laws, supports the adjudication of water rights, ensures the safety of dams, manages floods, surveys water resources, and oversees the Arizona Water Banking Authority and Arizona Water Protection Fund.	The department ensures that long-term, reliable water supplies are available in Arizona.
Residential Utility Consumer Office (RUCO)	Represents the interests of residential utility ratepayers in regulatory proceedings involving public service corporations before the Arizona Corporation Commission.	The office preliminarily reviews rate increase applications and intervenes in rate cases before the Arizona Corporation Commission to represent ratepayers' interests.

NEW MEXICO		
Agency/Entity (Commonly Known Acronym)	**Responsibilities**	**Energy-Related Areas of Responsibility**
New Mexico Energy Minerals and Natural Resources Department (NM EMNRD)	Protects and conserves the state's natural resources and includes a Youth Conservation Corps and Divisions of Energy Conservation and Management, Mining and Minerals, Oil Conservation, State Forestry, and State Parks (non-federal, non-municipal and non-tribal land). (The New Mexico Department of Fish and Game is attached to EMNRD for administrative support purposes.)	The Energy Conservation and Management Division develops and implements renewable energy and alternative fuel programs, including wind, solar, geothermal, biomass, electric and compressed natural gas vehicle programs. It also oversees energy-efficiency programs, natural gas transportation infrastructure, and safe transportation of radioactive waste. The Mining and Minerals Division oversees active mines, including coal mines. It also identifies, regulates, safeguards and reclaims abandoned mines. The Oil Conservation Division consists of four district offices that issue drilling permits, inspect wells, respond to spills, investigate violations and institute enforcement actions, and also three bureaus that handle administration and enforcement of environmental rules.
New Mexico Environment Department (NMED)	Protects and restores the environment through its divisions and other sub-agencies, including the Resource Protection Division (including the U.S. Department of Energy Oversight, Hazardous Waste, Petroleum Storage Tank and Solid Waste Bureaus), Water Protection Division (including the Construction Programs, Drinking Water, Ground Water Quality and Surface Water Quality Bureaus), and Environmental Protection Division (including the Air Quality, Environmental Health, Occupational Health and Safety, and Radiation Control Bureaus).	The department oversees permitting, compliance and enforcement for air, water and waste regulatory requirements associated with the energy sector, including water generated by oil and natural gas wells ("produced water"). The department also investigates and remediates pollution from contamination and hazardous waste and provides oversight for U.S. Department of Energy cleanup.
New Mexico Office of the State Engineer (NM OSE)	Has authority over the supervision, measurement, appropriatio, and distribution of all surface and groundwater in New Mexico, including streams and rivers that cross state boundaries.	The office prosecutes all water right adjudications brought on behalf of the state, including water transfers for energy projects.
New Mexico State Land Office (NM SLO)	Generates revenue from leases on state trust land (surface and subsurface) for purposes including energy projects, agriculture and mining; the office is overseen by the elected New Mexico Commissioner of Public Lands.	The energy projects carried out on state trust lands through this office include renewable energy (wind and solar) projects, oil and gas fields, and coal mines.
New Mexico Economic Development Department (NM EDD)	Develops programs and initiatives to create jobs, develop the tax base and provide incentives for business development in New Mexico.	The department markets the state as a good potential site for energy projects, including natural gas, oil, wind and solar. It promotes the state's Renewable Energy Production Tax Credit.
New Mexico Public Regulation Commission (NM PRC)	Regulates the utilities, telecommunications and motor carrier industries to ensure fair and reasonable rates and to assure reasonable and adequate services to the public as provided by law.	The commission enforces state and federal regulations for oil and natural gas pipeline safety and manages consumer issues related to natural gas, propane, investor-owned water and sewer services, electric companies, telecommunication, wireless marketing and electric cooperatives.

NEW MEXICO continued		
Agency/Entity (Commonly Known Acronym)	**Responsibilities**	**Energy-Related Areas of Responsibility**
New Mexico Human Services Department (NM HSD)	Administers services using state and federal funds to support low-income New Mexicans through programs such as the Supplemental Nutrition Assistance Program, Temporary Assistance for Needy Families, and the Low-Income Home Energy Assistance Program.	The Income Support Division administers the federal Low-Income Home Energy Assistance Program.
New Mexico Border Authority	Focuses on improvements to the state's ports of energy and also serves the governor as an advisor and liaison for those interested in opportunities at the ports of entry.	This executive branch state agency does not have explicit energy-related areas of responsibility other than publicizing energy-related development along the border.

TEXAS		
Agency/Entity (Commonly Known Acronym)	**Responsibilities**	**Energy-Related Areas of Responsibility**
Railroad Commission of Texas (RRC)	Regulates oil and gas, pipeline safety, and mining.	The commission grants oil and gas drilling permits and sets allowable production rates for wells; administers the abandoned well plugging and abandoned site remediation program; conducts field inspections and investigates complaints; oversees rates and safety for intrastate pipelines; regulates safety for storage, transportation and use of liquefied natural gas; regulates natural gas rates for consumers; and regulates exploration, mining and reclamation for coal and uranium.
Public Utility Commission of Texas (PUC)	Regulates electric utilities, telecommunication, and water and sewer utilities.	The commission regulates costs, rates and tariffs for wholesale and retail electricity markets and transmission and distribution lines; regulates siting for generation, transmission and distribution of electricity; governs the intrastate electricity grid operator, Electric Reliability Council of Texas; structures wholesale electric competitive markets and conducts planning for Texas' interstate grids operated by the Southwest Power Pool and Midcontinent Independent System Operator; provides oversight of financial assurance and decommissioning trusts for nuclear power plants; and implements energy efficiency, reliability and other standards in determining energy rates.
Texas Commission on Environmental Quality (TCEQ)	Regulates environmental quality for air, water and waste.	The commission oversees air, water and waste permitting, compliance and enforcement for energy-related facilities; conducts investigations and responds to complaints; promotes energy efficiency through public education programs, such as Take Care of Texas; issues guidance for quantifying emission reductions from energy-efficiency and renewable-energy measures in State Implementation Plans; groundwater impact contingency plans for pipelines; and coordinates with federal agencies under the National Environmental Policy Act.
State Comptroller	Regulates state fiscal affairs including tax collection, state accounts and government revenue.	The State Comptroller administers the State Energy Conservation Office, which provides energy-efficiency codes for buildings, loans for public buildings' efficiency upgrades, research and educational programs. The State Comptroller also collects economic data, provides forecasts for sectors related to energy and transportation, chairs the Interagency Task Force on Economic Growth and Endangered Species, and provides special reports on government spending and accountability related to energy and natural resources (e.g., a report on funding the state water plan).
General Land Office	Manages land in the public domain.	The office manages oil and gas leases on public lands and develops renewable energy sources on public lands as diversification of revenue for the Permanent School Fund, which has received $16.8 billion in total revenue since its inception 1876.
Texas Parks and Wildlife Department (TPWD)	Manages state parks, hunting, fishing, boating and wildlife conservation.	The department enforces regulations under the Endangered Species Act on state-listed endangered species potentially impacted by energy development, such as the Texas horned lizard and golden-cheeked warbler.

