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PASO DEL NORTE ENERGY SECTOR REVIEW

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PASO DEL NORTE ENERGY SECTOR REVIEW

An overview of the energy markets in the Paso del Norte region reveals not only a wealth of energy sources, and the degree to which the region relies on those sources, but also the critical support that it provides to the broader Mexican and U.S. energy markets. Particularly abundant in the region are solar, wind, and geothermal resources with the closest oil and natural gas deposits concentrated several hundred miles away in the Permian and San Juan Basins. Despite this distance, however, the economies of the Paso del Norte's principal cities—Ciudad Juárez, El Paso, and Las Cruces—depend heavily on oil and natural gas, as well as on each other's infrastructures to supply both natural gas and oil to sustain their economic activity. While renewable sources currently constitute a relatively small portion of the region's energy sources, the incorporation of these resources, particularly solar energy, is growing.

In addition to the types of sources on which the region depends, geography plays a determinative role in the nature of its energy sector. Seated at the crossroads of North America, just to the east of the continental divide, the Paso del Norte region offers the most efficient overland trade route between the Pacific and Atlantic coasts, and significant transcontinental pipeline and related infrastructure converge here. Complementing this east-west trade route, the Paso del Norte, as its name suggests, provides a strategic gateway between central Mexico and the Front Range of the Rockies, extending all the way into northern Canada. The juncture of these north-south and east-west trade routes creates a nexus of major, critical transcontinental pipelines, refineries, and other related assets that transport raw and refined products both originating from and passing through the Paso del Norte region across vast areas of North America.

Surrounding all of the extraction, transmission, and subsequent downstream market deployment of these varied energy resources are the region's various legal and regulatory structures. While the laws and regulations of Texas, New Mexico, and the U.S. federal government regulate the energy sector in their jurisdictions, Mexico and the State of Chihuahua apply markedly different laws and regulations to the same sector. So, while these trade routes encourage and stimulate the commercial and financial integration and convergence of the economies of Mexico and the U.S., the legal and regulatory divergence in the energy sectors of such geographically related and economically intertwined communities in the Paso del Norte region yield many challenges, most importantly by hindering the creation of a seamless, regional, and binational energy market of sufficient scale between Texas, New Mexico, Chihuahua, and, ultimately, between the U.S. and Mexico. On the other hand, although such regulatory divergence may split the market, it also offers unique and extremely valuable specializations in facilitating and supporting regional cross-border and binational energy markets.

This Sector Review describes in detail the fundamental structural elements of the Paso del Norte's binational energy sector, its unique dynamics across the region's state and national boundaries, as well as its divergent costs and pricing. It begins, in Part I, with a survey of the characteristics of the primary oil, gas, and renewable energy sources followed by a discussion of the physical infrastructure and regulatory aspects that govern their extraction and transmission. In Part II, the Sector Review examines the deployment of these primary energy sources by describing their comparative physical and regulatory infrastructure and the fossil fuel, renewable energy, and electricity markets.

ENERGY RESOURCES IN THE PASO DEL NORTE REGION

Crude oil and natural gas are the prevailing sources of energy for world markets. The same is true for the markets present in the Paso del Norte region, despite the fact that the closest hydrocarbon deposits lie far from the region's major cities. The region, so heavily invested in the manufacturing and logistics industries, for example, relies greatly on both natural gas to power its factories and fuel oil to power the rail and trailer fleets which carry the goods produced here to distant markets. For the extraction of oil and gas that does take place in the region, it is governed by different customary, legal, and regulatory systems, most markedly apparent between Mexican federal law and U.S. state and federal laws. This varied governance structure repeats with respect to the transmission of oil and natural gas across the region as well. In this geo-strategic gateway, the Paso del Norte region hosts significant national and binational pipeline networks that must comply with its varying and multileveled legal systems.

Included amongst the energy sources which sustain the Paso del Norte region are also renewable energy resources, such as solar, wind, and geothermal. And, while renewable energy resources do not yet dominate the region's energy use, they continue to yield an ever-greater share of total energy used. The establishment and operations of renewable generation face the same challenges that the hydrocarbon sector faces, that their development must contend with a variety of legal and regulatory structures. Nevertheless, their expansion is growing, to a great extent fostered by market and fiscal incentives established by those very same legal systems. The final major source of energy that supplies electricity to the Paso del Norte region comes from the Palo Verde nuclear energy plant in Arizona.

A. Hydrocarbon Resources

1. Deposits and Extraction

At the national level, the U.S. and Mexico have tremendous capabilities when compared to other countries in terms of their hydrocarbon reserves and their technical capacities for producing oil and natural gas. The U.S., as a whole, possesses an estimated 36.4 billion barrels of oil reserves.¹ Texas alone holds 33.7% of those reserves, while New Mexico holds only 4%.² As of 2014, the U.S. was the world's leading oil producer with a production rate of 14 million barrels per day, with Texas and New Mexico contributing 32% and 3.8% of that production, respectively.³ The closest oil reserves to the Paso del Norte region in Texas and New Mexico reside in the oil rich Permian Basin, which they both share. The Permian Basin, as of 2013, is the largest oil-producing region in the U.S., accounting for 18% of the country's total oil output.⁴ And, due to technological advances in hydraulic fracturing (commonly known as fracking), production has soared from 850,000 barrels per day in 2007 to 1,350,000 in 2013.⁵ Most of this oil produced in the Permian Basin is known as light, or sweet crude, which is easier to extract, refine, and transport.

In Mexico, proven reserves of oil are estimated at 9.8 billion barrels, 71% of which are located on the southern edges of the Gulf of Mexico, in the Cantarell, Ku-Maloob-Zaap, and Antonio J. Bermúdez fields.⁶ Northern Mexico, by contrast, including the State of Chihuahua, is generally free of significant proven oil reserves or production.⁷ From those oil rich fields that Mexico does have, it currently produces 2.5 million barrels per day, ranking tenth in world production.⁸ In recent years, though, this production has declined

markedly, 30% since 2004, to less than 1.2 million barrels per day.⁹ The type of oil extracted from these fields is heavy, sulfurous crude requiring advanced refining capabilities that Mexico does not possess. For years, significant amounts of Mexican oil have been exported to the U.S. to be refined and then imported back into Mexico. In 2015, this refined petroleum supplied 45% of Mexico's domestic market.¹⁰

Regarding natural gas, U.S. reserves are also abundant and estimated at 338 Tcf (trillion cubic feet).¹¹ The extraction and production of these natural gas resources in the U.S. exceeds all other countries with a daily production rate of 74 Bcf (billion cubic feet) per day.¹² Texas holds more than 25% of total U.S. reserves and contributes 31% of national production, while New Mexico accounts for nearly 4.5% of these reserves and 5% of production.¹³ In fact, the San Juan Basin, located in the western border region of New Mexico and Colorado, is the fourth most productive gas field in the U.S., having produced, for example, over 1 Tcf in 2013.¹⁴

Mexico has considerably less natural gas reserves than the U.S., with proven reserves of 17 Tcf.¹⁵ Unlike Mexico's oil reserves, much of the country's natural gas reserves, about 21% of the total, are located in the northeast, mostly in the Burgos and Sabinas Basins, which extend from the State of Coahuila to the States of Nuevo León and Tamaulipas.¹⁶ Overall, production of natural gas in Mexico is less than in the U.S., with a relatively constant output in recent years of 6 Bcf per day, such that Mexico currently ranks but 20th worldwide in the production of natural gas.¹⁷

Though still a relatively new enterprise in Mexico, hydraulic fracturing is seen as a way to increase domestic natural gas production significantly in order to reduce imports through the development of non-conventional reserves. Where the

Barnett Shale and Permian Basin converge on the eastern edge of Chihuahua, in the Presidio-Ojinaga border region, Petróleos Mexicanos (Pemex), the Mexican state-owned oil and gas company, has drilled exploratory and apparently productive wells.¹⁸ Yet, even if large amounts of shale gas are discovered, the extraction of these reserves would require large volumes of water which are unavailable locally and expensive to transport.¹⁹

Extraction Framework

In the Paso del Norte region, the extraction and transmission of hydrocarbons must comply with laws and regulations of several jurisdictions. A state's conception of property and contract rights as well as its laws and regulations regarding the construction and operation of extraction and transmission facilities constitute the fundamental principles of the energy market and its development. As a transboundary region, the Paso del Norte hosts three states and two federal governments that apply different laws in each territorial jurisdiction, resulting in varied characteristics of the energy sector in one geographic region, the Rio Grande Valley. While the state laws of Texas and New Mexico and the U.S. federal government all share similar principles, their differences with the principles underlying the Mexican system are stark. In the U.S., where the Constitution serves as a foundational restraint on governmental power, federal authority is of limited jurisdiction and comes to bear only in certain circumstances, as with the development of oil and gas on federal land, or interstate transmission and sale. The various states, such as Texas and New Mexico, therefore, have original and broad jurisdiction governing these activities at the state level. The Mexican federal government, on the other hand, has a constitutional system that positively enumerates all the instances in which federal authority prevails and the Mexican states are not endowed with the same level of autonomy as their U.S. counterparts.

The federal government in Mexico has plenary and exclusive jurisdiction over many activities, particularly so in the energy sector, which is still the case even after the recent reforms allowing private investment.

Another salient difference is the source of law. The U.S. has a common law system at the state level that structure both the rights and the procedures inherent to the resolution of disputes for property and contract issues. The scope and contours of these rights and dispute resolution procedures are primarily determined by the manner in which prior disputes were settled, a system known as judicial precedent. In this way, property and contract law develop continuously and simultaneously with business innovation and practice over time. Mexico, on the other hand, is a jurisdiction whose legal system is based on Roman Law and through its system of legal codes enumerates, in an a priori and categorical fashion, the rights and procedures governing the resolution of conflict. These codes stand outside of business practice and can only be changed with the passage of new legislation. The *Código Civil Federal* (Federal Civil Code, FCC), the root of property and contract law, for example, dates to 1928.²⁰

In the Paso del Norte region, the extraction of hydrocarbons is a question of property and contract rights that diverge across jurisdictions.

Fundamentally, in all of the jurisdictions present in the Paso del Norte region, the extraction of hydrocarbons is a question of property rights. In the U.S., where property rights are determined at the state level, the States of Texas or New Mexico determine the rights associated with the extraction of hydrocarbons. Only in limited circumstances does the U.S. federal government have original jurisdiction over extraction, as when, for example, the hydrocarbons to be extracted are

within federal lands. In Mexico, the ownership of all subsurface hydrocarbons found in the country is originally and inalienably vested in the nation. So, while individuals in Texas and New Mexico are free to buy and sell hydrocarbon deposits on private lands, and while each state establishes the laws, regulations, and agencies which govern their extraction, the Mexican federal government begins with full title and ownership to hydrocarbons and exclusively regulates their extraction.

The ownership of hydrocarbons in Texas and New Mexico generally follows two principles of property law: Ownership-in-Place and the Rule of Capture. Under the Ownership-in-Place principle, a landowner owns all substances, including oil and gas deposits within the subsurface of the property.²¹ This principle, though, is not absolute. The Rule of Capture limits Ownership-in-Place by stipulating that the owner of a tract of land acquires title to the oil and gas which he produces from wells drilled thereon.²² If the oil and gas deposits, which are fluid and fugacious, extend beneath the properties of two or more owners, the one that produces first acquires title. The Rule of Capture, then, incentivizes property owners to extract oil and gas reserves, even when extraction could diminish reserves found under neighboring property. So, while a property owner may have the rights to the subsurface minerals under Ownership-in-Place, the title to the oil and gas that those deposits yield are lost if they are first extracted through activity on a neighboring property.

Often, a landowner in either Texas or New Mexico possesses a proprietary right to subsurface oil and gas deposits, but neither the capital nor the technology to extract them. In both states, an oil or gas company, through an oil and gas lease, can offer the capital and technology to extract the deposits and pay the landowner bonuses and royalties in exchange for the rights to the oil or gas. In 2015, Texas had 21,624 private active and

producing oil and gas wells. The Texas counties that constitute part of the Paso del Norte region had 154, all of them located in Culberson County. There are no private active oil and gas leases in the New Mexico portion of the Paso del Norte region.

The States of Texas and New Mexico, in addition to governing the property and contract laws inherent to oil and gas production, also regulate the permitting, construction, and environmental safety of oil and gas development activities. The Railroad Commission of Texas (RRC) has jurisdiction over the exploration, production, and transportation of oil and gas within the state, as well as the authority to enforce environmental and safety regulations. The Oil and Gas Division (OGD) of the RRC, in particular, oversees the regulatory compliance of oil and natural gas exploration and production.²³ The RRC also works to protect the correlative rights of the different interest holders in oil and gas deposits in order to prevent waste.²⁴ The Texas Commission on Environmental Quality (TCEQ), whose principle areas of regulations concern air and water quality as well as waste management, collaborates with the RRC to supervise and enforce the rules governing field waste associated with oil and natural gas exploration, extraction, and production.²⁵ The New Mexico Energy, Minerals, and Natural Resources Department (NMEMNRD), through its Oil Conservation Division (OCD), regulates oil, natural gas, and geothermal operations, as well as monitors correlative rights of oil and gas developers.²⁶ Additionally, the New Mexico Environment Department (NMED) monitors the environmental impacts of oil and gas extraction on air and water quality, as well as the hazardous waste that they produce.²⁷

Circumstances arise, though, in both Texas and New Mexico, where a sovereign, either the state or federal government, but not a private individual, owns the land which contains the oil and gas deposits and develops them on behalf of

the public good, particularly through fee generating activities, such as leasing the land for grazing, or hydrocarbon and mineral extraction. In these cases, the oil and gas company will have to enter into an agreement with either the state or federal government, whichever possesses title to the land. Unlike leases between private individuals, leases with a government have many more administrative procedures and requirements, primarily because the government acts as a fiduciary to ensure that the deposits and their extraction are of general, public benefit to the state's population. Some universal requirements found in leasing oil and gas resources from the Texas, New Mexico, or U.S. governments include procedures to ensure competitive bidding and the payment of bonuses and royalties.

Development of hydrocarbons in the U.S. depends on whether the land is owned privately or by the state or federal government.

When oil and gas deposits are on Texas or New Mexico state lands, the oil and gas company will enter into a lease with either the State of Texas through the Texas General Land Office (GLO) or with the State of New Mexico through the State Land Office (SLO).²⁸ Each land office is headed by a commissioner who directs, controls, and cares for the state's public lands.²⁹ The land commissioners in both states have the authority to enter into leases that, in exchange for fees and payments, grant right-of-way for primary extraction and for oil and gas pipelines.³⁰

The public lands in both states are often referred to as school lands, as they are meant to generate income for the institutions of public education, and the state leases its land to developers in order to maximize revenue. The developer extracting oil or gas deposits will have to pay royalties and other fees. The royalties and other revenues that these leases generate are managed by

the GLO's Permanent School fund in Texas and the SLO's Land Grant Permanent Fund in New Mexico for the benefit of the states' communities.³¹ Similar to private lands, the New Mexico and Texas state lands in the Paso del Norte region see extremely little oil and gas activity. Out of a total of 5,651 active and producing wells on state lands in Texas, El Paso County and its neighboring counties only account for 236 of these well leases, the vast majority of which, 201, are in Culberson County. In El Paso County there is one, in Jeff Davis County, eight, in Presidio County, nine, and in Hudspeth County, 17. In New Mexico, no active oil and gas leases on state lands are found in Doña Ana, Luna, Sierra, or Otero Counties.³²

With respect to accessing U.S. federal lands, an oil or gas development company must enter into a lease with the U.S. federal government, and although similar in form and principle to the state leases (requiring competitive bidding, royalty schedules, and public benefit) they also contain particular federal criteria. On these federal lands, the U.S. Department of the Interior (DOI) oversees the Bureau of Land Management (BLM). This department is the central, but not sole, authority governing oil and gas development (as well as the development of renewable resources) within the U.S. federal government.³³ The Secretary of the Interior, with respect to the management of BLM lands, exercises similar functions as those of the state land commissioners in Texas and New Mexico. Also, like the SLO and GLO in Texas and New Mexico, the BLM also collects and then deposits all royalties generated with the Office of Natural Resources Revenue.³⁴ When other federal agencies, such as the U.S. Department of Agriculture or even the Department of Defense govern the surface use of the land, these agencies therefore have the ability to determine whether extractive activity is permissible or not.