Glossary of Abbreviations and Acronyms

ACC-Utilities	Arizona Corporation Commission, Utilities Division
AGA	American Gas Association
ASEA	Agencia de Seguridad, Energía y Ambiente (Mexico's Agency for Industrial Safety and Environmental Protection for the Hydrocarbons Sector)
BMTP	*Texas-Mexico Border Transportation Master Plan*
CAISO	California Independent System Operator
CENACE	Centro Nacional de Control de Energía (Mexico's National Energy Control Center)
CFE	Comisión Federal de Electricidad (Mexico's Federal Electricity Commission)
CNH	Comisión Nacional de Hidrocarburos (Mexico's National Hydrocarbons Commission)
CONUEE	Comisión Nacional para el Uso Eficiente de la Energía (Mexico's National Commission for the Efficient Use of Energy)
CPUC	California Public Utilities Commission
CRE	Comisión Reguladora de Energía (Mexico's Energy Regulatory Commission)
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DoS	U.S. Department of State
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
ERCOT	Electric Reliability Council of Texas
ERO	Electric Reliability Organization
FERC	Federal Energy Regulatory Commission
FPISC	Federal Permitting Improvement Steering Council
FTA	free trade agreement
GATT	General Agreement on Tariffs and Trade
GNEB	Good Neighbor Environmental Board
GW	gigawatt
GWh	gigawatt hours
HHS	U.S. Department of Health and Human Services
IECC	International Energy Conservation Code
IID	Imperial Irrigation District (California)
km	kilometer
km²	square kilometer
kV	kilovolt
kWh	kilowatt hour
LIHEAP	Low Income Home Energy Assistance Program
LNG	liquefied natural gas
m³	cubic meter
MW	megawatt
MWh	megawatt hour
NADB	North American Development Bank
NAFTA	North American Free Trade Agreement
NERC	North American Electric Reliability Corporation
NM EMNRD	New Mexico Energy, Minerals and Natural Resources Department
NMED	New Mexico Environment Department
NMPRC-Utility	New Mexico Public Regulation Commission, Utility Division
NRCS	Natural Resources Conservation Service (U.S. Department of Agriculture)
PEMEX	Petróleos Mexicanos (Mexico's national oil and gas company)
PHMSA	Pipeline and Hazardous Materials Safety Administration (U.S. Department of Transportation)
SDG&E	San Diego Gas & Electric
SENER	Secretaría de Energía (Mexico's Ministry of Energy)
USDA	U.S. Department of Agriculture
USIBWC	U.S. Section of the International Boundary and Water Commission
USMCA	United States-Mexico-Canada Agreement
WAP	Weatherization Assistance Program

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Endnotes

1 For maps of different methods of defining the border, also see Ganster and Lory (2016, pp. 12–13).

2 For the socioeconomic context of the border region, see the 17th and 18th reports of the Good Neighbor Environmental Board, which can be found at www.epa.gov/faca/good-neighbor-environmental-board-gneb-reports-president-united-states. Also see Ganster and Lorey (2016).

3 For an analysis of the impact of energy insecurity on health, also see Hernandez (2019).

4 The Area Median Income is the midpoint of a region's income distribution; half of the families in a region earn more than the median, and half earn less (Metropolitan Council 2018).

5 The U.S. Census determined that in 2017, 19.7% of the New Mexico population lived below the poverty level. factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_1YR_S1701&prodType=table. For a household with one individual, the poverty threshold in 2017 was US$12,488. www2.census.gov/programs-surveys/cps/tables/time-series/historical-poverty-thresholds/thresh17.xls.

6 For more information, see liheapch.acf.hhs.gov/about.

7 For the full statute, see liheapch.acf.hhs.gov/pubs/liheapstatute.htm.

8 For a detailed commentary on the Weatherization Assistance Program, see the February 13, 2019, testimony of Annamaria Garcia, Director, Office of Weatherization and Intergovernmental Program, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, before the House Appropriations Subcommittee on Energy and Water Development, U.S. House of Representatives. docs.house.gov/meetings/AP/AP10/20190213/108877/HHRG-116-AP10-Wstate-GarciaA-20190213.pdf.

9 For additional information about the U.S.-Mexico border states, see liheapch.acf.hhs.gov/profiles/California.htm, liheapch.acf.hhs.gov/profiles/Arizona.htm, liheapch.acf.hhs.gov/profiles/NM.htm and liheapch.acf.hhs.gov/profiles/Texas.htm.

10 S.B. 350, Calif. Leg., 2019–2020 Sess. leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350

11 Definition modified from Carlson et al. (2012).

12 See, for example, ourworldindata.org/natural-disasters.

13 For an overview of the United States' energy trade balance as of 2018, see "The Changing U.S. Energy Trade Balance Is Still Dominated by Crude Oil Imports" in the U.S. Energy Information Administration's October 16, 2018, issue of Today in Energy. www.eia.gov/todayinenergy/detail.php?id=37253.