Oil and gas extraction that occurs on federal BLM land, and the eventual pipeline development to transport these resources, must comply with the National Environmental Policy Act (NEPA) of 1969. This law broadly mandates that U.S. federal agencies publicly assess and disclose their actions for potential environmental effects prior to making decisions.³⁵ The BLM, therefore, requires an Environmental Assessment (EA) and an Environmental Impact Statement (EIS) for activities such as oil and gas development. The developer must, in these cases, comply with NEPA rules by providing the BLM with a Notice of Intent, a preliminary EIS, and a final EIS (FEIS), when deliberating and issuing Record of Decision.³⁶

Territorially, though, New Mexico and Texas possess significantly different amounts of federal land. New Mexico was admitted to the union as a territory and came with substantial acreage under federal title. Texas, in part because it was admitted to the U.S. as a sovereign country, has very little federal land. Only 1.8% of land in Texas is federal, compared to 34.7% in New Mexico.³⁷ In terms of oil and gas production on these federal lands, New Mexico ranks amongst the most productive. New Mexico has 6,579, oil and gas leases on federal lands, second only to Wyoming, while the State of Texas has only 278.³⁸ Of all those federal leases in both Texas and New Mexico, none are located in the Paso del Norte region, except for Otero County, which has one active oil and one active gas lease.³⁹

Nationality requirements also limit oil and gas leases on federal lands to U.S. citizens. A foreign individual can participate, but only as a shareholder in a corporation organized under U.S. state and federal laws, and then only if the foreigner's home country allows similar privileges to U.S. citizens.⁴⁰ A foreign corporation may not own a federal oil and gas lease, but it may own stock in a corporation that does, yet again

only if that foreign corporation's home country permits like privileges for U.S. citizens.⁴¹ No explicit statutory requirements limit the leasing of state lands in Texas and New Mexico based on nationality as they do for federal lands.

The nation of Mexico, as established in Article 27 of the Mexican Constitution, has original and inalienable title to all subsurface oil and gas deposits and the federal government has exclusive jurisdiction over all aspects of this sector.⁴² For decades, Pemex, as the state-owned oil company, had the exclusive authority to explore, extract, transport, import, export, store, distribute, and commercialize oil and natural gas resources. Yet, in an effort to boost production of oil and natural gas, given Pemex's aging infrastructure, the reduced yield of oil in shallow gulf waters, the foreign capital needs to develop deep water wells, and the transition to more cost effective and cleaner natural gas fired electricity generation, Mexico's recent Energy Reform amended Article 27 of the Mexican Constitution and yielded other associated laws in order to establish a new market framework that permits the participation of private developers. Now, former state-owned monopolies in the energy sector, such as Pemex, or the electric utility, the *Comisión Federal de Electricidad* (Federal Electricity Commission, CFE), while still state-owned, will generally have to compete with private firms for contracts involving most aspects of the energy sector. Nevertheless, certain areas, due to national security reasons, or for the public good, will be reserved to the state.

In Mexico, the *Ley de Hidrocarburos* (Hydrocarbons Law) is the principal law that provides the new framework for oil and gas development in Mexico, stipulating the roles and duties of various agencies that oversee the extraction, sale, transportation, storage, distribution, and commercialization of oil and natural gas.⁴³ Its principal actor is the *Secretaría de Energía* (Energy Secretariat,

SENER), which manages the country's energy policies to guarantee the competitive, efficient, and environmentally sustainable supply of energy.⁴⁴ The *Secretaría de Energía*, in particular, through its *Comisión Nacional de Hidrocarburos* (National Hydrocarbons Commission, CNH), is responsible for regulating and permitting these activities as well as managing the process of bidding, assigning, and leasing the rights to oil and natural gas exploration and extraction.⁴⁵ Under this new law, four types of oil and gas development contracts are now permitted:

- Service Agreements, where private firms acquire payment for, but not ownership of, any oil and gas produced;
- Profit Sharing Contracts, where private firms acquire payment based on profits but not ownership of any oil and gas;
- Production Sharing Contracts, where private firms acquire oil and gas in kind based on production levels; and,
- Licenses, where private firms acquire ownership of the oil and gas produced once royalties and taxes are paid.⁴⁶

Importantly, the law also stipulates that the Mexican government will have the power, given certain conditions, to rescind exploration and extraction contracts, and that any dispute regarding these rescissions will be subject to Mexican law and ineligible for arbitration.⁴⁷

In 2014, during the transition to private sector competition for the exploration and extraction of oil reserves, the Mexican government, through SENER, first transferred certain exploratory and production rights in oil fields to Pemex in *Ronda Cero* (Round Zero). Pemex was granted

100% of its request for proven and probable oil and gas reserves and was granted 67% of probable deep-water reserves.⁴⁸ In the current round, *Ronda Uno* (Round One), the oil and gas fields have been open to private bids in four phases, with the first three now complete. Rights to develop natural gas reserves in the *Burgos* Basin were auctioned off in the third phase of *Ronda Uno*.⁴⁹ *Ronda Dos* (Round Two) will take place in March of 2017. Yet, while the bids in *Ronda Uno* and subsequent bidding rounds are open to the participation of private actors, Pemex must still participate in the exploration and production of any cross-border oil and gas deposits.⁵⁰

The environmental and safety regulations governing the extraction of oil and natural gas deposits in Mexico are also determined and enforced exclusively at the federal level. Environmentally, the Energy Reform yielded, within the *Secretaría de Medio Ambiente y Recursos Naturales* (Secretariat of the Environment and Natural Resources, SEMARNAT), the *Agencia Nacional de Seguridad Industrial y de Protección al Medio Ambiente del Sector Hidrocarburos* (National Agency of Industrial Safety and Environmental Protection for the Hydrocarbon Sector, ASEA).⁵¹ This agency supervises and regulates industrial and operational safety as well as environmental protection (including impact analysis) in the extraction of oil and gas.⁵² These energy sector reforms not only yield the framework for the extraction of oil and gas, but also establish the regulations governing the now competitive transmission of oil and gas.

2. Transmission Framework

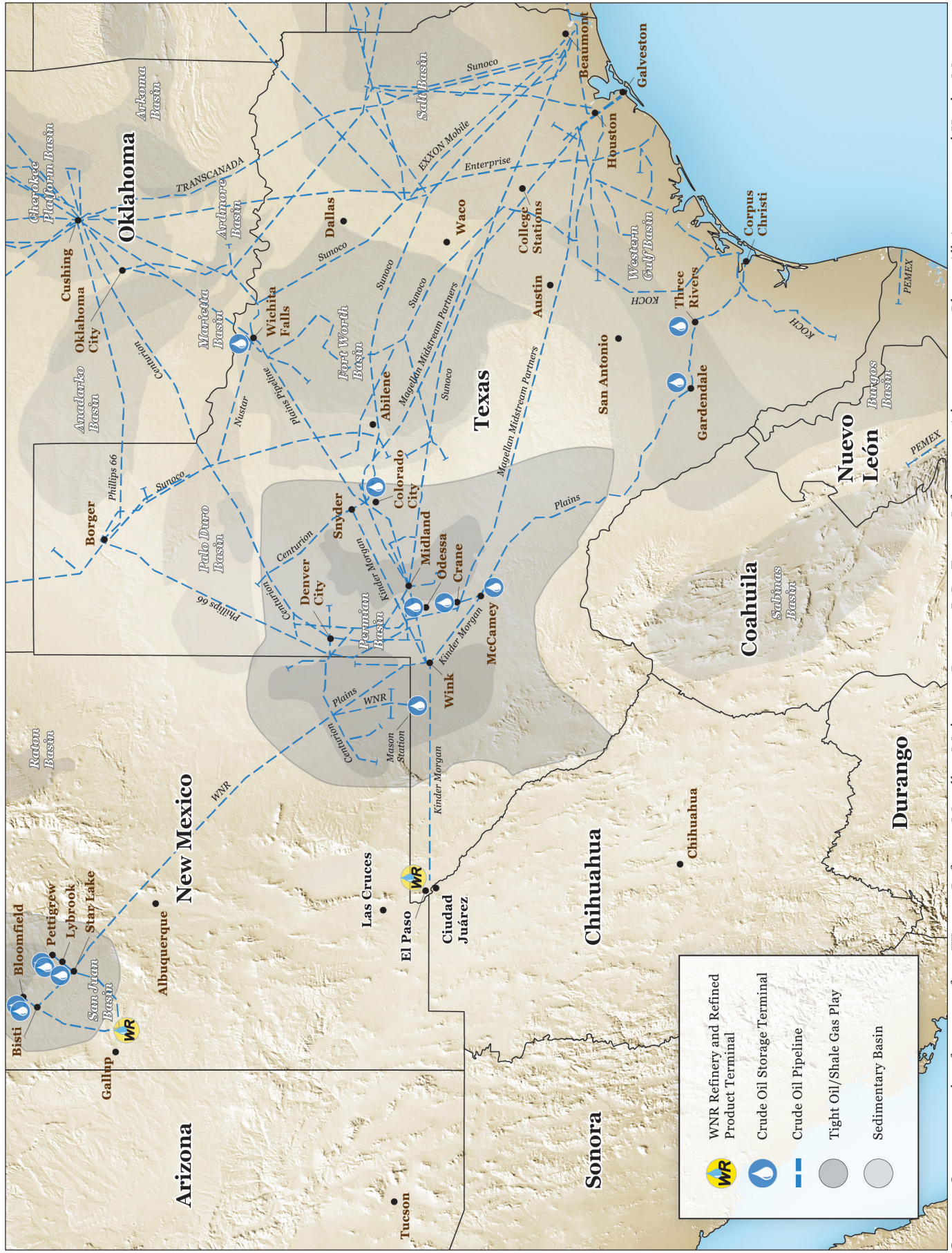
Pipeline transportation of hydrocarbons constitutes a major means of transporting oil and natural gas from the production fields to the distribution centers and refineries.⁵³ The total U.S. interstate crude oil and natural gas distribution, transmission, and gathering pipelines extend for

over 1.6 million miles.⁵⁴ Texas alone accounts for more than 93,000 miles of these crude oil and natural gas interstate pipelines.⁵⁵ But, Texas also has significant intrastate oil and natural gas pipelines, more than any other state, with over 200,000 intrastate natural gas pipelines and a total in excess of 439,000 miles of interstate and intrastate pipelines.⁵⁶ New Mexico has a far smaller oil and natural gas pipeline infrastructure than Texas, with approximately 10,800 interstate miles and 22,000 intrastate miles.⁵⁷

By comparison, total Mexican oil and natural gas pipeline transmission infrastructure comprises approximately 8,860 miles, of which 3,200 miles correspond to the oil extracted in the Gulf Coast region and terminating at refineries in the States of Nuevo León, Guanajuato, Veracruz, Hidalgo, Campeche, and Oaxaca, with none extending into the State of Chihuahua.⁵⁸ The pipeline infrastructure existing in the Paso del Norte region that transports these oil resources is extensive (Map 1). The only crude oil pipeline in the entire Paso del Norte region, operated by Kinder Morgan Energy Partners, transports crude oil over 450 miles from Scurry County, Texas to the Western Refining (WR) refinery in El Paso, Texas, a key supplier of local oil fuels in the binational region.⁵⁹ Due to an almost 40-year prohibition on exporting oil from the U.S., no cross-border oil pipelines currently exist in the Paso del Norte region, or at any other point on the U.S. Mexico border.

On the U.S. side of the Paso del Norte region, the El Paso Natural Gas (EPNG) pipeline system, privately owned by Kinder Morgan Energy Partners, has a length of 10,235 miles, a capacity of 5.65 Bcf per day, and transports natural gas from the San Juan, Permian, and Anadarko Basins to consumers in Texas, New Mexico, Arizona, California, Nevada, and Oklahoma. The El Paso Natural Gas pipelines also transport natural gas to Mexico through the northern part of Chihuahua (Map 2).⁶⁰

Map 1. Paso del Norte Crude Oil Pipeline Network



	WNR Refinery and Refined Product Terminal
	Crude Oil Storage Terminal
	Crude Oil Pipeline
	Tight Oil/Shale Gas Play
	Sedimentary Basin

Source: Own map with information from Western Refining, Magellan Midstream Partners L.P., Energy Information Administration, Plains All American, and Kinder Morgan, 2015
 Note: The map only illustrates principal crude oil pipeline infrastructure which leads to the Paso del Norte region

Table 1
Natural Gas Pipelines Projects in Northern Central Mexico

Pipeline	Company	Operational	Investment (USD Million)	Length (Miles)	CDMCF*
Guaymas - El Oro	IEnova	August 2016	429	203.8	500
El Encino - Topolobampo	TransCanada	October 2016	1,000	329.0	670
San Isidro - Samalayuca	IEnova	January 2017	200	14.3	1,135
El Encino - La Laguna	Fermaca	March 2017	1,290	262.0	1,500
Ojinaga - El Encino	IEnova	March 2017	509	127	1,350
Samalayuca - Sásabe	CFE	November 2017	1,260	403.9	472

*Total Capacity of Daily Million Cubic Feet

Source: Licitaciones Comisión Federal de Electricidad, 2016

The *Sistema Nacional de Gasoductos* (National Gas Pipeline System, SNG), owned by *Pemex Gas y Petroquímica Básica* (Pemex Basic Gas and Petrochemicals, Pemex Gas), currently accounts for most of Mexico's pipeline system and has a length of approximately 5,620 miles and an average capacity of approximately 5.06 Bcf per day.⁶¹ As part of the recent Energy Reform, the pipeline market is transitioning from governmental monopoly and concessions to open access and competition. Before, since 1995, private participation was limited to only one downstream activity at a time, transportation, storage, or distribution. Now, to the help realize the transition to greater natural gas powered electricity production, the Energy Reform has allowed for much greater levels of private participation in the exploration, extraction, transmission, and commercialization of natural gas. The first phase of this transition will expand preexisting pipeline systems, presently concentrated in the eastern and northeastern part of the country, to reach western and central Mexico through States such as Chihuahua, Durango, and Sonora.

Mexico's natural gas pipeline system will increase markedly in the following years from 7,790 miles in 2015 to 13,010 miles in 2019 (a 67% increase).⁶² In 2014, the *Programa Nacional de Infraestructura* (National Infrastructure Program,

PNI) set the objectives and plans for 18 new pipelines to transport natural gas across the country in an effort to avoid market and critical scarcity of natural gas.⁶³ The program draws upon funding from *Fondo Nacional de Infraestructura* (National Infrastructure Fund, FONADIN) to achieve these plans.⁶⁴ Most of this new infrastructure, recently or in the process of being built, is located in the Paso del Norte region, particularly in and through the State of Chihuahua (Table 1). And, as demand has grown for natural gas in Mexico, so have U.S. natural gas exports to Mexico, such that, U.S. now exports 75% of natural gas to Mexico, with nearly 79% of the total exported natural gas coming from Texas.⁶⁵ In 2015, the natural gas export facilities in El Paso and Clint, Texas, processed approximately 12.3% of total U.S. natural gas exports into Mexico.⁶⁶

For the States of Chihuahua and Durango, for example, the *Comisión Federal de Electricidad* (Federal Electricity Commission, CFE), Mexico's national electric utility, forecasts that by the end of 2028 the electric power plants located in those states will alone require 393,000 Mcf of natural gas per day.⁶⁷ Such requirements, as well as the State of Chihuahua's strategic position between Texas, northern Mexico, and the population centers and ports on the Pacific and Gulf Coasts have given rise to significant privately owned and operated gas

Map 2. Paso del Norte Natural Gas Pipeline Network



Source: Own map of major pipelines with information from the Energy Information Administration and the Comisión Reguladora de Energía, 2015

Note: The map shows the principal natural gas transmission network in the Paso del Norte region

pipelines in the state which now hosts several regional and cross-country networks. The *Gasoductos de Chihuahua* pipeline, with a 24-inch diameter and a length of 23.4 miles, imports natural gas into Mexico from the interconnection valve with EPNG in El Paso, Texas, and terminates at the *Samalayuca Power Plant* south of Ciudad Juárez. The *Gasoductos de Chihuahua* pipeline also connects to its natural gas compression station, *Gloria a Dios*, located approximately 22 miles south of Ciudad Juárez, with a transportation capacity of 100,000 Mcf per day. This station is then connected to the 16-inch SNG gas pipeline owned by *Pemex Gas y Petroquímica Básica*, which allows the transportation of natural gas to Encino, Chihuahua, where it is then distributed to Chihuahua City (Map 2).⁶⁸

Other pipelines extend from this and other border points to Chihuahua City to supply natural gas both regionally and nationally, such as the *Tarahumara*, *El Encino-Topolobampo*, *El Encino-La Laguna*, and SNG pipelines. The *Tarahumara* pipeline, owned by Fermaca Global, and having initiated operations in 2013, extends for 237 miles with a capacity of 850,000 Mcf per day. It transports natural gas from El Paso, Texas, to the municipality of El Encino, Chihuahua.⁶⁹ The *El Encino-Topolobampo* pipeline, owned by Transcanada, with a capacity of 670,000 Mcf per day, will extend for 329 miles from El Encino to the thermoelectric plant in Topolobampo on the Pacific Coast. It is set to begin operations in the latter part of 2016.⁷⁰ The *El Encino-La Laguna* pipeline, also owned by Fermaca Global, and set to start operations in 2017, extends for 262 miles with a capacity of 1.5 Bcf from the same point in El Encino, Chihuahua, to La Laguna in Durango, where it will be connected to the *Ojinaga-El Encino* pipeline that will transport natural gas from Texas.⁷¹

To further supply Mexico with natural gas imports from the U.S., the binational *Waha-Ojinaga-El Encino* pipeline transports natural gas from

just south of the Permian Basin, in Waha, Texas, to Ojinaga, Chihuahua, on the eastern border of the State of Chihuahua, with a length of 127 miles and a capacity of 1.35 Bcf per day.⁷² Another binational pipeline, the *Waha-Central Eléctrica Norte III*, also originates in Waha, Texas, and will terminate at the soon to be completed *Samalayuca III* electricity plant (operational in 2017), just south of Ciudad Juárez. The Waha to El Paso section of this pipeline, with a length of 180 miles and a capacity of 1.13 Bcf per day, owned and operated by Roadrunner Gas Transmission, is now complete.⁷³ The second section is divided into two 15-mile segments, one interconnecting to the *Corredor Chihuahua* pipeline and the other leading to the *Samalayuca III* electricity plant. Both sections will have a capacity of 1.13 Bcf per day and will be operational in 2017.⁷⁴

The oil and natural gas pipeline networks in the Paso del Norte region must comply with separate laws and various regulatory agencies of several jurisdictions.

Another major infrastructure project for natural gas transmission taking shape in the Paso del Norte region is the *Samalayuca-Sásabe* pipeline that will transport natural gas to the border city of Sásabe, Sonora, from its origin in Samalayuca, Chihuahua. This pipeline will have a capacity of 472,000 Mcf per day with a distance of 403 miles and will provide natural gas to CFE power plants in Chihuahua, Sonora, and other states in northwest Mexico.⁷⁵ This pipeline will also feed other strategic pipelines, including the *Sásabe-Guaymas* and *San Isidro-Samalayuca* pipelines, and will start transporting natural gas in the last quarter of 2017.⁷⁶

Transmission Regulatory Framework

The oil and natural gas pipeline networks in the Paso del Norte region must, like extractive activities, comply with the separate laws and various regulatory agencies of several jurisdictions. The U.S. and Mexico, at the state and federal level, have diverse agencies that regulate, for example, the environmental impact procedures, permitting, right-of-way, and the market impact of oil and gas pipeline networks. In both countries, two fundamental elements of pipeline development center on the permits to construct and operate the pipeline as well as the right-of-way the pipeline will require.

Usually, in all of the region's jurisdictions, compliance with environmental standards or an impact assessment process is a necessary prerequisite to the acquisition of a permit to build and operate an oil or natural gas pipeline. With respect to environmental and operational safety of pipelines on private or state land, Texas and New Mexico again have similar regulatory structures, and, as with extractive activities, both states have no generally applicable and specific environmental impact assessment process. Even so, the application of multiple safety, air, water, waste disposal, and zoning regulations, though, do serve to mitigate environmental impact. But, when the oil or natural gas pipeline is constructed on land held by the U.S. government, such as on BLM land, federal law will apply to the environmental impact process and to safety regulations. The National Environmental Protection Act requires federal agencies to follow an environmental review process of proposed oil and gas pipeline construction and operation.⁷⁷ For the construction and operation of interstate oil and gas pipelines, the Federal Energy Regulatory Commission (FERC) requires a thorough environmental review process that considers the ecological, cultural, and economic impact of the proposed project before granting a permit.

In Mexico, the federal government again exclusively governs the environmental impact assessment of pipeline construction and operation.⁷⁸ The environmental impact analysis regarding the construction of pipelines must be conducted according to the processes stipulated by the *Ley General de Equilibrio Ecológico y la Protección al Ambiente* (General Law of Ecological Equilibrium and Environmental Protection, LGEEPA).⁷⁹ This law requires that SEMARNAT acquire *Manifestaciones de Impacto Ambiental* (Environmental Impact Statements, MIA) from the developer in order to ascertain the impact of the project on a wide variety of areas, such as ecological, climatological, socio-economic, and even cultural conditions. The *Ley de Hidrocarburos* also independently requires a social impact analysis, a *Comprobante de Solicitud de Evaluación de Impacto Social* (Social Impact Evaluation, EIS), in addition to the environmental impact assessment.⁸⁰

The state agencies that then grant permits (certificates of convenience and necessity) for intrastate commerce in the Paso del Norte Region are the Railroad Commission of Texas (RRC) in Texas and the Public Regulation Commission (PRC) in New Mexico.⁸¹ But, with respect to interstate pipelines, U.S. federal law, through the Natural Gas Act, declares that because the business of transporting and selling of natural gas for ultimate distribution to the public is affected with a public interest, then federal regulation of oil and natural gas in interstate commerce is necessary.⁸² If the pipeline will cross state boundaries, a certificate of public convenience and necessity must be acquired from the FERC, the agency that regulates the transportation and sale of oil and gas in interstate commerce, as a prerequisite to the construction, extension, operation, or even acquisition of any facilities used for the interstate transportation of oil or gas.⁸³

The federal jurisdiction of the FERC also extends to the exporting of natural gas to a foreign country, such as Mexico, which is unlawful without its consent.⁸⁴ While no crude oil pipelines cross the U.S.-Mexico border, natural gas, on the other hand, has been routinely exported to Mexico through cross-border pipelines for many years, mostly through ones originating in Texas. When transporting natural gas across the U.S.-Mexico border, firms must comply with certain regulations established by both countries. In particular, the U.S. Natural Gas Act requires anyone who wishes to import or export natural gas to or from a foreign country to obtain authorization from the Office of Regulation and International Engagement in the U.S. Department of Energy, which grants two types of authorizations: short term (up to two years) and long term (more than two years).⁸⁵ Long-term authorizations are generally used when a company has a signed gas purchase or sales agreement or contract, a tolling agreement, or other agreement resulting in imports or exports of natural gas, for a period of time longer than two years.⁸⁶ The Federal Energy Regulatory Commission not only reviews and approves applications for the construction and operation of oil pipelines, but also regulates the rates charged by the private pipeline operators for transporting oil and natural gas by pipeline in order to ensure that the rates charged are just and reasonable.⁸⁷

In Texas, the Railroad Commission of Texas (RRC), through its Office of Pipeline Safety (OPS), regulates, inspects, and enforces all intrastate gas and liquid pipeline safety requirements.⁸⁸ In New Mexico, the Pipeline Safety Bureau (PSB) of the New Mexico Public Regulation Commission (PRC) is responsible for licensing oil and natural gas pipelines as well as investigating intrastate pipeline incidents and accidents.⁸⁹ The Bureau, like the Office of Pipeline Safety in Texas, is responsible for conducting safety compliance inspections and enforcing state and federal pipeline

safety regulations for intrastate gas and hazardous liquid pipeline facilities.⁹⁰

For interstate oil and natural gas pipelines in the U.S., their safety is governed by the Pipeline and Hazardous Materials Safety Administration (PHSMA) in the Department of Transportation, which has jurisdiction to prescribe and enforce safety standards for pipelines generally concerning their design and construction.⁹¹ But, the Department of Transportation's authority does not apply when the transportation is wholly within the state, and that state enforces its own safety standards.

In Mexico, the *Ley de Hidrocarburos*, as for the exploration and extraction of oil and gas reserves, also establishes regulatory structures for the transmission of oil and gas through pipeline networks.⁹² Permits for the storage, transmission, and sale of oil and gas are granted by the *Comisión Reguladora de Energía* (Energy Regulatory Commission, CRE).⁹³ The *Comisión Reguladora de Energía* grants permission for cross-border pipelines as well.⁹⁴ The *Ley de Hidrocarburos* created the *Centro Nacional de Control del Gas Natural* (National Center for Natural Gas Management, CENAGAS), which has a special jurisdiction to manage natural gas pipeline systems (formerly wholly owned and operated by *Pemex Gas y Petroquímica Básica*) and to ensure that the activities within this system are in compliance with the law.⁹⁵ It will coordinate the granting of new permits for private companies that win international or domestic tenders with the CRE for gas pipeline construction and operation.

The other fundamental element, the right-of-way, concerns the exercise of a property right to build and operate oil and natural gas pipelines, whether on private, state, or federal lands. This property right only provides a limited interest in that land, and does not transfer title or ownership. A right-of-way is but an easement, a tem-

porary burden upon the property that provides just enough space for the pipeline to cross and be maintained with minimal impact to the landowner's property. If the land required for the construction of an oil or gas pipeline is privately held, then the right-of-way must be acquired either through negotiations with the landowner or condemned through the exercise of the power of eminent domain, if the landowner is unwilling to accept the offer through negotiation. In Texas and New Mexico, a pipeline developer has the power to exercise eminent domain and condemn privately held land needed for a right-of-way.⁹⁶ On state public lands in Texas and New Mexico, only the state land commissioner has the authority to grant the required right-of-way.⁹⁷ On BLM lands, which are abundant in the New Mexico portion of the Paso del Norte region, the Secretary of the Interior grants the right-of-way for oil and gas pipelines.⁹⁸

Where property is required to build an oil or gas pipeline in Mexico, the *Ley de Hidrocarburos* also established the procedures for acquiring a right-of-way to build and operate a pipeline. In Mexican law, this right-of-way is known as a *servidumbre*, a legal servitude that places an encumbrance on a property for the benefit of another.⁹⁹ The law stipulates that the pipeline developer first negotiate with the property owner to achieve a settlement for the use of this property.¹⁰⁰ In cases where no agreement can be reached, this law grants the pipeline developer the right to proceed to court to have a *servidumbre*, and the requisite compensation owed to the landowner, to be declared administratively.¹⁰¹

B. Renewable Resources

The renewable energy resources located in the Paso del Norte region, particularly solar, wind, and geothermal, hold significant potential. The U.S. currently generates 11.1% of its total energy from renewable energy resources, and Mexico 7.6%, noticeably lower than the use of hydrocar-

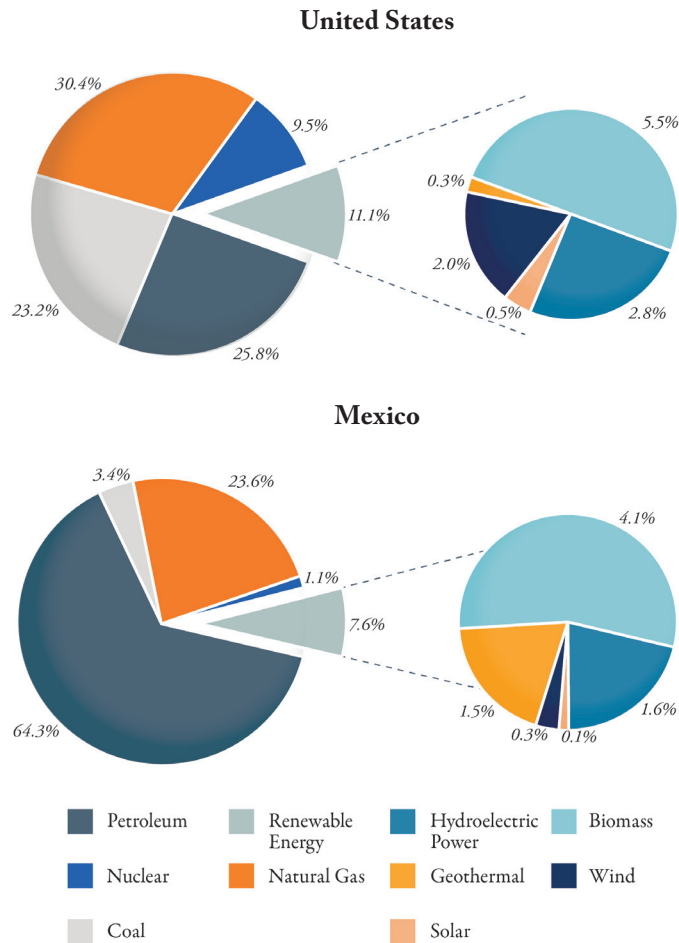
bons in both countries (Figure 1).¹⁰² While renewable sources are not presently a large share of the energy sources that the region utilizes, much like the U.S. and Mexico at the national levels, growth in the inclusion of these energy resources in generating electricity has grown substantially in recent years, and that trend is set to accelerate both regionally and binationally. Two principal reasons for this acceleration are the requirements to integrate more renewable energy sources into the grid, commonly known as Renewable Portfolio Standards (RPS), and financial and tax incentives to stimulate investment in renewable energy infrastructure. Much like the extraction and transmission of hydrocarbons, the harnessing and delivery of these renewable energy resources to the end user also must contend with the significantly divergent physical and regulatory infrastructure that converge in the Paso del Norte region.