14 Sabine Pass was the first lower-48 liquefied natural gas liquefaction-for-export facility, approved by the Federal Energy Regulatory Commission in 2012. More information about Sabine Pass can be found at www.bechtel.com/getattachment/Blog/technical/June-2019/lng-import-export-case-study/Cheniere-Energy-Sabine-Pass-LNG.pdf

15 The processing plant will remove impurities such as water, carbon dioxide and sulfur, as well as inert gases such as helium, which would reduce the energy value of the natural gas. The processing plant also may remove so-called natural gas liquids such as ethane, propane and butane, which then are used for other purposes.

16 The three bulleted statements are quoted from comments filed with the PHMSA and dated October 17, 2018, by the named trade associations as well as the Association of Oil Pipelines and the American Petroleum Institute, which can be found online at www.aga.org/contentassets/5528e3e26e424e66b5182790b3539948/aga-apga-api-aopl-ingaa-industry-comments---phmsa-risk-modeling-report.pdf, page 1, footnotes 5, 1 and 3, respectively.

17 The trade groups representing different types of utilities present different numbers, focused on numbers of persons served rather than "customers" served. The U.S. Energy Information Administration does not specify what it means by "customers" with respect to the data provided, but it is reasonable to assume that "customers" are measured by numbers of meters for which a bill is sent. Persons served could mean, among other things, the number of persons who benefit from the electricity delivered. Subject to this definitional uncertainty, the Edison Electric Institute, representing investor-owned utilities, states that U.S. investor-owned utilities serve "about 220 million Americans" (www.eei.org/about/members/Pages/default.aspx). The American Public Power Association, representing utilities that are "not for profit, community-owned" and "locally controlled" (www.publicpower.org/public-power/stats-and-facts), states that "approximately 2,000 public power utilities provide electricity to 49 million people" (www.publicpower.org/our-members). The National Rural Electric Cooperative Association states that U.S. electric cooperatives "serve 42 million people" (www.electric.coop/wp-content/uploads/2019/04/Co-op_Facts_and_Figures_4-2019.pdf).

18 Western Area Power Administration is "one of four power marketing administrations within the U.S. Department of Energy whose role is to market and transmit wholesale electricity from multi-use water projects" per its website (www.wapa.gov/About/Pages/about.aspx). The Western Area Power Administration's service area includes the four U.S. states on the Mexican border (www.wapa.gov/regions/Pages/Regions.aspx).

19 S.B. 100, Calif. Leg., 2017–2018 Sess. leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100.

20 California Public Utilities Code § 454.53.

21 See, for example, California Public Resources Code (Cal. Pub. Res. Code) §§ 3209 (pooling agreement), 3640-3681 (unit agreements); Arizona Revised Statutes (A.R.S.) 27-505 (pooling of interests), 27-531 through 27-531 (integration of units and spacing of units); New Mexico Statutes Annotated 1978 (N.M.S.A.) 70-2-18 (pooling), 70-7-1 through 70-7-21 (Statutory Unitization Act); Texas Natural Resource Code (Tex. Nat. Res. Code) §§ 101.001 et seq. (voluntary cooperative agreements), §§ 102.001 et seq. (voluntary and mandatory pooling).

22 See, for example, Cal. Pub. Res. Code § 3203 (requirement for approval); Arizona Revised Statutes 27-513 (permit to drill well); New Mexico Administrative Code 19.15.14.8 (permit to drill, deepen or plug back); 16 Texas Administrative Code, Part 1, Chapter 3, Rule § 3.5 (application to drill, deepen, reenter, or plug back).

23 See, for example, Cal. Pub. Res. Code §§ 3600-3609 (spacing of wells); A.R.S. 27-504 (establishing units); N.M.S.A. 70-2-11 (prevention of waste), 70-2-12.B.(10) (spacing of wells); Texas Nat. Res. Code § 85.201 (conservation and prevention of waste), 16 Texas Administrative Code, Part 1, Chapter 3, Rule § 3.37 (well spacing).

24 See, for example, Cal. Pub. Res. Code §§ 3450-3451 (recommendation of maximum efficient rate).

25 This is pursuant to the Mineral Lands Leasing Act, Public Law No. 66-146, 41 Stats. 437, as amended by the Federal Oil and Gas Onshore Leasing Reform Act, Public Law No. 100-203, 101 Stats. 1330. See in particular 30 U.S.C. § 226 (lease of oil and gas lands).

26 This is pursuant to the Outer Continental Shelf Lands Act, as amended in 1978, 43 U.S.C. §§ 1331-1356.

27 See 43 U.S.C. § 1331(a).

28 For example, in California, state lands are generally subject to lease by the State Lands Commission. With respect to oil and gas leases, see Cal. Pub. Res. Code §§ 6826-6836 (oil and gas leases generally), §§ 6851-6855 (oil and gas leases on lands other than tide and submerged lands), §§ 6870-6879 (oil and gas leases on tide and submerged lands and beds of navigable rivers and lakes).

29 For the California Public Utilities Commission; Arizona Corporation Commission, Utilities Division; New Mexico Public Regulation Commission, Utility Division; and Railroad Commission of Texas, key statutes setting forth their respective general regulatory powers are as follows: California—Cal. Pub Utilities Code §§ 451, 701, 702, 761, 762, 768, 770 and 1001; Arizona—Arizona Constitution, Art. 15, Sections 2 and 3, and A.R.S. 40-202, 40-203, 40-207, 40-281, 40-321, 40-322, 40-331, 40-336, and 40-361; New Mexico—NMSA 62-6-4, 62-6-19, 62-6-20, 62-6-21, 62-6-24, 62-9-1 and 62-9-3; Texas—Texas Utility Code §§ 102.001, 104.001, 104.252, 104.256, 121.151, and 121.201.

30 15 U.S.C. § 717(b). The statutory authority granted was to the "Federal Power Commission." This authority, however, was transferred to the Federal Energy Regulatory Commission under 42 USC §7172(a)(1)(C).