1. Assets and Facilities

Solar

The U.S. and Mexico, and the Paso del Norte region in particular, have some of the most abundant solar resources in the world. Across the U.S., the annual average irradiation is 4.6 kWh/m² (kilowatt-hour/meter squared). Texas and New Mexico, though, have a comparative advantage with respect to the levels of solar irradiation, with average levels of 5.4 kWh/m² and 6.4 kWh/m², respectively. For El Paso and Las Cruces, the annual average irradiation is 6.6 kWh/m². In Mexico, the highest levels of solar irradiation are in the northwestern part of the country, with an annual average irradiation of 6 kWh/m².¹⁰³ The State of Chihuahua leads Mexico with an average solar irradiation of 6.27 kWh/m².¹⁰⁴ Similar to El Paso and Las Cruces, Ciudad Juárez possesses high levels of solar irradiation with an average of 6.7 kWh/m² (with a minimum of 5.9 kWh/m² and a maximum of 7.4 kWh/m²) (Map 3).¹⁰⁵

Figure 1
Energy Produced by Source in the U.S. and in Mexico



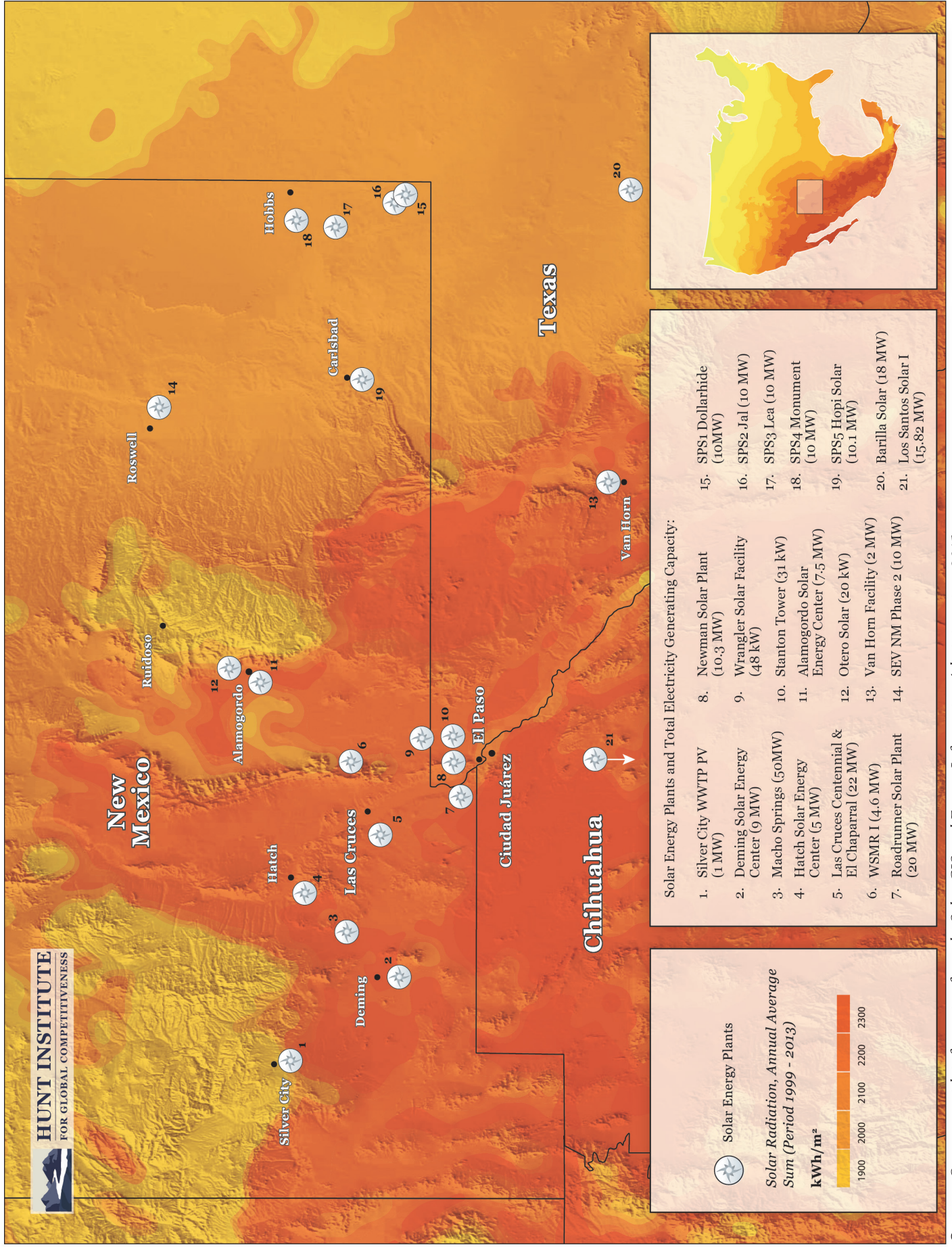
Source: *Energy Information Administration, 2014*

Solar energy markets are growing at an accelerated pace and electricity generated by this renewable energy resource is increasingly competitive. Since 2008, for example, solar energy output has grown seventeen-fold in the U.S., from 1.2 GW (gigawatt) to an estimated 20 GW in 2015—enough energy to power almost 4 million homes. With this expansion of scale, the costs associated with such infrastructure, and the price of the energy it generates, continue to decrease. In addition to the utility-scale solar infrastructure, the cost of distributed rooftop solar photovoltaic panels in 2014 was approximately 50% of what it was in 2011.¹⁰⁶ But, physical and market barriers and grid integration, specifically given the remote lo-

cation of the massive solar energy resources, continue to keep solar energy relatively expensive, especially when compared to energy produced by hydrocarbons.

Regionally, the States of Texas and New Mexico have been moving to take advantage of these resources and have seen an increase in the installed capacity of solar energy. Texas has 534 MW (megawatt) of solar energy generation capacity, ranking the state tenth nationally. In 2015, investments in solar installations in Texas totaled \$372 million among more than 445 solar companies.¹⁰⁷ New Mexico has also seen increased solar energy infrastructure. Its current installed

Map 3. Paso del Norte Solar Radiation



Source: Own map with information from the Solar GIS and Energy Information Administration, 2015

capacity is 365 MW, ranking twelfth nationally. In 2015, the investments in solar infrastructure in New Mexico totaled \$86 million among 102 companies.¹⁰⁸ Major solar energy projects are being encouraged for development by the federal government in New Mexico, though. The BLM has recently designated over 77,000 acres in Doña Ana County, just to the west of Las Cruces, as a Solar Energy Zone, known as the Afton SEZ, for streamlined regulatory approval and development, but has to date seen little activity.¹⁰⁹

El Paso Electric (EPE), the investor-owned electric utility servicing far west Texas and southern New Mexico, participates in the solar energy sector in Texas and New Mexico through the self-generation and purchased power. To begin, the utility achieves a generating capacity of approximately 260 MWh per year using its photovoltaic systems at the Newman and Rio Grande gas fired electricity plants.¹¹⁰ El Paso Electric also owns several other small solar energy generation facilities. The Wrangler Solar Facility in El Paso is a concentrated photovoltaic facility with a capacity of 48 kW that began commercial operation in October 2011 and generates approximately 128,000 kWh per year. The Stanton Tower Solar Installation, also in El Paso, came on line in 2012 and has a capacity of 31 kW, generating 67,471 kWh per year. Finally, the Van Horn Solar Facility, in service in 2013, has a capacity of 20 kW and generates 33,141 kWh per year (Map 3).¹¹¹

The solar energy portfolio of El Paso Electric, though, mostly derives from the purchase of solar energy from several other facilities in the Paso del Norte region. Its principal supplier is the Macho Springs Solar Facility, the largest solar facility in New Mexico, with a capacity of 50 MW that began commercial operation in May of 2014. Another central provider to EPE is the Roadrunner Solar Generating Facility, the second largest solar facility in New Mexico, with a capacity of 20

MW, beginning commercial operation in August of 2011. Several others that provide solar energy to EPE include the Las Cruces Centennial Solar Farm with a capacity of 12 MW, the El Chaparral Solar Farm with a capacity of a 10 MW, and the Hatch Solar Energy Center with a capacity of a 5 MW.¹¹² In 2015, the PSEG Solar Source opened the 13 MW solar energy facility in El Paso next to the Newman plant, the largest in the city.¹¹³

Other solar generating facilities in the region include two small-scale solar facilities. The White Sands Missile Range Solar Power System (WSMR) has a capacity of 4.6 MW and is operated by Siemens Government Technologies, Inc. The Deming Solar Energy Center has a capacity of 9 MW and is operated by First Solar Energy (Map 3).¹¹⁴

Mexico currently possesses little solar energy infrastructure with 64 MW of total installed capacity.¹¹⁵ Nevertheless, the Mexican government has ambitious plans to expand and expects to increase the use of solar power from 64 MW in 2014 to 627.5 MW by the end of 2018.¹¹⁶ Nevertheless, Mexico recently placed a 15% tariff on imported solar panels that could frustrate attempts to reach solar energy production targets.¹¹⁷ The State of Chihuahua is among several states in the initial phase of installing solar energy capacity. In 2014, the majority of Chihuahua's installed capacity for energy was dominated by fossil fuels (98.6%). The remaining (1.4%) included hydroelectric power and biogas. But, by the year 2020, solar energy projects in the State of Chihuahua are expected to increase solar energy production by more than 9%.¹¹⁸ One of those projects is the recently operational solar farm, *Los Santos Solar I*, a 15.82 MW solar facility in the municipality of Villa Ahumada, Chihuahua. This project obtained its certification in April 2015 and will provide electricity to an estimated 5,838 households.¹¹⁹ And, while Ciudad Juárez hosts a major SunEdison solar panel factory that annual-

ly exports 1.3 million solar panels to the U.S., the city generates very little solar energy.¹²⁰ A new solar energy infrastructure plan, managed by the *Comisión Reguladora de Energía* (Energy Regulatory Commission, CRE), to generate 188 MW for the city has recently been approved.¹²¹

Wind

In the U.S., Texas and New Mexico, like other plains states—such as North Dakota, Kansas, Montana, Nebraska, Wyoming, Oklahoma, Iowa, and South Dakota—all have excellent wind energy potential. Texas ranks first in the nation in wind energy production (and sixth globally), while New Mexico ranks 12th nationally.¹²² As of 2015, Mexico ranks 18th in the world in installed wind energy generating capacity. The highest amounts of wind energy sources in Mexico are present in the State of Oaxaca, located in the south of the country. In the Paso del Norte region, El Paso and Las Cruces have an annual average wind speed of approximately 4.8 m/s (meters per second) to 5.4 m/s.¹²³ The State of Chihuahua and Ciudad Juárez also possess significant wind potential (Map 4).¹²⁴

The U.S. is among the leading countries in the generation of wind energy, with an installed wind energy generating capacity of 74,472 MW. In the U.S., Texas leads wind energy generation with 17,713 MW of installed capacity from 116 wind projects.¹²⁵ The majority of the state's wind energy generating capacity (70%) is located in the west-central region, stretching from Abilene to Lubbock, and along the Gulf Coast (22%). The remaining (8%) lies in the northern part of the state near Amarillo. Wind energy accounts for 76% of Texas renewable energy consumption and for nearly 10% of the state's total wind energy production.¹²⁶ In 2005, the Public Utility Commission of Texas (PUCT) required that 5,880 MW, or about 5% of the state's electricity demand, come from renewable generation by 2015, and

10,000 MW by 2025. Texas met this requirement early, with wind energy production currently over 17,000 MW. Furthermore, Texas maintains 6 of the 10 largest wind farms in the nation.¹²⁷ The largest wind farm in Texas is the Roscoe Wind Farm, near Abilene, with a capacity of 781 MW.¹²⁸ By comparison, El Paso Electric's Hueco Mountain Wind Ranch consists of two 660 kW wind turbines.¹²⁹

New Mexico exhibits considerable potential for wind energy generation as well, and wind power currently contributes more than 6% of New Mexico's electricity generation.¹³⁰ New Mexico, like Texas, is among twelve states located in the middle of the country that collectively have 90% of the total commercial wind electricity potential in the United States.¹³¹ New Mexico, though, is just beginning to utilize wind energy with a total installed capacity of only 750 MW.¹³² The state has about a dozen commercial wind farms in operation, the largest of which is the New Mexico Wind Energy Center, located between Santa Rosa and Clovis, New Mexico with a capacity of 204 MW. The Public Service Company of New Mexico (PNM), an electric utility serving mostly the middle Rio Grande region, from Santa Fe to Albuquerque, as well as Deming, Lordsburg, and Silver City in the southwestern part of the state, purchases all of its generated electricity. Another major wind farm in the state is the San Juan Mesa Wind Project, also located near Clovis, with a capacity of 120 MW.¹³³ The Macho Springs Wind Power facility, located northeast of Deming in Luna County, New Mexico, has a capacity of 50 MW.¹³⁴

A significant ongoing project in New Mexico seeks to deploy wind energy from the eastern plains of New Mexico to consumers in Arizona and California. Those states have enacted strong RPS that require ever-greater incorporation of renewable energy sources into their grids. The SunZia Southwest Transportation Project involves

the construction, operation, and maintenance of two transmission lines beginning in Lincoln County, New Mexico, and eventually crossing over to the electricity grids in Arizona and California. The lines would extend 515 miles and could potentially provide anywhere from 3,000 to 4,500 MW of electricity. Operations are expected to begin in 2021.¹³⁵

Mexico utilizes considerably less wind energy facilities. Globally, Mexico ranks 24th worldwide, with an installed capacity of only 1,900 MW.¹³⁶ Nationally, the CRE has established an ambitious goal of creating 12 GW of installed capacity by 2020.¹³⁷ In an effort to reach this goal, the CRE has approved various projects with an authorized capacity of 3,339 MW. To date, though, and in spite of the wind energy potential in the State of Chihuahua, no major wind projects exist there.¹³⁸

Geothermal

Geothermal energy has been a small, yet consistent, source of electricity in both the U.S. and Mexico, mostly located near tectonic plates. Indeed, most of the geothermal energy produced in the U.S. and Mexico originates in Imperial Valley border region in southern California and northern Baja California.¹³⁹ But recent advances in technology have broadened the potential of geothermal resources in other areas. While the U.S. is already the world's leader in terms of total installed capacity for utilizing geothermal energy with 3.5 GW, the U.S. Geological Survey (USGS) has identified potential for geothermal energy production in 13 western states of up to 16,457 MW from known geothermal systems.¹⁴⁰ Since 2001, geothermal deposits have increasingly been confirmed in other western states, including New Mexico and Texas. The Paso del Norte region also has a strong base from which to produce geothermal energy, such as recent demonstration of a technically viable

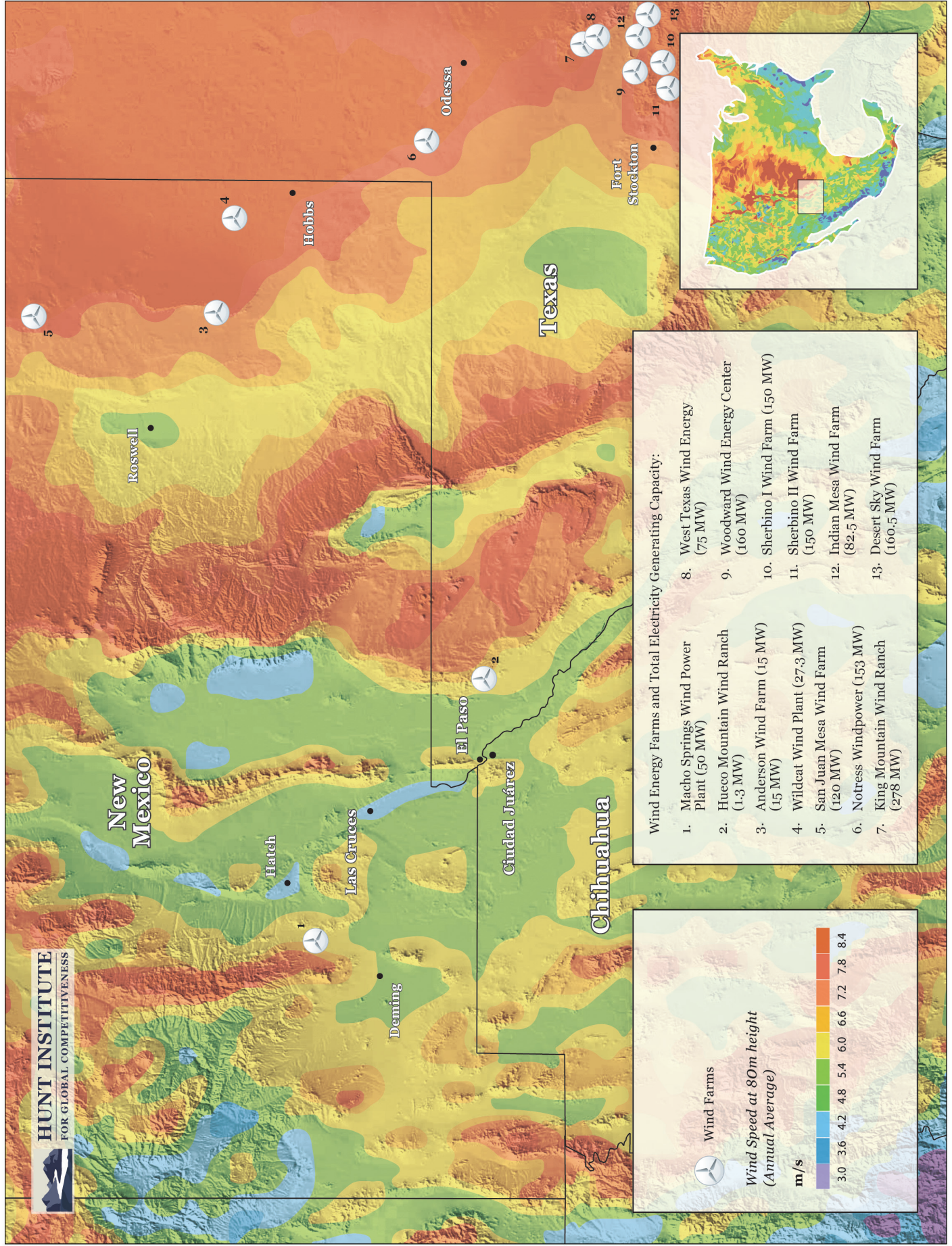
geothermal system on the Fort Bliss Military Base in El Paso County.¹⁴¹ Currently, though, only one active facility is present in the region (Map 5).

Texas has a strong advantage in geothermal energy. One such area is the tectonically active area of the Rio Grande Rift that begins in Colorado and continues southward through New Mexico and Texas along the Rio Grande and then terminating in the Big Bend region.¹⁴² Areas with geothermal resources potential can therefore be found in the Presidio Bolson, Hueco Bolson, and the Big Bend area. The Counties of El Paso, Culberson, Hudspeth, Jeff Davis, Presidio, and Brewster could potentially make use of geothermal resources.¹⁴³

Although geothermal energy only produced 0.1% of the state's total output of electricity, New Mexico contains, compared to other states, important geothermal resources.¹⁴⁴ These geothermal resources extend from the Arizona-New Mexico border to the Paso del Norte region.¹⁴⁵ The Dale Burgett Geothermal Plant in the Animas Valley near Lordsburg is representative of the installed capacity in New Mexico. This plant began providing electricity to the PNM in 2013 with a capacity of 4 MW.¹⁴⁶

Mexico is among the top five countries in the world utilizing or poised to employ geothermal energy generation with an installed capacity of approximately 823 MW.¹⁴⁷ The *Comisión Federal de Electricidad* has identified geothermal reservoirs in Mexicali, Baja California, to the south of Imperial Valley, which has Mexico's largest geothermal energy plant, *Cerro Prieto*. It is also the second largest geothermal plant in the world and maintains an installed capacity of 720 MW.¹⁴⁸ Mexico also has geothermal resources in the State of Chihuahua, particularly in the *Maguarichi* zone, located in the southwestern part of the state along the *Sierra Tarahumara*, and eight other states that could

Map 4. Paso del Norte Annual Average Wind Speed



Source: Own map with information from the Energy Information Administration and the International Renewable Energy Agency, 2015

potentially generate more than 5,691 MW.¹⁴⁹ Another area with geothermal resources in the state is San Antonio El Bravo, near Ojinaga, Chihuahua, with an average potential of 36 MW.¹⁵⁰

The *Comisión Federal de Electricidad* is set to increase its installed generation capacity by 17,092 MW between 2014 and 2020.¹⁵¹ New construction and upgrades associated with these generating capacity upgrades will account for 71% of the budget with wind power making up 14%, and the rest allocated to hydroelectric geothermal and gas turbine plants.¹⁵² Projects associated with this increase will require an estimated total investment of approximately \$45.8 billion.¹⁵³ In 2015, the SENER granted 13 permits to explore geothermal resources and five concessions to continue generating energy from certain fields in the States of Baja California, Baja California Sur, Puebla, and Michoacán.¹⁵⁴ And, in 2016, it granted three new exploration permits for sites in the States of Baja California, Guanajuato, and Jalisco.¹⁵⁵

2. Production and Transmission Frameworks

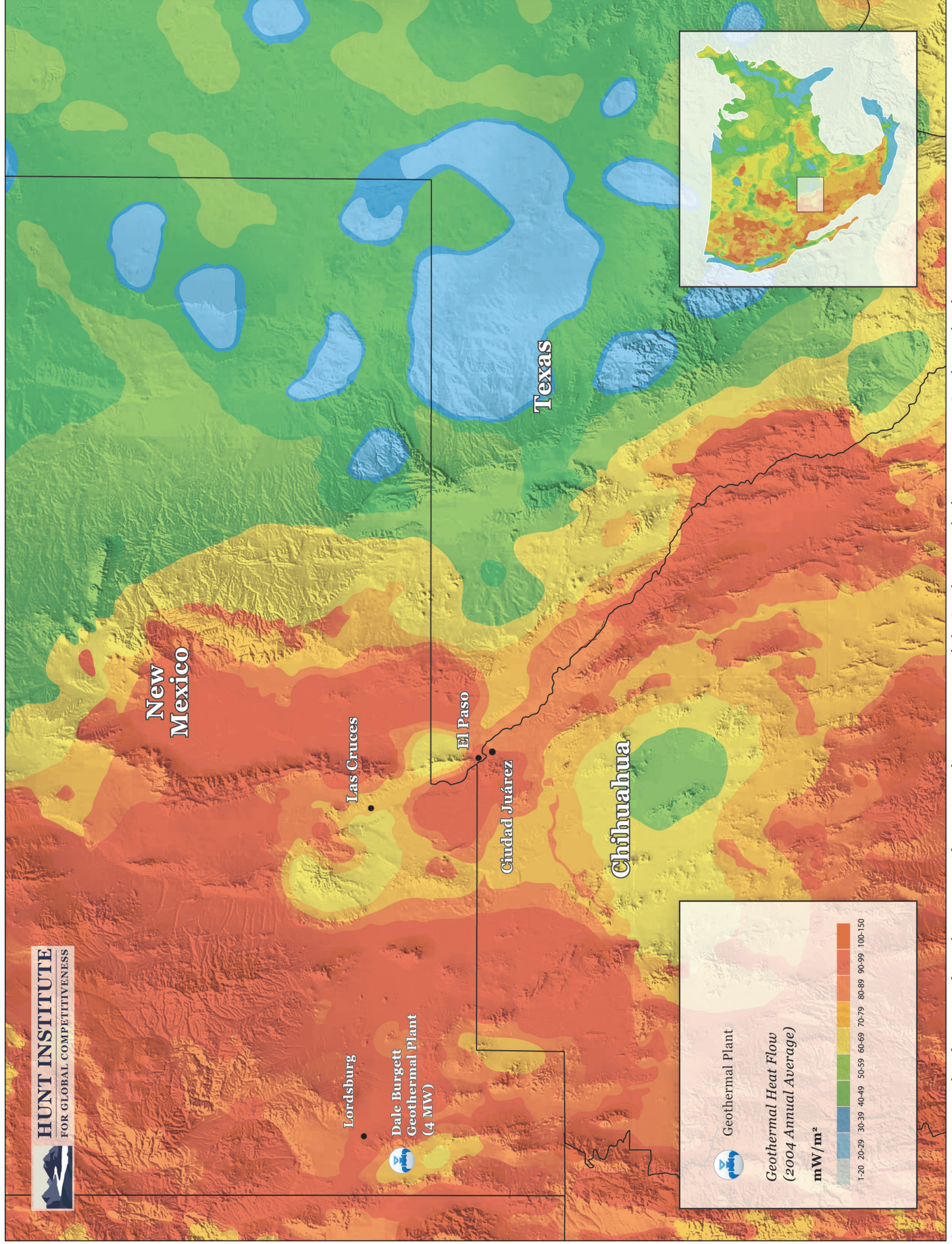
In the U.S. and Mexico, the local, state, and federal governments regulate varying aspects of the construction and operation of renewable energy generation and transmission facilities. The regulatory requirements and processes for the planning, construction, and operation of utility-scale and small-scale (distributed) renewable energy generating facilities and their transmission networks share similar regulatory processes that govern oil and gas extraction and transmission, described above. Four principal areas of concern for developing renewable energy generating facilities, whether for solar, wind, or geothermal power in the Paso del Norte region, are environmental impact analysis, permitting, and, for the transmission of the energy generated, acquiring the right-of-way and connecting to the electricity grid.

Geothermal energy, because it is generated from subsurface heat, has special laws that govern its development. Obtaining geothermal development rights in all jurisdictions of the Paso del Norte region is not unlike acquiring rights to oil and natural gas deposits. On private and state lands in Texas and New Mexico, statutes govern these rights, but what constitutes a geothermal resource varies between the states, creating a divergence in the regulatory agency responsible for its oversight.¹⁵⁶ On federal lands in the U.S., the federal government has its own legal structures governing the development of these resources depending on whether they are on BLM lands or even Military Bases, such as with the potential resources on Fort Bliss in El Paso County.¹⁵⁷ Geothermal projects, though, will require both the surface and the mineral rights (geothermal rights) to any land in order to access it and begin development.¹⁵⁸

There are two additional steps exclusive to the development of geothermal projects, the exploration and drilling and well development phase. In Texas, a drilling exploration permit from the Texas Railroad Commission (RRC) is necessary no matter who owns the surface or mineral rights. For the development of an existing well, no permit is required. If geothermal resources have already been discovered, then no application to prospect is required. The subsequent drilling and well development phase will require a drilling permit from the RRC regardless of who owns the surface and mineral rights to the land. In New Mexico, the Energy, Minerals, and Natural Resources Department (EMNRD) will provide the pre-drilling exploration and the drilling exploration permits necessary for geothermal projects.¹⁵⁹

In Mexico, geothermal deposits are, like hydrocarbons, property of the nation and exclusively governed by federal law.¹⁶⁰ Geothermal energy development is now, subsequent to the Energy Reform, regulated by a new law, the *Ley de Energía Geotérmica* (Geothermal Energy Law), that estab-

Map 5. Paso del Norte Geothermal Resources



Significant legal mandates and fiscal incentives at the federal and state levels in both the U.S. and Mexico have led to a dramatic increase in both utility-scale and small-scale renewable energy generation across the Paso del Norte region.

lishes procedures for the exploration and extraction of this resource in a manner similar to that of hydrocarbon resources.¹⁶¹

But, generally, all large, utility-scale renewable energy generation and distribution in Texas, New Mexico, and Mexico, require various permits and property rights similar for those governing hydrocarbon extraction and transmission. The generating facility and the transmission lines will generally need an environmental impact assessment, a permit of operation, and a right-of-way for the transmission lines. Small-scale, distributed generation in these same states is usually exempt from requiring an operating permit, an environmental impact statement, or a right-of-way. In the U.S., federal regulation also oversees developments on federal lands and interstate trade in electricity for those who send electricity across state lines, such as El Paso Electric.¹⁶²

Although no specific environmental impact procedure at the state level in Texas and New Mexico applies to utility-scale electricity generation and transmission, these activities, just like oil and gas extraction and transmission, must nevertheless comply with a multitude of air, water, waste, and zoning requirements. And, in addition to these regulations, Texas and New Mexico law require that the permitting agencies, the PUCT and the PRC, respectively, take into account the environmental impact that a proposed facility or transmission line would have.¹⁶³ Federal environmental impact requirements, established by the NEPA, frequently apply to generation and transmission of renewable energy sources in the Paso del Norte region given the presence of these resources

on BLM land in New Mexico and the presence of state and national boundaries that trigger federal reliability and market oversight when crossed—the same principle that triggers its oversight of the oil and gas pipeline transmission system. The transmission of electricity between countries, such as the U.S. and Mexico, is also subject to federal regulation for both siting and market oversight.¹⁶⁴ In Mexico, the environmental impact of generation and transmission is also overseen at the federal level, through the *Ley General del Equilibrio Ecológico y la Protección al Ambiente* (General Law of Ecological Equilibrium and Environmental Protection, LGEEPA) and the *Secretaría de Medio Ambiente y Recursos Naturales* (Secretariat of the Environment and Natural Resources, SEMARNAT). As with oil and gas extraction and transmission, the *Secretaría de Energía* (Energy Secretariat, SEN-ER) requires that no project commence until the *Evaluación de Impacto Social* (Social Impact Evaluation, EIS) has been submitted and reviewed.¹⁶⁵

In Texas and New Mexico, utility-scale renewable energy generation facilities and transmission lines cannot provide service unless their development would advance the accommodation, convenience, and safety of the public.¹⁶⁶ The Public Utility Commission of Texas and the PRC in New Mexico grant the certificate of convenience and necessity required for constructing and operating a utility-scale renewable energy facility and the associated transmission lines.¹⁶⁷ In order to connect to the grid, the PUCT requires, for electric utilities outside the ERCOT service area, such as El Paso Electric, a separate but related procedure.¹⁶⁸ In New Mexico, the construction of utility-scale renewable energy facilities to generate more than 300 MW of electricity as well as the construction

of transmission lines to operate at 230 kV or more need a location permit granted by the PRC.¹⁶⁹

Utility-scale renewable energy generating facilities in Mexico, with a power generating capacity equal to or greater than 500 kW are required to obtain a power generation permit from the CRE.¹⁷⁰ Connecting to the electricity grid will also require an interconnection agreement from Mexico's national electrical grid operator, the *Centro Nacional de Control de Energía* (CENACE), following the general conditions established by the CRE for these agreements.¹⁷¹

Under Texas and New Mexico law, electrical utilities and cooperatives can also exercise eminent domain as they build out transmission lines.¹⁷² Privately held land in these states is subject to the same consequences of being condemned to facilitate the construction of utility-scale renewable generation facilities and transmission lines as it is with oil and natural gas extraction and transmission. With respect to state public lands, the land commissioners in Texas and New Mexico grant applications for the required right-of-way. The same is true of the Secretary of the Interior with respect to BLM land. In Mexico, the federal law, the *Ley de la Industria Eléctrica* (Electricity Industry Law, LIE) creates a framework for the acquisition of land for utility-scale renewable generation and transmission lines, through negotiations or by use of eminent domain, mirroring the procedures set out in the *Ley de Hidrocarburos* concerning the construction of oil and gas pipelines.¹⁷³ If no land use agreement can be negotiated or agreed to, the developer may initiate a judicial process through which the requisite compensation can be determined and the land can be acquired by means of a *servidumbre*.¹⁷⁴

3. Market Incentives

Significant legal changes at the federal and state level in both the U.S. and Mexico have led to an increase in renewable energy use and will certainly generate even further development of these resources. Some of the market incentives come through mandates, such as limiting carbon emission under the Environmental Protection Agency's (EPA) finalized Clean Power Plan, designed to reduce greenhouse gas emissions from existing coal-fired plants to 30% of 2005 levels, or requiring certain amounts of renewable energy in a utility's portfolio. In the U.S., these renewable portfolio standards (RPS) exist only at the state level and vary between Texas and New Mexico. Mexico, on the other hand, has created federally mandated minimums of renewable energy generation. Other market incentives arise from favorable fiscal and governmental financing options. In the U.S., both the state and federal governments provide substantial tax rebates and credits as well as favorable financing mechanisms. Mexico offers far fewer fiscal and financial incentives.

Renewable Portfolio Standards

In the states that constitute the Paso del Norte region, laws have taken effect in recent years requiring ever-greater amounts of renewable energy sources in the electricity supply. In the U.S., these laws are commonly known as renewable portfolio standards (RPS) and are established at the state level, as is the case in Texas and New Mexico. While several national RPS proposals have made their way through the U.S. Congress, there is currently no federal RPS program in place.¹⁷⁵ The states, rather, have autonomy to develop their own RPS, and these standards can differ greatly.

The States of Texas and New Mexico have set ambitious goals concerning the incorporation of renewable energy as a source of electricity. In 1999, Texas adopted the Goals for Renewable Energy, a statewide RPS mandate that eventually set a target of 10,000 MW of new renewable energy capacity by 2025.¹⁷⁶ With over 12,000 MW of renewable energy generation capacity achieved by 2010, Texas reached its goal 15 years ahead of schedule.¹⁷⁷ Since 2004, New Mexico has required that all investor-owned utilities incorporate an increasingly certain share renewable energy sources in their total energy portfolio.¹⁷⁸ And, out of the renewable energy generated by the utility, 30% must come from wind, 20% from solar, 5% from other sources, and 3% distributed generation. By January of 2015, these utilities were supposed to have at least 15% renewable sources in their portfolios, and 20% by 2020.¹⁷⁹

In Texas, the same law that created the renewable energy standards also created the Renewable Energy Credit market, managed by ERCOT, to stimulate the production of renewable energy. Generators earn credit for each MWh generated from renewable sources, which can then be traded on the open market. In New Mexico, public utilities also have the option to satisfy their renewable energy portfolio standards by purchasing renewable energy certificates.¹⁸⁰ El Paso Electric has been purchasing renewable energy certificates from its New Mexico customers since 2010 and currently holds \$6,285,000 worth of certificates.¹⁸¹ The credits that El Paso Electric purchases help the utility comply with the New Mexico RPS while also providing a financial incentive for generators of distributed energy.