31 See 15 U.S.C. § 717c(f).

32 See 15 U.S.C. § 717b(e) and 15 U.S.C. § 717a(11) (definition of "LNG [liquefied natural gas] terminal").

33 15 U.S.C. § 717(c). See also 15 U.S.C. § 717f(e) (requirements to be satisfied for grant of certificate of convenience and necessity; right of Federal Energy Regulatory Commission to attach to the issuance of the certificate "such reasonable terms and conditions as the public convenience and necessity may require.")

34 15 U.S.C. § 717f(c).

35 15 U.S.C. § 717f(b).

36 15 U.S.C. § 717f(b). The Department of Energy's Office of Fossil Energy implementing regulations for obtaining an authorization to import and/or export natural gas or liquefied natural gas can be found at 10 CFR Part 590.

37 Regulation of Natural Gas Pipelines After Partial Wellhead Decontrol, Order No. 436, 50 Fed. Reg. 42,408 (Oct. 18, 1985). FERC Order 436 was vacated by a court decision, but then ultimately readopted in substantial part by FERC in Order No. 500-H, 54 FR 52344 (Dec. 21, 1989), FERC Stats. & Regs. [Regulations Preambles 1986-1990] ¶ 30,867 (1989), reh'g granted in part and denied in part, Order No. 500-I, 55 FR 6605 (Feb. 26, 1990), FERC Stats. & Regs. [Regulations Preambles 1986-1990] ¶ 30,880 (1990), aff'd in part and remanded in part, American Gas Association v. FERC, 912 F.2d 1496 (D.C. Cir. 1990), cert. denied, 111 S. Ct. 957 (1991).

38 Pipeline Service Obligations and Revisions to Regulations Governing Self-Implementing Transportation; and Regulation of Natural Gas Pipelines After Wellhead Decontrol, Order No. 636, 57 Fed. Reg. 13,267 (April 16, 1992), FERC Stats. & Regs. [Regs. Preambles January 1991-June 1996] ¶ 30,939 (1992), on reh'g, Order No. 636-A, FERC Stats. & Regs., Regulations Preambles Jan. 1991 - June 1996 ¶ 30,950, on reh'g, Order No. 636-B, 61 FERC ¶ 61,272 (1992), on reh'g, 62 FERC ¶ 61,007 (1993), aff'd in part, vacated and remanded in part, United Dist. Cos. v. FERC, 88 F.3d 1105 (D.C. Cir. 1996), order on remand, Order No. 636-C, 78 FERC ¶ 61,186 (1997).

39 15 U.S.C. § 717c–1 (prohibition on market manipulation in contravention of rules and regulations as FERC may establish); 15 U.S.C. § 717t–2 (FERC granted authority to establish natural gas market transparency rules).

40 15 U.S.C. § 717b(e) grants the right of approval to the Federal Power Commission. This authority, however, was transferred to the U.S. Department of Energy (DOE) under 42 USC §7151(b). DOE then delegated its power of approval to the Federal Energy Regulatory Commission (FERC) pursuant to DOE Delegation Order No. 00-004.00A (effective May 16, 2006). As noted above, FERC's jurisdiction includes liquefied natural gas facilities that are either onshore or "near shore" (i.e., within the offshore jurisdiction of the states). See 15 U.S.C. § 717a(11) (definition of "LNG [liquefied natural gas] terminal").

41 Hackberry LNG Terminal, L.L.C., 101 FERC ¶ 61,294 (2002). See also 15 U.S.C. § 717b(e)(3)(B), which effectively codified the rule of Hackberry, but made that rule mandatory only until January 1, 2015, and ceases to have effect on January 1, 2030, 15 U.S.C. § 717b(e)(3)(C).

42 See the Public Utility Commission of Texas website on industries covered at www.puc.texas.gov/industry/Default.aspx and the links to regulation of the electricity industry on that page.

43 For the California Public Utilities Commission; Arizona Corporation Commission, Utilities Division); and New Mexico Public Regulation Commission, Utility Division, the same statutory general powers exercised for gas utilities are also applicable to electric utilities. See footnote 48. For the Public Utilities Commission of Texas, key statutory provisions setting forth its general regulatory powers with respect to electric utilities include the following: PUC-Texas, Texas Utility Code §§ 32.001, 36.001, 37.051, 38.002, 38.005, 38.051, 38.071.

44 In California, for example, the California Public Utilities Commission, in accordance with its statutory authority, has promulgated a general order that establishes the requirements (and related procedures) for the construction of any transmission line (≥ 200 kV), power line (between 50kV and 200kV) or distribution line (< 50 kV). CPUC, General Order 131-D, docs.cpuc.ca.gov/PUBLISHED/Graphics/589.PDF.

45 As an example of a procurement contract approval for purposes of cost recovery, see the California Public Utilities Commission resolution approving renewable energy power purchase agreements entered into by San Diego Gas & Electric, available at docs.cpuc.ca.gov/published/Final_resolution/168460.htm.

46 For an overview of the role and history of regional transmission operators and independent system operators, see "About the ISO/RTO Council" at isorto.org/#about-section.

47 For a discussion of regional transmission operators and independent system operators as managers of wholesale electricity markets, see Sergici, S. 2018. "Status of Restructuring: Wholesale and Retail Markets." Presented to the National Conference of State Legislatures on June 26. www.ncsl.org/Portals/1/Documents/energy/energy_markets_SSergici_present_32498.pdf.

48 Public Law 109-58 (August 8, 2005). Section 368 corridors on federal lands are intended for use by oil, gas and hydrogen pipelines, as well as electric transmission and distribution facilities. Information on the identification and environmental review of the federal effort supporting the siting of Section 368 corridors in California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming can be found at corridoreis.anl.gov.

49 16 U.S.C. § 824(b). The statutory authority granted was to the "Federal Power Commission." This authority, however, was transferred to the Federal Energy Regulatory Commission under 42 USC §7172(a)(1)(B).

50 16 U.S.C. §§ 824d, 824e.

51 The companies that own or operate the facilities subject to Federal Energy Regulatory Commission (FERC) jurisdiction are identified as "public utilities" for purposes of FERC regulation (with specified exceptions), 16 U.S.C. §§ 824(e), and as such are subject to FERC jurisdiction.