Unlike the U.S., Mexico's RPS are set at the federal level. No state can set its own requirements. The *Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética* (Law for Renewable Energy Utilization and Energy Transition Funding, LAER-

FTE), enacted in 2008, requires that the electricity industry incorporate 35% of renewable energy resources into their primary energy generating practices by the year 2024.¹⁸² In order to meet the goal of producing 35% of Mexico's energy from renewable sources by 2024, the Mexican government, through SENER, requires power producers to obtain *Certificados de Energía Limpia* (Clean Energy Certificates, CEL) and sets the rules for the auction of these clean energy certificates. The criteria to obtain a CEL are designed and implemented by SENER. The *Comisión Reguladora de Energía* will then issue the certificates and monitor compliance. Eventually, as the government requires more CELs, year after year, a market will develop that will in turn promote greater renewable energy production. Producers will have no CEL requirements until 2018.¹⁸³

In 2016, the *Centro Nacional de Control de Energía* (National Center for the Control of Energy, CENACE), the Mexican electrical grid operator, conducted an unprecedented auction in which long-term, 20-year, contracts to sell renewable energy to the grid were available to private producers, both foreign and domestic—the first time that a power contract was awarded to a producer other than the former monopoly, the CFE. Four foreign companies, Recurrent Energy, Enel Green Power, Sunpower Systems, Gestamp Wind, as well as three domestic companies, *Alten Energía Renovables*, *Parque Eólico Reynosa III*, and *Energía Renovable del Istmo II* were successful. These companies obtained the rights to sell 5,385 GWh of electricity annually over 15 years to the CFE, which also agreed to acquire more than 5.4 million 20-year tradable CELs. Out of the total energy awarded in this auction, 74% was for solar energy and the remaining 26% was for wind energy. These renewable energy projects will begin operating in 2018 and boost Mexico's electricity capacity by 1,720 MW.¹⁸⁴ The solar generating facilities will be located in the States of Aguascalientes, Coahuila, and Guanajuato, while the States of Tamaulipas and Zacatecas will host the wind farms.¹⁸⁵

The Border Environment Cooperation Commission and the North American Development Bank offer specific binational financing mechanisms for energy projects in the border region.

Tax Credits and Governmental Finance

One of the major market incentives for renewable energy generation nationally and regionally has been the U.S. federal Residential Renewable Energy Tax Credit, which has provided tax credits for a variety of renewable energy generation facilities, such as solar, wind, and geothermal.¹⁸⁶ Against taxes owed, the taxpayer can take as a credit 30% of the costs of the renewable energy generating facility under this program. A tax credit is a dollar for dollar reduction in the income taxes that the entity claiming the credit would otherwise pay the federal government. This program will expire for all renewable energy sources at the end of 2016, except for solar, which was extended to 2021.¹⁸⁷

Another federal tax credit program is the Renewable Electricity Production Tax Credit (PTC).¹⁸⁸ This tax credit program provides the taxpayer an inflation adjusted per kWh tax credit for electricity generated by a qualified source, such as solar, wind, and geothermal. The tax credit will expire for all renewable sources by the end of 2016, except for wind, which will continue to the end of 2019. The Business Energy Investment Tax Credit (ITC) is a corporate tax credit that provides tax credits based on the purchase price of a renewable energy generating facility.¹⁸⁹ While wind and solar receive the greatest rebate amount under this credit, at 30%, geothermal receives a rebate of 10%.¹⁹⁰

In addition to tax credits, various federal agencies have programs to provide favorable financing. For example, the U.S. Department of Energy has a loan program that finances solar, wind, and geothermal projects in a variety of sectors, whether for commercial, industrial, municipal, agricultural,

non-profit, academic, or governmental—state or municipal—purposes. Another, the Farm Security and Rural Investment Act of 2002 authorized \$115 million for the U.S. Department of Agriculture (USDA) to help farmers, ranchers, and rural small businesses, through favorable loan terms, guarantees, and other grants, to invest in renewable energy projects, including solar, wind, and geothermal generation. It will remain in effect until 2018.¹⁹¹

The federal government also provides favorable financing options through bonds. The Qualified Energy Conservation Bond (QECB) allows state, local, and tribal governments to borrow money without paying interest on those bonds for the development of solar, wind, and geothermal projects.¹⁹² In place of receiving an interest payment from the borrower, the bondholder receives a tax credit from the government for the value of the interest. Another, the Clean Renewable Energy Bonds (CREB) may be used by certain entities—also primarily in the public sector—to finance renewable energy projects. The list of qualifying projects is generally the same as that used for the federal Renewable Electricity Production Tax Credit (PTC). A Clean Renewable Energy Bond may be issued by electric cooperatives, government entities (states, counties, or cities), and by certain lenders. The bondholder here again receives federal tax credits in lieu of a portion of the interest, resulting in a lower effective interest rate for the borrower.¹⁹³

Binationally, the North American Free Trade Agreement (NAFTA) created two institutions that have facilitated the growth of renewable energy generation facilities along the U.S.-Mexico border, the Border Environment Cooperation

Commission (BECC) (*Comisión de Cooperación Ecológica Fronteriza*, COCEF) and the North American Development Bank (*Banco de Desarrollo de América del Norte*, NADB). The Border Environmental Cooperation Commission works to preserve, protect, and enhance the environment of the border region in order to advance the well-being of the people of the United States and Mexico by developing environmental infrastructure projects, such as renewable energy generation facilities. It coordinates between investors and localities, conducts financial feasibility and impact studies, and certifies projects to receive funding from the NADB.¹⁹⁴ The North American Development Bank, among other activities, provides financing, loans, and loan guarantees for these projects. Between 2011 and 2016, the NADB and the BECC financed over \$1.4 million worth of renewable energy generating facilities, with over 1,700 MW of capacity, in the border region. The Paso del Norte region hosts one of these projects, the *Santos Solar I* energy installation in Villa Ahumada, Chihuahua.

The States of Texas and New Mexico, like the federal government, have a wide variety of tax incentives and special legislative provisions aimed at stimulating the growth of electricity generation from renewable sources, both utility-scale and small-scale. Texas provides corporations the opportunity to deduct the cost of a solar or wind energy generating facility from their franchise tax (corporate income tax).¹⁹⁵ In addition, through its Solar Energy Devices Business Franchise Tax Exemption, Texas provides tax exemptions for all businesses engaged solely in the manufacturing, selling, or installing of solar or wind energy devices from paying the franchise tax.¹⁹⁶ The Renewable Energy Systems Property Tax Exemption allows property tax to be offset by the full amount of the property's increased appraised value resulting from the installation or construction of a solar or wind energy generating facility.¹⁹⁷

New Mexico offers many more tax credits for renewable energy generation than Texas, for individuals and corporations. The Renewable Energy Production Tax Credit provides individual and corporate taxpayers the opportunity to lower their tax liability through the production of the generation of renewable sources, particularly solar and wind.¹⁹⁸ But, if the renewable generation is from solar energy, the tax credit increases significantly.¹⁹⁹ The Geothermal Heat Pump Tax Credit, also available to individuals and corporations, allows a taxpayer who has installed a geothermal heat pump to deduct up to 30% of the purchase and installation cost, yet not to exceed \$9,000.²⁰⁰ Another program, the Solar Market Development Tax Credit, is a personal and business income tax credit of 10% of the purchase and installation costs of a solar photovoltaic system, again up to a limit of \$9,000.²⁰¹ The Property Tax Exemption for Residential Solar Systems permits residential property owners to discount the increase in value that results from the installation of solar energy systems from otherwise value from tax appraisal.²⁰²

Businesses in New Mexico also have several tax credit programs available to them. The Solar Energy Gross Receipts Tax Deduction allows revenue derived from the sale and installation of solar energy generating facilities to be deducted from the taxable amount of gross receipts tax, up to the whole amount of taxes owed by the company.²⁰³ This gross receipts deduction is also available when a business sells wind and solar systems, also up to the entire amount of tax owed.²⁰⁴ Under the Advanced Energy Gross Receipts Tax Credit program, a tax credit equal to 6% of the eligible generation plant costs and expenditures of a solar or geothermal facility producing over 1 MW may be deducted from gross receipts before the gross receipts tax is calculated.²⁰⁵ This tax credit is also available in the case of revenue generated from the lease or sale of goods or services in the construction

of a qualified generating facility.²⁰⁶ The Alternative Energy Product Manufacturers Tax Credit allows manufacturers of renewable energy generation systems, as well as fuel cells, to deduct up to 5% of qualified expenditures from their combined tax liabilities by fulfilling job creation requirements.²⁰⁷

The States of Texas and New Mexico have also passed legislation creating special entities and zones with mechanisms such as favorable financing and legal authority to stimulate the development of renewable energy generation and transmission. In Texas, the State Legislature, in 2005, mandated ambitious plans to develop transmission capacity to capitalize on and send remote renewable energy sources to population centers in the ERCOT service area, central and eastern Texas, and to help achieve the state's RPS. Texas now ranks number one in the nation for wind energy capacity.²⁰⁸ The success of the wind energy in Texas, due to the RPS, has even led to emerging constraints in transmission capacity. The Competitive Renewable Energy Zone (CREZ) transmission project in West Texas attempts to resolve these transmission capacity issues. The last 3,600 miles of the \$6.9 billion CREZ transmission lines were completed in December 2013, alleviating statewide east-west congestion.

New Mexico does not have a substantial mechanism like the CREZ that has yielded such a complex network of regulatory coordination and physical transmission lines, but it has established Renewable Energy Financing Districts and Solar Energy Improvement Special Assessments. The Renewable Energy Financing Districts authorize counties and municipalities to create such a district in order to provide favorable financing from the federal PACE funds to property owners within the district to install solar, wind, and geothermal renewable energy generating facilities.²⁰⁹ The Solar Energy Improvement Special Assessment authorizes a county to create a solar

energy improvement special assessment provision that establishes rules for certifying certain financial institutions as solar energy improvement financing institutions. This certification by the county allows the bank to provide up to 40% of the cost of solar energy generating facilities and for the loan to be repaid on a special property assessment with the bank maintaining a lien on the property until the loan is repaid.²¹⁰ The State of New Mexico, in 2007, also created the New Mexico Renewable Energy Transmission Authority (RETA) for the express purpose of providing transmission service for the export of the state's renewable energy generation.²¹¹ This state agency can, in the pursuit of greater transmission capacity, enter into agreements, exercise eminent domain to establish a right-of-way, and issue tax-exempt bonds.²¹²

New Mexico and Texas also have laws conferring certain rights for harvesting solar energy. Texas, in its Property Code, forbids Home Owner Associations from restricting the installation and use of solar panels.²¹³ New Mexico creates a far more expansive set of property rights in solar energy, as established in its Declaration of Solar Rights, allowing property owners to create transferable solar easements, based on prior appropriation, in order to maintain and protect access to solar energy.²¹⁴ Furthermore, New Mexico prohibits not only counties and municipalities from restricting a solar energy generating facility, but also any contractual or real property restrictions that would interfere with the rights established in the state's Declaration of Solar Rights.²¹⁵

In Mexico, far fewer options exist to stimulate renewable energy growth than in the U.S., Texas, or New Mexico. With respect to fiscal incentives, the Mexican federal government does offer a 100% deduction of the cost of renewable energy generation equipment, for solar, wind, or geothermal energy, in the *Ley del Impuesto Sobre la Renta* (Income Tax Law, ISR).²¹⁶ In the case of

a utility-scale energy generator that derives 90% of its income from the sale of renewable energy, the generator can deduct the depreciation of the generating facility assets, by 5% a year up to the full cost of the assets.²¹⁷ Regarding favorable governmental financing, fewer options exist to offset the cost of renewable energy generation facilities. Individuals and companies can access the *Fideicomiso para el Ahorro de Energía Eléctrica* (Trust for Electric Energy Savings, FIDE), though, for loans of up to \$15,150 for solar panels.²¹⁸ The *Secretaría de Energía*, SENER, established another financing program through the *Programa de Mejoramiento Integral Sustentable en Vivienda Existente* (Holistic Sustainability Improvement Program for Existing Residential Structures) to promote the use of clean and efficient energy resources, such as solar panels, in low income residential housing. For this program, *Nacional Financiera* (National Financial, NAFINSA), a governmental development bank, has approximately \$50 million to finance up to \$2,600 per household for the purchase of solar panels. The *Comisión Federal de Electricidad* then installs the solar panels and bills their account.²¹⁹

Net Metering

Another major market incentive that benefits the Paso del Norte region is net metering. Net metering is a system where customers who produce their own electricity, from the small-scale (distributed) generation of renewable sources, receive payment for surplus energy as it is transferred into the grid and sold to the utility company. The laws of Texas and New Mexico establish a customer's rights to engage in such production, set the rules for accessing the grid, and determine the rate of payment for the surplus electricity sold to the utility.²²⁰

El Paso Electric has offered net metering to its customers in its services area since 2011 and divides the process between generators of less than 10 kW, between 10 kW and 100 kW, and between 100

kW and 1,000 kW.²²¹ Because the EPE service area is spread across Texas and New Mexico, the laws and regulations differ according to the relevant jurisdiction. In Texas, the utility must purchase excess generation from the distributed renewable generator at a price determined by commission rule.²²² Within Texas, EPE pays for net excess generation at the utility's avoided cost rate and credits the value to future bills.²²³ In New Mexico, all utilities that the PRC regulates, including EPE, must offer net metering and purchase it at the utility's avoided cost.²²⁴ El Paso Electric's purchased power rate schedule in its New Mexico service area provides between \$0.02 and \$0.08 per kWh for residential and non-residential customers.²²⁵

In 2015, El Paso Electric, from its Texas service area, bought back a total of 494 MWh, which is a 110% increase compared to what it bought back in 2013. This surplus generated electricity came mostly from residential customers (70%). During the same time period, EPE bought back considerably more electricity in its New Mexico service area than it did in its Texas service area, with a total of 2,109 MWh (a 90.56% increase). Similar to Texas, the majority of this surplus electricity generated came from residential customers in New Mexico (over 90%).²²⁶

Mexican law also exempts small, distributed generators, those whose capacity is at 500 kW or less, from production permits otherwise required from utility-scale producers. The exempt generators can only sell their excess electricity to a supplier permitted to engage in the commercial sale of electricity to basic and qualified users.²²⁷ The terms of the sale of excess power generated by the small producer is determined by the CRE, which has created model contracts to facilitate such transactions, the *Convenio de Compraventa de Excedentes de Energía Eléctrica* (Contract for the Purchase and Sale of Excess Electric Energy).²²⁸ Within this contract, the CRE provides a complex series of formulas, rather than a fixed rate as in Texas and New Mexico, that deter-

mine the amount paid to these small-scale, exempt generators for surplus energy.²²⁹

C. Nuclear Resources

A major source of electricity in the Paso del Norte region is nuclear energy. While New Mexico and Chihuahua have no nuclear energy facilities, Texas has two, but they are located within the ERCOT grid near Dallas and Houston and do not deliver electricity to the WECC portion of the Paso del Norte region. The Palo Verde nuclear facility, the largest nuclear plant in the U.S., capable of

producing up to 3,990 MW of electricity and located in western Arizona, does provide significant amounts of electrical energy to southern California, Texas, New Mexico, and, in particular, the Paso del Norte region. El Paso Electric owns 15.8% of this plant and 47% of the electricity that EPE generates originates there.²³⁰ The Public Service Company of New Mexico (PNM), with service areas in Bernalillo, Sierra, Luna, and Grant Counties in New Mexico, is a 10.2% owner in the Palo Verde nuclear facility and receives approximately 17% of its total owned and leased generating capacity from this facility.²³¹

ENERGY MARKETS IN THE PASO DEL NORTE REGION

In the Paso del Norte region, the same multiplicity of jurisdictions that govern upstream hydrocarbon and renewable energy development also govern the midstream and downstream markets for gasoline, natural gas, and electricity. The U.S. and Mexican federal governments, and the state governments of Texas and New Mexico, all have divergent laws and regulatory mechanisms that govern the refining and commercialization of oil and natural gas as well as the generation and distribution of electricity. Consequently, the energy sector is supported by divergent infrastructure capacity and market constraints resulting in unequal costs in these markets.

For example, the infrastructure for and commercialization of hydrocarbons and electricity in Mexico was closed to private investment for decades, while such activities have been dominated almost exclusively by private concerns in Texas and New Mexico. The Energy Reform in Mexico has greatly opened these activities to private investment, and seen the emergence of new private infrastructure projects and service providers. Even so, the reach of private capital and what it can acquire has still been highly circumscribed. Another critical element that further separates these costs within the hydrocarbon and electricity markets in the Paso del Norte region is rate regulation. The federal governments of the U.S. and Mexico, each to varying degrees, oversee and approve certain rates charged for oil, natural gas, and electricity. The States of Texas and New Mexico regulate electricity rates in the Paso del Norte region, through their respective agencies, the Public Utility Commission of Texas (PUCT) and the New Mexico Public Regulation Commission (PRC), and consequently are not subject to open market competition. At the U.S. federal level, the Federal Energy Regulatory Commission (FERC)

regulates the prices charged for the transportation of oil and natural gas through interstate pipelines, as well as electricity rates in interstate transmission. Mexico has by far the most regulated market rates for hydrocarbons and electricity. Oil and natural gas prices are still set by the government and electricity rates are regulated for most users. But a new, limited wholesale market for large (qualified) users has come into effect with the Energy Reform. Finally, another important divergence in regulatory oversight concerns the reliability standards and operation of the major electricity grids that cover the U.S. and Mexico, all of which converge in the Paso del Norte region.

A. The Hydrocarbon Markets

1. Gasoline and Diesel Fuels

While not possessing any significant oil reserves itself, the Paso del Norte region, through its proximity to the Permian Basin and with its crude oil and gasoline pipeline infrastructure, is home to significant interstate, international, and intercontinental pipeline systems. In addition to facilitating the intercontinental energy trade in hydrocarbons, the Paso del Norte region is a significant regional crude and refined oil consumer in its own right. But, unlike natural gas, crude oil is not consumed in its natural form, and must be further refined into a number of products, such as gasoline and diesel fuels. The two main suppliers of crude oil to the region are Magellan Midstream Partners, which sends crude oil from Crane, Texas, and Kinder Morgan Energy Partners, from Scurry, Texas, to the Western Refining (WR) storage facility in El Paso.²³² Western Refining is the principal oil refiner for the Paso del Norte region and owns and operates a refinery in El Paso, Texas and another in Gallup, New Mexico. The Western Refining refinery in El Paso has a refining capacity of

Before refined gasoline and diesel fuels make their way to retail markets in the region, they must comply with quality standards that, for the sake of protecting the environment and public health, govern the composition of the fuels as well as the manner in which they are stored and sold.

131,000 barrels per day and the Gallup refinery has a capacity of 25,000 barrels per day, and each refinery makes up 53% and 10% of its total refining capacity, respectively (Map 6).²³³

Despite major global oil reserves, Mexico only possesses six refineries, none of which are remotely proximal to the Paso del Norte region, but found mostly along the Gulf Coast. The closest to the region, in Cadereyta, is located to the southeast, over the Sierra Madre Oriental, outside of Monterrey, Nuevo León. Because of this limited refining capacity, unable to meet market demands, Mexico imports substantial quantities of gasoline. For example, in 2015, Mexico imported from the U.S. 53.9% of its total gasoline needs.²³⁴ Ciudad Juárez, in particular, wholly depends on U.S. refineries to satisfy its gasoline demand. About half of the gasoline exported to Ciudad Juárez comes from the WR refinery in El Paso, which then sends this gasoline from El Paso through the Magellan Midstream Partners pipeline in the U.S. to the Pemex storage terminal in Ciudad Juárez, the *Terminal de Almacenamiento y Reparto* (Storage and Distribution Terminal, TAR).²³⁵

The other half of total gasoline that is exported to Ciudad Juárez comes from a variety of other U.S. refineries. These refineries send this gasoline to an 180,000 barrel storage facility in El Paso, and then through to Ciudad Juárez via two sections of pipeline that cross the U.S.-Mexico border. The first half, on the U.S. side of the border, is owned and operated by *P.M.I. Comercio Internacional* (PMI), the foreign subsidiary of the Mexican governmental oil company, *Petróleos Mexicanos* (Pemex). The second half of the pipeline, on the Mexican side, is owned and operated

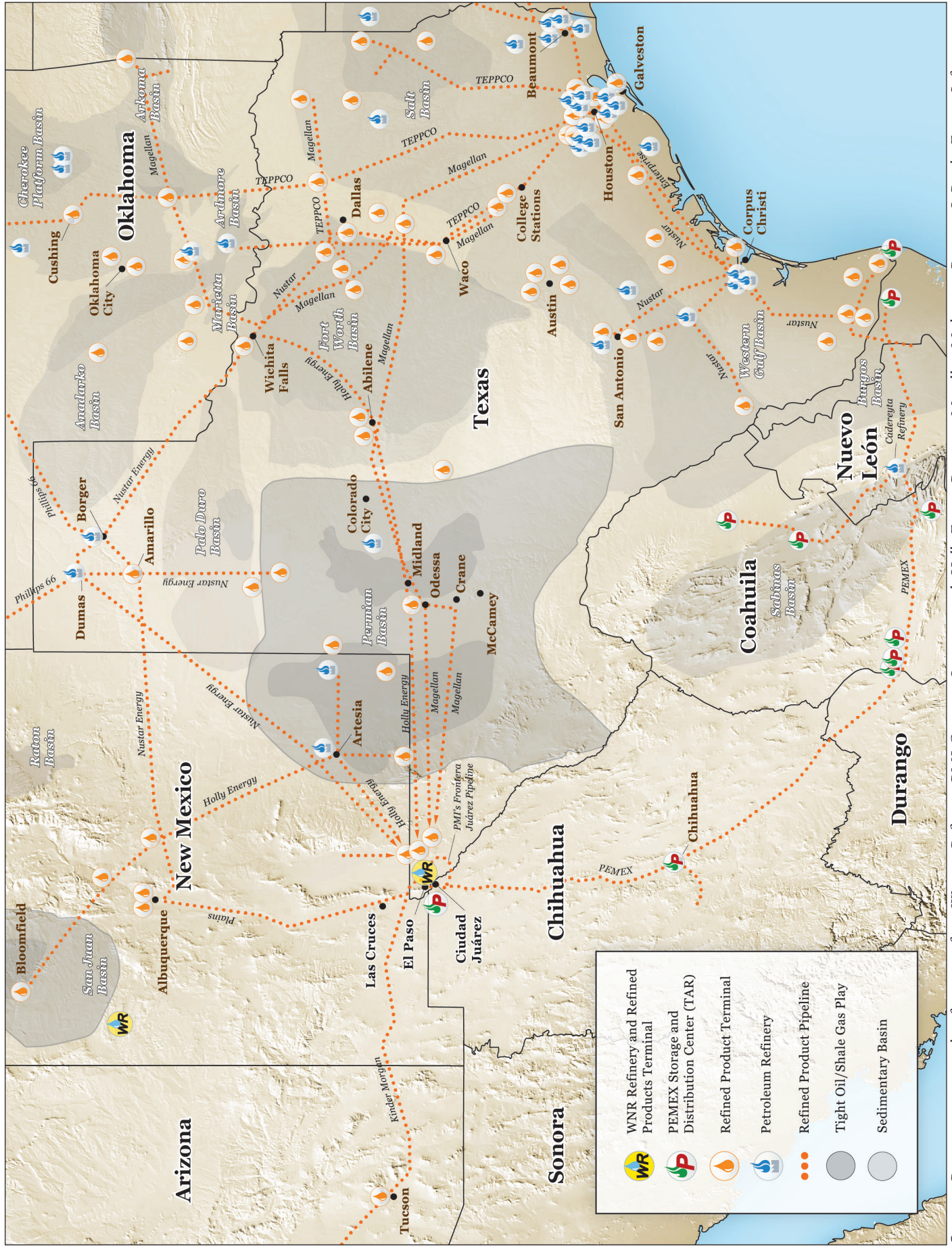
by the Pemex subsidiary, *Pemex Gas y Petroquímica Básica* (Pemex Basic Gas and Petrochemicals, Pemex Gas). These two halves of the *Frontera-Juárez* pipeline combine to send refined oil over 49 miles from PMI gasoline storage terminal in El Paso to the TAR in Ciudad Juárez.²³⁶

Fuel Quality Standards

Before these refined gasoline and diesel fuels make their way to the retail markets in the region, they must comply with regulations that, for the sake of protecting the environment and public health, govern the composition of the fuels as well as the manner in which they are handled and sold. One of the central areas of regulatory concern is air quality, which requires state and federal rules concerning the chemical content of diesel and gasoline, also known as fuel quality standards. In the U.S., the federal government, through the Clean Air Act of 1970 (CAA), empowers the Environmental Protection Agency (EPA) to enforce the regulatory standards for gasoline and diesel fuel quality for both on-road vehicles (such as cars, trucks, and tractor-trailers) and nonroad vehicles (such as diesel-powered locomotives).²³⁷ The various states, like Texas and New Mexico, often create their own additional fuel quality standards to supplement the federal regulations to address local and seasonal needs. In Mexico, the regulation of fuel quality for these vehicles also occurs only at the federal level, through the *Comisión Reguladora de Energía* (Energy Regulatory Commission, CRE).

One of the central goals of the fuel quality regulations for both the U.S. and Mexico, who have similar but varying structures, is to limit sulfur and carbon monoxide (CO) emissions gener-

Map 6 Paso del Norte Refined Oil Infrastructure



	WNR Refinery and Refined Products Terminal
	PEMEX Storage and Distribution Center (TAR)
	Refined Product Terminal
	Petroleum Refinery
	Refined Product Pipeline
	Tight Oil/Shale Gas Play
	Sedimentary Basin

Source: Proprietary map with information from Western Refining, PMI Comercio Internacional, Holly Energy Partners, Magellan Midstream Partners L.P., the Energy Information Administration, Plains All American, and Kinder Morgan, 2015

ated by both gasoline and diesel used in on-road and nonroad vehicles. For gasoline used in cars and light trucks in the U.S., the EPA requires, through its Tier 3 Gasoline Sulfur Program, that gasoline have a sulfur content that does not exceed 10 ppm (parts per million) by 2017.²³⁸ For on-road vehicles that use diesel (e.g., tractor-trailers) and nonroad diesel vehicles (e.g., diesel locomotives), the EPA requires, as of 2014, the use of Ultra Low Sulfur Diesel (ULSD), a grade of fuel with less than 15 ppm.

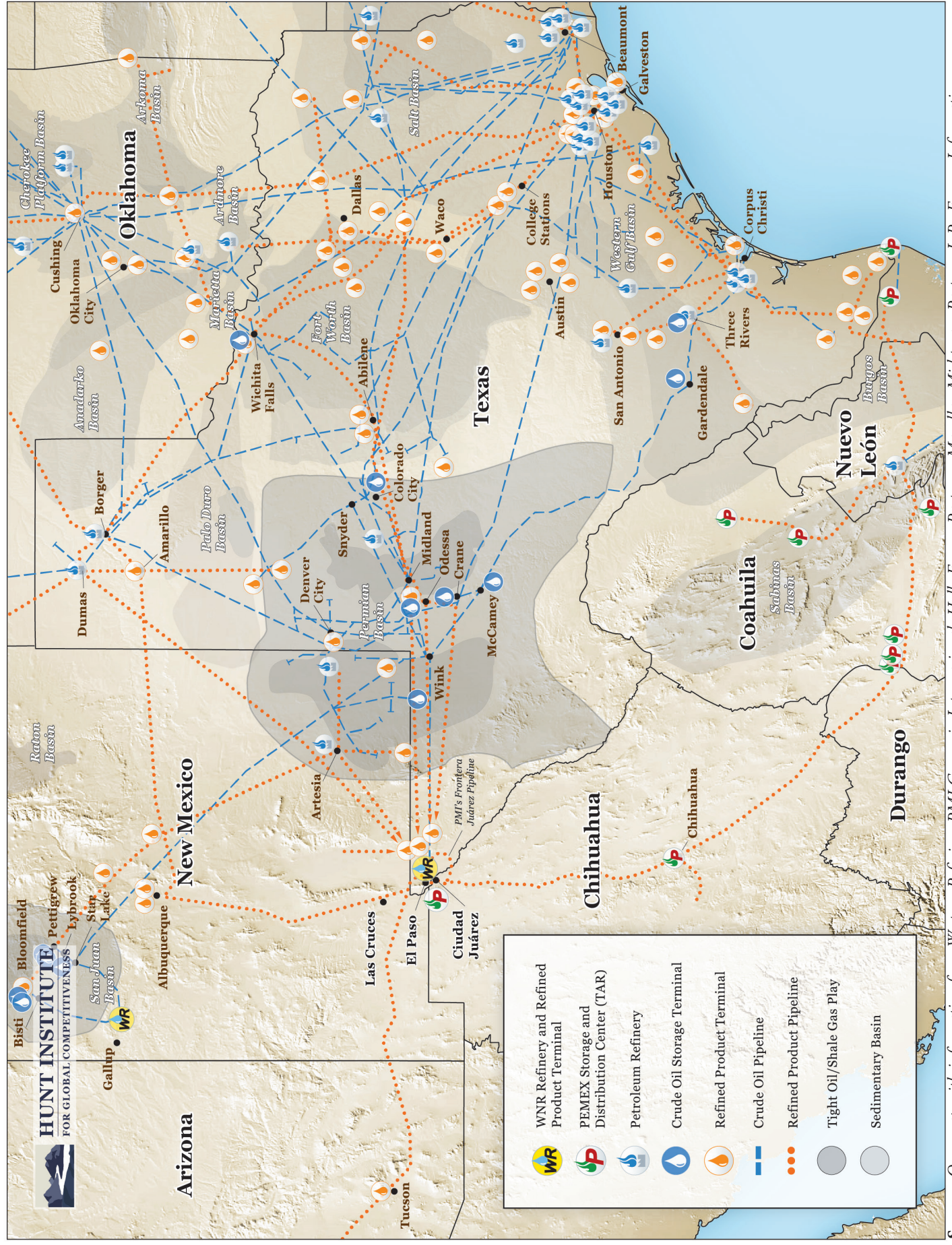
In Mexico, the CRE most recently finalized, in 2015, the sulfur and oxygen content in gasoline and diesel fuels.²³⁹ For gasoline, this regulation requires that gasoline have a maximum sulfur content of 80 ppm, significantly higher than the limit required by the EPA.²⁴⁰ With respect to automotive diesel fuel sold in Mexico, it may not have a sulfur content of greater than 500 ppm, except for the *Zona Fronteriza Norte* (Northern Border Zone, ZFN).²⁴¹ In this zone, which includes the northern municipalities in the State of Chihuahua (including Ciudad Juárez, Villa Ahumada, Ascensión, Casas Grandes, Janos, Nuevo Casas Grandes, and Praxedis Guerrero), a stricter limit of 15 ppm applies, known in Mexico as *Diésel de Ultra Bajo Azufre* (DUBA), the same for ULSD in the U.S.²⁴² Nevertheless, because Mexican oil is high in sulfur content and must already be exported to the U.S. to be refined, these new fuel quality regulations could lead to market constraints due to limited refining capacity in Mexico.