52 29 FERC ¶ 61,140, at 61,291.

53 Federal Energy Regulatory Commission exercises limited jurisdiction with respect to the Electric Reliability Council of Texas under 16 USC 824i (Interconnection Authority) and 16 USC 824j (Wheeling). See AEP Energy Partners, Inc., 164 FERC ¶61,056 (2018) at www.ferc.gov/industries/electric/indus-act/rto/ercot.asp.

54 Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities, FERC Order No. 888, FERC Stats. & Regs. ¶ 31,036 (1996); FERC order on reh'g, Order No. 888-A, FERC Stats. & Regs. ¶ 31,048, order on reh'g, Order No. 888-B, 81 FERC ¶ 61,248 (1997); FERC. 1998. order on reh'g, Order No. 888-C, 82 FERC ¶ 61,046, aff'd in relevant part sub nom (1998); Transmission Access Policy Study Group v. FERC, 225 F.3d 667 (D.C. Cir. 2000), aff'd sub nom. New York v. FERC, 535 U.S. 1 (2002). www.ferc.gov/legal/maj-ord-reg/land-docs/order888.asp.

55 Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities, Order No. 1000, 76 FR 49842 (Aug. 11, 2011), FERC Stats. & Regs. ¶ 31,323 (2011); FERC order on reh'g, Order No. 1000-A, 139 FERC ¶ 61,132 (2012); FERC order on reh'g, Order No. 1000-B, 141 FERC ¶ 61,044 (2012). www.ferc.gov/industries/electric/indus-act/trans-plan.asp.

56 Regional Transmission Organizations, Order No. 2000, FERC Stats. & Regs. ¶ 31,089 (1999); FERC order on reh'g, Order No. 2000-A, FERC Stats. & Regs. ¶ 31,092 (2000); FERC aff'd sub nom. Pub. Util. Dist. No. 1 v. FERC, 272 F.3d 607 (D.C. Cir. 2001).

57 Integration of Variable Energy Resources, Order No. 764, FERC Stats. & Regs. ¶ 31,331 (cross-referenced at 139 FERC ¶ 61,246) (2012).

58 Demand Response Compensation in Organized Wholesale Energy Markets, Order No. 745, FERC Stats. & Regs. 31,322 (cross-referenced at 134 FERC ¶ 61,187) (2011).

59 16 U.S.C. § 824o.

60 Order Certifying NERC as the Electric Reliability Organization (ERO) and Ordering Compliance Filing, 116 FERC ¶ 61,062 (2006).

61 EPA presents an overview or summary of each of these laws: www.epa.gov/clean-air-act-overview; www.epa.gov/laws-regulations/summary-clean-water-act; www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act; www.epa.gov/laws-regulations/summary-national-environmental-policy-act; and www.epa.gov/sdwa.

62 42 U.S.C. § 4370M, et seq.

63 42 U.S.C. § 4370M, et seq. The U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Army Corps of Engineers, U.S. Department of Commerce, U.S. Department of the Interior, U.S. Department of Energy, U.S. Department of Transportation, U.S. Department of Defense, Federal Energy Regulatory Commission, Nuclear Regulatory Commission, U.S. Department of Homeland Security, U.S. Department of Housing and Urban Development, Advisory Council on Historic Preservation, Office of Management and Budget, and Council on Environmental Quality are all members of the Federal Permitting Improvement Steering Council and tasked with improving federal infrastructure permitting.

64 The Federal Highway Administration (FHWA) also has developed its Environmental Review Toolkit site that, although focused on transportation infrastructure projects, provides quick public access to information about Executive Order 13807 and its implementation, including subsequent agreements, fact sheets, memos and guidance on agency processes. The FHWA toolkit site is located at www.environment.fhwa.dot.gov/nepa/oneFederal_decision.aspx.

65 For a brief introduction to the history of the 1938 expropriation, see the U.S. State Department's Office of the Historian's Milestones: 1937–1948, "Mexican Expropriation of Foreign Oil, 1938." history.state.gov/milestones/1937-1945/mexican-oil.

66 For an overview of the Mexican Energy Reform, see the "Key Elements of the Energy Reform" summary prepared by the Mexican Embassy to the United States, embamex.sre.gob.mx/eua/index.php/en/fact-sheets/more-facts-sheets/1218-key-elements-of-the-energy-reform-march-2014.

67 These figures are calculated using information from the U.S. Energy Information Agency's "U.S. Natural Gas Exports and Re-Exports by Country" (including prices), which can be found at www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm.

68 For an overview of President López Obrador's plans for PEMEX and the challenges presented, see Malkin, E. 2019. "To Halt Energy Slide, Mexico Turns to a Trusted Provider: Mexico." New York Times, April 11. www.nytimes.com/2019/04/11/business/energy-environment/mexico-oil-electricity-gasoline.html.

69 For a more in-depth discussion of Mexican oil and gas exploration and development under the Energy Reform, see McNeece, J., E. Save and M. Hindus. 2014. "Mexico's Energy Reform Provides Significant Opportunities in Oil and Gas Exploration and Production." Pratt's Energy Law Report 14(3). www.pillsburylaw.com/en/news-and-insights/mexico-s-energy-reform-provides-significant-opportunities-in-oil-1.html.

70 Mexican Constitution, Art. 27.

71 Mexican Constitution, Art. 27.

72 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 6.

73 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 13.

74 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Arts. 11, 23.

75 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Arts. 41–47.

76 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 129. The law governing Agencia de Seguridad, Energía y Ambiente is the Ley de la Agencia Nacional de Seguridad Industrial y de Protección al Medio Ambiente del Sector Hidrocarburos (Law of the National Agency for Industrial Safety and Environmental Protection for the Hydrocarbons Sector).

77 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 48. II, Art. 51.

78 Mexican Regulations for Title Three of the Hydrocarbons Law, Art. 77.

79 Mexican Regulations for Title Three of the Hydrocarbons Law, Art. 77.

80 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 82; Mexican Regulations for Title Three of the Hydrocarbons Law, Arts. 77, 78 (rates to be established are maximum rates).

81 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 48. II, Art. 51.

82 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 70.

83 Mexican Regulations for Title Three of the Hydrocarbons Law (Reglamento de las Actividades a que Se Refiere el Título Tercero de la Ley de Hidrocarburos), Arts. 33, 2 XXI

84 Mexican Regulations for Title Three of the Hydrocarbons Law, Art. 39.

85 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 82; Mexican Regulations for Title Three of the Hydrocarbons Law, Arts. 77, 78 (rates to be established are maximum rates).

86 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 81.

87 Mexican Regulations for Title Three of the Hydrocarbons Law, Art. 21.

88 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 82; Mexican Regulations for Title Three of the Hydrocarbons Law, Arts. 77, 78 (rates to be established are maximum rates).

89 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 68, Transitory Article Twelfth.

90 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 66. Regarding the Centro Nacional de Control de Energía's (Mexican National Energy Control Center) role as manager of Sistema de Transporte y Almacenamiento Nacional Integrado de Gas Natural (National Integrated Transportation and Storage System), see www.gob.mx/cenagas/articulos/convocatoria-de-temporada-abierta-2016-85077.

91 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 48. II, Art. 51.

92 Mexican Regulations for Title Three of the Hydrocarbons Law, Arts. 77, 78.

93 The electronic bulletin board is required under Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 70 and Mexican Regulations for Title Three of the Hydrocarbons Law, Arts. 72, 73. On daily reporting, see, for example, EIA. 2017. "Mexico Publishes First Monthly Natural Gas Price Index After Moving to Competitive Market." Today in Energy, August 30. www.eia.gov/todayinenergy/detail.php?id=32712.

94 Ley de la Comisión Federal de Electricidad (Federal Electricity Commission Law). On the Comisión Federal de Electricidad's status as a productive state enterprise owned exclusivity by the federal government, see Article 2.

95 Ley de la Comisión Federal de Electricidad (Federal Electricity Commission Law), Art. 10.

96 Ley de la Comisión Federal de Electricidad (Federal Electricity Commission Law), Arts. 12 IV, 137-139 (rates) 50 (conditions of service).

97 The amendments to the Mexican Constitution with respect to electricity specified that only planning and control of the national electric system and the public service of transmission and distribution of electricity pertain exclusively to the state, subject to such contracts with private parties regarding such activities as the law may permit, and that applicable laws will determine the form in which the private sector can participate in other activities of the electrical industry. Mexican Constitution, Art. 27, paragraph 6, Art. 25, paragraph 5. For a discussion of the activities that private parties can undertake under the Law of the Electrical Industry and the other elements of the Energy Reform, see Save, E., M. Hindus and J. McNeese. 2014. "Energy Reform Legislation in Mexico Gives the Private Sector Unprecedented Opportunities in the Mexican Electrical Power Industry." Pratt's Energy Law Report.

98 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Arts. 1, 4 V, 6 V.

99 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Art. 2.

100 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Art. 30.

101 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Art. 107-108.

102 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Arts. 137-139.

103 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Art. 12 VI.

104 H.R. 132, 116th Congress, first session, (2019–2020). www.congress.gov/bill/116th-congress/house-bill/132/text.

105 This is pursuant to Executive Order 10485, 18 Fed. Reg. 5397, Sept. 3, 1953, www.archives.gov/federal-register/codification/executive-order/10485.html, as amended by Executive Order 12038, 43 Fed. Reg. 4957, Feb. 3, 1978, www.archives.gov/federal-register/codification/executive-order/12038.html. The power to issue Presidential Permits for cross-border electricity transmission was delegated to the Assistant Secretary for the Office of Energy by Redelegation Order No. 00-006.50, issued on November 17, 2014.

106 This is pursuant to Executive Order 10485, as amended by Executive Order 12038. For references, see the prior footnote. The power to issue Presidential Permits for that portion of cross-border gas pipelines crossing the border is delegated to the Federal Energy Regulatory Commission under Delegation Order No. 00-004.00A, effective May 16, 2006.

107 This is pursuant to Executive Order 13337, 69 Fed. Reg. 25299, April 30, 2004. www.federalregister.gov/documents/2004/05/05/04-10378/issuance-of-permits-with-respect-to-certain-energy-related-facilities-and-land-transportation. The delegation of authority was made pursuant to U.S. Department of State Delegation of Authority 118-2 of January 26, 2006, and Delegation 415 of January 18, 2017.

108 On April 10, 2019, President Trump issued Executive Order 13867, Issuance of Permits with Respect to Facilities and Land Transportation Crossings at International Boundaries of the United States, which rescinds Executive Order 13337 and requires the U.S. Department of State to update its procedures for making Presidential Permit decisions. Executive Order 13867 establishes a new process for cross-border infrastructure, including pipelines, and makes it clear that the President is indeed the final decision maker on whether or not to issue the permit (84 FR 15491), April 15, 2019.

109 In accordance with Council on Environmental Quality guidance on analyses of impacts from actions that take place outside the United States (i.e., "extraterritorial actions"), an appropriate review under the National Environmental Policy Act would not necessarily address potential effects on environmental, cultural and human resources in Mexico because the government of Mexico applies its own sovereign laws to analyze potential environmental effects resulting from project activities occurring in Mexico. For more information, see Council on Environmental Quality. 1997. "Memorandum to Agencies on the Application of the National Environmental Policy Act to Proposed Federal Actions in the U.S. with Transboundary Effects." Memorandum. July 1, p. 4, at footnote 2.

110 Executive Order No. 13337 (69 FR 25230) provides that after consideration of the application and any comments received, "If the Secretary of State finds that issuance of a permit to the applicant would serve the national interest, the Secretary shall prepare a permit, in such form and with such terms and conditions as the national interest may in the Secretary's judgment require, and shall notify the officials required to be consulted ... that a permit be issued." U.S. Department of Energy (DOE) Presidential Permit decisions require a "public interest" determination that incorporates considerations around environmental and human health impacts and potential for the project to impede the reliability of the U.S. grid. DOE's Presidential Permit application procedures are found at 10 CFR §§ 205.320.

111 The current form of the International Boundary and Water Commission is an update to the International Boundary Commission established pursuant to the provisions of the Convention between the United States and Mexico signed in Washington March 1, 1889. See 1944 Water Treaty, Article 2.

112 The official name of the 1970 Boundary Treaty is the Treaty to Resolve Pending Boundary Differences and Maintain the Rio Grande and Colorado River as the International Boundary (T.I.A.S. 7313); it was signed at Mexico City, Mexico, November 23, 1970, and went into effect April 18, 1972.

113 The technical name of the 1944 Water Treaty is the Treaty Between the United States of America and the United Mexican States, signed in Washington, D.C., on February 3, 1944, relating to the utilization of the waters of the Colorado and Tijuana Rivers and of the Rio Grande (Rio Bravo) from Fort Quitman, Texas, to the Gulf of Mexico, and Protocol supplementary thereto, signed in Washington, D.C., November 14, 1944, www.ibwc.gov/Files/1944Treaty.pdf.

114 11 U.S.C. §717b(a). The law originally provided that the referenced order would be given by the Federal Power Commission. This authority, however, was transferred to the U.S. Department of Energy under 42 USC §7151(b).

115 Executive Order 10485, as amended by Executive Order 12038. The power to issue the order is delegated to the Federal Energy Regulatory Commission under Delegation Order No. 00-004.00A, effective May 16, 2006.

116 11 U.S.C. §717b(a).

117 11 U.S.C. §717b(c)

118 The U.S. Department of Energy identifies Mexico as a party to a free trade agreement that requires national treatment for trade in natural gas. www.energy.gov/fe/services/natural-gas-regulation/how-obtain-authorization-import-andor-export-natural-gas-and-lng (Natural Gas Import & Export Regulation—Free Trade Agreement (FTA) Countries and Liquefied Natural Gas Exports).

119 15 U.S.C. § 717b(e). As noted above, the Federal Energy Regulatory Commission's jurisdiction includes liquefied natural gas facilities that are either onshore or "near shore" (i.e., within the offshore jurisdiction of the states). See 15 U.S.C. § 717a(11) (definition of "LNG [liquefied natural gas] terminal").

120 U.S. Department of Energy Redelegation Order No. 00-002.04D (November 6, 2007).

121 A current list of all applications for export of liquefied natural gas from the lower 48 states and the status of those applications is presented at energy.gov/fe/downloads/summary-lng-export-applications-lower-48-states. Almost all applicants have submitted an application for export to FTA countries and a matching application to export to non-FTA countries.

122 See, for example, Sabine Pass Liquefaction, LLC, DOE/FE Order No. 2961, FE Docket No. 10-111-LNG, fossil.energy.gov/ng_regulation/sites/default/files/programs/gasregulation/authorizations/2011/orders/ord2961.pdf, at 28 (May 20, 2011).

123 See, for example, NERA Economic Consulting. 2018. Macroeconomic Outcomes of Market Determined Levels of U.S. LNG Exports. June 7. Washington, D.C.: U.S. Department of Energy. www.energy.gov/sites/prod/files/2018/06/f52/Macroeconomic%20LNG%20Export%20Study%202018.pdf.

124 See the citations to approved non-FTA applications for export permits in energy.gov/fe/downloads/summary-lng-export-applications-lower-48-states.

125 The average bulk price in 2018 for gasoline (all grades) in the United States was US$1.942 per gallon (www.eia.gov/dnav/pet/pet_pri_refmg_dcu_nus_a.htm). A barrel equals 42 gallons. Therefore, a barrel of gasoline, at the bulk price, would cost approximately US$81.564. At this price, the 188,790,000 barrels of gasoline exported to Mexico in 2018 would cost US$15.4 billion).

126 These figures are calculated from information found at the U.S. Energy Information Administration's "U.S. Natural Gas Exports and Re-Exports by Country" (including prices), which can be found at www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm.

127 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 48.

128 Ley de Hidrocarburos (Mexican Hydrocarbons Law), Art. 89 I.

129 6 USC § 824a(e).

130 For specific examples, please see the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability, Orders for Export to Mexico, Order No. EA-466 (Dynasty Power, Inc.), May 15, 2019, www.energy.gov/sites/prod/files/2019/05/f62/EA-466%20Dynasty%20Power.pdf or Order No. EA-442 (Fisterra Generación, S. de R.L. de C.V.), February 13, 2018, www.energy.gov/sites/prod/files/2018/03/f49/EA-442%20Fisterra%20Generacion%20%28MX%29_0.pdf.

131 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Art. 12 XXVIII.

132 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Art.17.

133 Ley de la Industria Eléctrica (Mexican Law of the Electrical Industry), Art. 22.

134 California Public Utilities Code § 399.11(a).

135 S.B. 100, Calif. Leg., 2017–2018 Sess. leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100.

136 For purposes of the renewables portfolio standard, renewable energy means electricity from "biomass, solar thermal, photovoltaic, wind, geothermal, fuel cells using renewable fuels, small hydroelectric generation of 30 megawatts or less, digester gas, municipal solid waste conversion, landfill gas, ocean wave, ocean thermal or tidal current," subject to various limitations. California Public Utilities Code § 399.11(a); California Public Resources Code § 25741(a)(1).

137 California Public Resources Code § 25741(a)(2)(A). See also California Public Utilities Code § 399.11(e)(1) and (2) (generating resources located outside of California that are able to supply renewables portfolio standard–eligible electricity to California end-use customers shall be treated identically to generating resources located within the state).

138 Order Certifying NERC as the Electric Reliability Organization (ERO) and Ordering Compliance Filing, 116 FERC ¶ 61,062 (2006).

139 A commentary from the Texas Department of Transportation on the Texas-Mexico Border Transportation Master Plan and its development was presented to the Fifth Mexico Gas Summit in San Antonio, Texas, on May 29, 2019. The commentary is available at onedrive.live.com/?authkey=%21A-CY9fyG5RsZmwIE&cid=8F763806468747CA&id=8F763806468747CA%2148075&parId=8F763806468747CA%2148068&o=OneUp.

140 S.B. 100, Calif. Leg., 2017–2018 Sess. leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100

141 S.B. 100, Calif. Leg., 2017–2018 Sess. leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100

142 This overview was written using information from the following websites: www.bherenewables.com/aboutus_geothermal.aspx, www.energy.ca.gov/renewables/renewable_links.html, www.cthermal.com/hells-kitchen, www.cthermal.com/hells-kitchen-power, www.drecp.org, www.icpds.com/?pid=2934, ww2.energy.ca.gov/sitingcases/pre1999_page/index.php?xkm=ajdkha2385duh-kasd155dsasjd5598fhajkhs, ww2.energy.ca.gov/sitingcases/elcentro/index.html, www.waterboards.ca.gov/waterrights/water_issues/programs/salton_sea, imperial.granicus.com/MetaViewer.php?view_id=2&event_id=849&meta_id=111789, www.zglobal.biz/projects, cloud.3dissue.net/5980/5962/5962/1689/index.html?421, www.power-technology.com/projects/mount-signal-solar-power-plant-imperial-county-california, and www.tenaskaimperialsolar.com/tenaska-imperial-solar-energy-center-west.

143 The Desert Renewable Energy Conservation Plan is a collaboration between the California Energy Commission, California Department of Fish and Wildlife, U.S. Department of the Interior's Bureau of Land Management, and U.S. Fish and Wildlife Service. The goal is to help align local, state and federal conservation plans with renewable energy development. Renewable Energy Conservation Planning Grants were awarded to the counties in the plan area by the California Energy Commission.

144 S.B. 350, Calif. Leg., 2019–2020 Sess. leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350.

145 S.B. 350, Calif. Leg., 2019–2020 Sess. leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350

146 Arizona Prop. 127, Renewable Energy Standards Initiative (2018).

147 The New Mexico Border Authority is an executive branch state agency providing leadership in the development of the state's international ports of entry and serving as the governor's advisor and point of contact for the ports of entry. This agency facilitates new infrastructure, trade opportunities, job opportunities, job training capabilities and other activities contributing to productive economy along the New Mexico border. www.nmborder.com/About_Us.aspx

148 The Paso del Norte is sometimes referred to as the "Borderplex." The term Borderplex, however, more commonly refers to the Santa Theresa Point of Entry industrial area and maquiladora area.

149 Carbon dioxide emissions are estimated by the U.S. EIA based on energy consumption quantities in each sector and therefore do not include emissions from vented or flared natural gas. U.S. EIA assigns the emissions to the state that converts the source into electricity or consumes the source directly. A different metric may be desirable when discussing New Mexico's energy import and export decisions.

150 The Environmental Improvement Board promulgates rules and standards for food protection, drinking water supply (including capacity development), liquid waste, air quality management, occupational health and safety, public swimming pools, radiation safety, hazardous wastes, petroleum storage tanks, and solid waste.

151 S.B. 489, 54th Leg., 1st Sess. (Nm. 2019). nmlegis.gov/Sessions/19%20Regular/final/SB0489.pdf.

152 H.B. 546, 54th Leg., 1st Sess. (Nm. 2019). www.nmlegis.gov/Legislation/Legislation?chamber=H&legType=B&legNo=546&year=19.

153 H.B. 546, 54th Leg., 1st Sess. (Nm. 2019). www.nmlegis.gov/Legislation/Legislation?chamber=H&legType=B&legNo=546&year=19.

154 NMSA 1978, Section 70-2-12.1.

155 S.B. 489, 54th Leg., 1st Sess. (Nm. 2019). nmlegis.gov/Sessions/19%20Regular/final/SB0489.pdf.

156 S.B. 489, 54th Leg., 1st Sess. (Nm. 2019). nmlegis.gov/Sessions/19%20Regular/final/SB0489.pdf.

157 H.B. 267, 54th Leg., 1st Sess. (Nm. 2019). www.nmlegis.gov/Sessions/13%20Regular/final/HB0267.pdf.

158 H.B. 291 54th Leg., 1st Sess. (Nm. 2019). nmlegis.gov/Legislation/Legislation?Chamber=H&LegType=B&LegNo=291&year=19.

159 H.B. 291 54th Leg., 1st Sess. (Nm. 2019). nmlegis.gov/Legislation/Legislation?Chamber=H&LegType=B&LegNo=291&year=19.

160 H.B. 291 54th Leg., 1st Sess. (Nm. 2019). nmlegis.gov/Legislation/Legislation?Chamber=H&LegType=B&LegNo=291&year=19.

161 As an example, see www.sierraclub.org/texas/big-bend/trans-pecos-pipeline-myths-texas-oil-and-gas-want-you-swallow.

162 The General Agreement on Tariffs and Trade 1994, set out in Annex 1A to the World Trade Organization Agreement, technically identified as the Marrakesh Agreement Establishing the World Trade Organization, signed at Marrakesh, Morocco, on April 15, 1994.

163 The General Agreement on Tariffs and Trade 1994 Article XX provides certain exceptions to the general rule against prohibitions or restrictions on imports or exports. The one exception that might plausibly be applicable to energy trade pertains to restrictions that relate to "the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption." The key limitation is that the restrictions must apply to domestic activity, as well to the foreign trade. In addition, other language in the General Agreement on Tariffs and Trade 1994 provides that an exception cannot be "applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade."

164 Appellate Body Report, China—Measures Related to the Exportation of Rare Earths, Tungsten, and Molybdenum, WT/DS431/AB/R (August 7, 2014).

165 USMCA, Annex 2-A, Art. 2.A.3 1(a).

166 USMCA Annex 14-C, clause 6(a).

167 For an Annex 14-E proceeding, there is a 3-year statute of limitations as compared to the 4-year statute of limitations under Annex 14-D, probably because pursuit of domestic remedies is no longer required. Annex 14-E, section 4(b).

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