In addition to requiring limits to the sulfur content in gasoline and diesel fuels, the governments of the Paso del Norte region also set standards for the oxygenation of gasoline. Chemically, oxygenated fuel is standard gasoline blended with an oxygenate such as ethanol, methanol, MTBE, ETBE, or TAME, so that a minimum content of 2.7% oxygen by weight is attained in order to reduce carbon monoxide (CO) emissions in winter

months. Often, in order to reduce these emissions and meet the air quality standards under the Clean Air Act, states, such as New Mexico and Texas, must establish rules regarding the incorporation of fuel additives to increase their oxygen content. In Texas, the Commission on Environmental Quality (TCEQ) sets standards for fuel quality, such as oxygenation sulfur content in diesel fuels (TxLED program). Even so, these standards do not apply simultaneously to the whole state, but rather apply to certain cities for a few months of the year, generally the winter months. In the Paso del Norte region, the TCEQ, in 1992, established the El Paso's Oxygenated Fuels Program to ensure that the county did not exceed federal CO limits. Gasoline sold in El Paso County, between October and March of each year, must have a minimum oxygen content of 2.7% oxygen by weight. Currently, ethanol is the primary oxygenate utilized. To monitor and ensure that gasoline and diesel fuels comply with these TCEQ sulfur, oxygenate, and other standards, the state relies on the Texas Department of Agriculture's Fuel Quality Program.²⁴³

Similar to Texas, the Oil Conservation Division (OCD) of the New Mexico Energy, Minerals, and Natural Resources Department (NMEM-NRD) does require a minimum oxygen content of 2.7% by weight, but only for the City of Albuquerque and Bernalillo County during the winter.²⁴⁴ This requirement is limited to that region and does not apply to the New Mexico communities in the Paso del Norte region, such as Doña Ana, Luna, and Otero Counties. The New Mexico Department of Agriculture (NMDA) in collaboration with New Mexico State University (NMSU), in Las Cruces, tests and enforces fuels standards through its Oil Standards Bureau (OSB). In Mexico, the CRE has full power to create and enforce rules governing all fuel standards.²⁴⁵ In particular, and to a similar extent as with Texas and New Mexico regulations, the CRE regulations also govern the oxygenation of gasoline, allowing the use of MTBE, ETBE, and

Map 7 Paso del Norte Crude and Refined Oil Infrastructure



Source: Own map with information from Western Refining, PMI Comercio Internacional, Holly Energy Partners, Magellan Midstream Partners L.P., Energy Information Administration, Plains All American, and Kinder Morgan, 2015

Note: Only strategic refined product pipeline infrastructure, which leads to the Paso del Norte region, was illustrated in this map

TAME as additives, up to a maximum of 2.7% oxygen by weight. This standard applies to all producers, importers, storage service providers, transporters, distributors, marketers, and retailers in the country.

Gasoline Price Structures

Gasoline and diesel fuels, compliant with these federal and state standards, are then sold to the retail consumer by gas stations throughout the Paso del Norte region. In the U.S., these gas stations are privately owned and operated, and set their prices through market conditions and competition. Unlike the U.S., though, where competitive markets determine retail gasoline prices, Mexico sets its gasoline and diesel fuel prices through the *Secretaría de Hacienda y Crédito Público* (Finance Secretariat, SHCP).²⁴⁶ Due to these differing price structures in the U.S. and Mexico, border consumers historically paid lower gasoline prices on either the U.S. or Mexican side for many years, frequently resulting in the loss of revenue to Mexican border gasoline stations. To mitigate the negative impacts of this price arbitrage on Mexican gas station operators, the SHCP introduced, in 1991, a gasoline price harmonization program in the northern Mexican border to mirror the gasoline prices of neighboring U.S. border cities. The program included six northern border zones delimited by kilometer increments parallel to the U.S.-Mexico border, in which the price of gasoline would increase according to these increments until reaching the 45-kilometer limit, where gasoline prices matched those in the rest of Mexico.

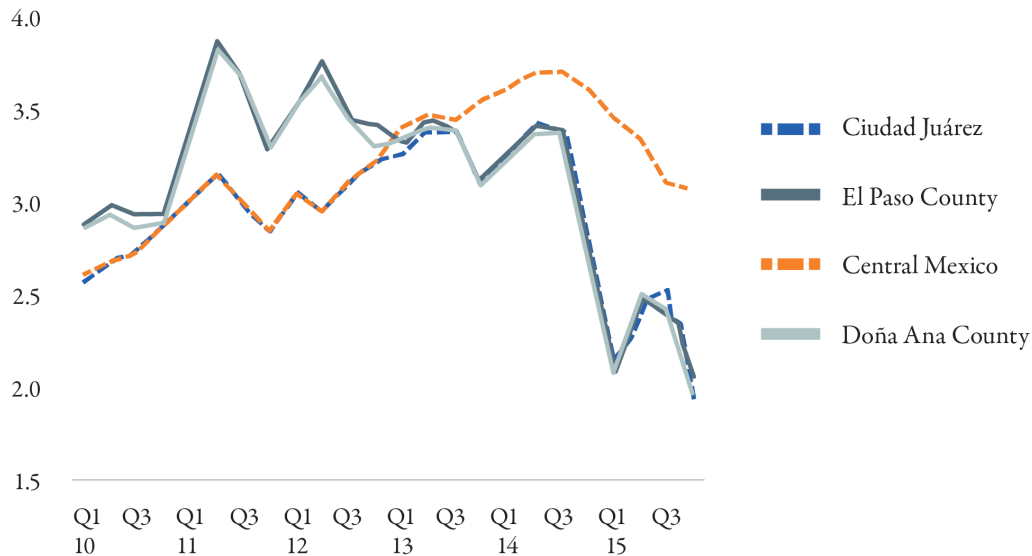
The program was not wholly successful and the SHCP struggled for years to find adequate pricing structures for the northern Mexican border. The *Secretaría de Hacienda y Crédito Público* then introduced a price ceiling into the harmonization gasoline price program to alleviate the burden on Mexican border

consumers whenever the retail gasoline prices in the U.S. were more expensive than those in the rest of Mexico. Currently, in the Mexican northern border zones, the SHCP adjusts retail gasoline prices every Tuesday for regular Magna grade gasoline in order to match the average weekly price for unleaded gasoline in the neighboring, U.S. border city.

Gasoline prices in Ciudad Juárez are set by the federal government to mirror the prices in El Paso, Texas.

The operation of a gas station in the Paso del Norte region also requires compliance with separate state and federal agencies. In the U.S., a gas station owner must comply with regulations that govern underground gasoline storage tanks at both the federal and state level. At the federal level, the EPA mandates that the tank have proper spill and corrosion protection, a leak detection system, and that the tank owner has sufficient insurance for any financial liability resulting from any damages the tank causes.²⁴⁷ In Texas, the TCEQ regulations governing gas stations also require compliance with provisions concerning waste management, air and water quality, and underground storage tanks, among others.²⁴⁸ In New Mexico, the Environmental Improvement Board (EIB), part of the New Mexico Environment Department (NMED), has similar regulations to those of Texas for the maintenance of underground storage tanks.²⁴⁹ The states of Texas and New Mexico also have agencies that test and measure the fuel products to ensure compliance with environmental protection standards as well as accurate weights and measures, to protect the integrity of the market. The Fuel Quality Program in Texas and the Oil Standards Bureau in New Mexico enforce quality standards (e.g., sulfur content and oxygenates) and the accuracy of the fuel pumps. These agencies also test to make sure that the octane levels of the gasoline (85, 87/88, and 91) match those posted for sale.

Figure 2
Average Regular Grade Real Price*
(USD per Gallon)



* U.S. CPI December 2015 = 100

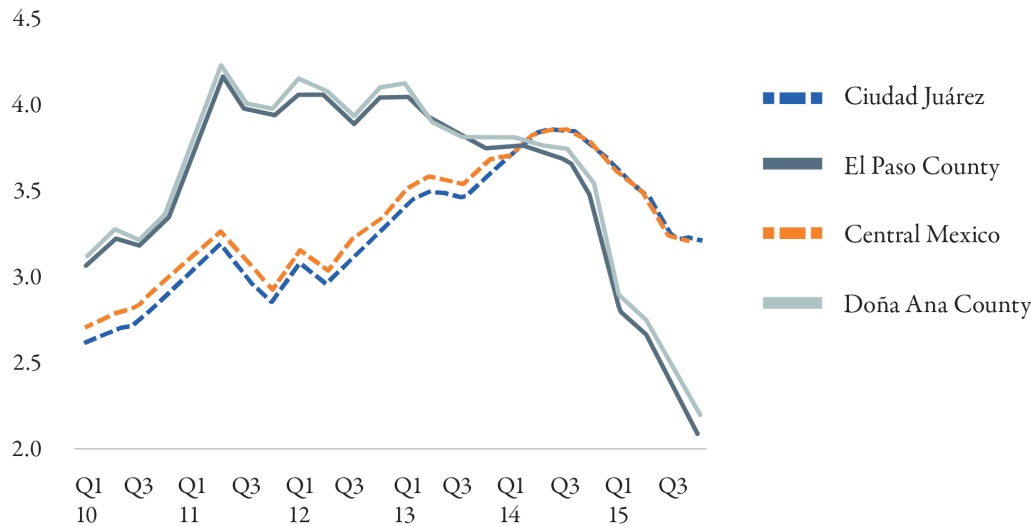
Source: GassBuddy, ONEXPO, and Pemex

In Mexico, the commercialization of gasoline and diesel had been, for decades, exclusively exercised by Pemex, the state-owned oil company, and all gas stations were but independently operated franchises. As of April 2016, this commercial exclusivity has ended and private companies and actors can compete directly against Pemex and its franchises.²⁵⁰ The CRE grants permission to open a gas station in Mexico and enforces technical and environmental standards concerning storage, distribution, and sales of gasoline and diesel.²⁵¹ The *Procuraduría Federal del Consumidor* (Federal Consumer Protection Bureau, PROFECO) ensures that the volumes posted and the octane levels that are sold are accurate.²⁵² In Mexico, two octane grades are available, regular grade, known as Magna at 87 octane, and premium grade, Magna Premium, at 92 octane. In Ciudad Juárez, though, Magna Premium is actually 91 octane, as its gasoline comes from U.S. refineries.²⁵³

The effects of the imbalance in infrastructure and regulatory mandates in the Paso del Norte region are visible in the prices of gasoline and diesel. From the beginning of 2010 to the beginning of 2013, Ciudad Juárez prices mirrored those of central Mexico, given that the gasoline prices in its neighboring city of El Paso were higher. Once central Mexico's gasoline prices were higher than those of El Paso, gasoline prices in Ciudad Juárez mirrored those of El Paso (Figure 2). Diesel fuel prices in Ciudad Juárez only mirror those in central Mexico and are thus higher than those in El Paso (Figure 3).

In 2015, total Magna grade gasoline sales in Ciudad Juárez reached approximately 191 million gallons. This volume is above the sales volume of other northern Mexican border cities with Texas, such as Reynosa and Nuevo Laredo, which sold 180 and 66 million gallons, respectively. But,

Figure 3
Average Diesel Grade Real Price*
(USD per Gallon)



* U.S. CPI December 2015 = 100

Source: GassBuddy, ONEXPO, and Pemex

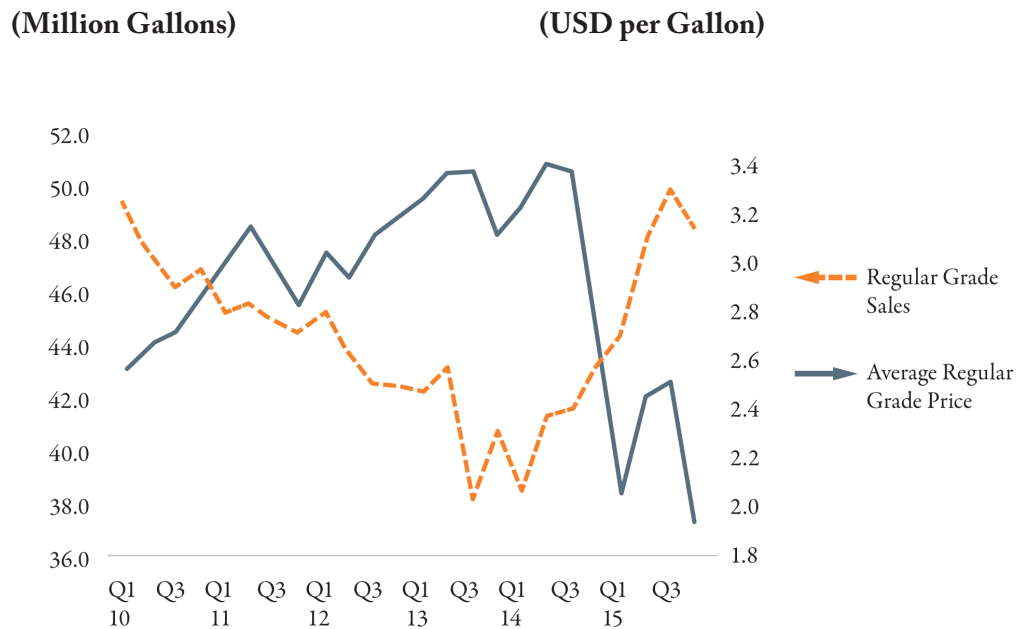
total Magna sales have steadily decreased in Ciudad Juárez from 2010 to 2013 (Figure 4). Once the average regular grade gasoline price fell, this trend reversed.

2. Natural Gas

In the U.S., electricity generation, as of 2007, has become the primary consumer of natural gas, having overtaken industrial use.²⁵⁴ And, Mexico’s largest consumer of natural gas is also electricity generation, and this consumption should increase greatly as the Energy Reform stimulate the use of natural gas in electricity generating facilities.²⁵⁵ Natural gas markets in the U.S. and Mexico, and particularly so in the Paso del Norte region, are composed of a series of regional supply and distribution centers which then, in turn, function as points of sale. A natural gas hub, where

natural gas is bought and sold, is found where two or more pipelines interconnect. One of the most well-known hubs is the Henry Hub terminal in Erath, Louisiana, on the Gulf Coast, which sets the benchmark price for U.S. natural gas markets. The importance of the Henry Hub, and its benchmark status, derives from the strategic connections it has to 12 other pipelines, most of which transport natural gas to the critical markets in the Midwest, Southeast, and Northeast.²⁵⁶ The price set at this hub has become an international reference point for futures contracts and other financial transactions involving natural gas. In fact, Mexico sets its regulated domestic gas price to the price at the Henry Hub. Other regional distribution centers, such as the Waha Hub in Texas and the El Paso Permian and El Paso San Juan Hubs in New Mexico, also function to set the price regionally.

Figure 4
Ciudad Juárez Regular Grade Sales* and Average Real Price



* Seasonally adjusted

Source: Pemex

In the U.S., natural gas prices are the result of generally open market competition. One of the few areas which see governmental oversight of market pricing of hydrocarbons is in interstate commerce. This oversight is exercised, not at the state level, but by FERC at the federal level. The FERC has the power, in order to prevent natural gas (and oil) transmission monopolies, to establish interstate transmission rates. In Mexico, the CRE establishes a nationally uniform method for calculating natural gas prices in Mexico.²⁵⁷ This method incorporates the Henry Hub natural gas spot price as a benchmark, the costs of transporting natural gas from Texas to the border, and other transportation costs associated with domestic transportation in Mexico.²⁵⁸ The *Comisión Federal de Competencia* (Federal Competition Commission, COFECO) then revises that price to ensure it is reasonable and fair throughout the country.²⁵⁹

From these hubs in the U.S., the pipeline company transports the natural gas through high pressure pipelines and resells it to a local distribution company. The Paso del Norte market is served by three natural gas distribution companies, Texas Gas Service, Zia Natural Gas Company, and Gas Natural de Juárez. Texas Gas Service is a division of ONE Gas, a publically traded company, founded in 1906 in Oklahoma, with 800 employees.²⁶⁰ Texas Gas is the third largest natural gas distribution company in Texas, providing service to the El Paso, Odessa, Midland, Amarillo, Dallas, Austin, and Brownsville metropolitan areas and has approximately 644,000 customers.²⁶¹ The Zia Natural Gas Company, a privately held company with 55 employees and headquartered in Ruidoso Downs, New Mexico, provides service to 35,000 customers in Doña Ana, Lea, Colfax, and Lincoln Counties.²⁶² *Gas Natural de Juárez* pro-

Table 2
Paso del Norte Real Average Monthly Cost of Natural Gas (USD)

Provider	Year	Residential @ 6 Mcf	Commercial @ 30 Mcf	Industrial @ 300 Mcf
Texas Gas Service	2011	46.6	194.3	1,838.4
	2012	39.4	158.0	1,481.6
	2013	43.5	176.1	1,761.9
	2014	49.9	206.7	1,987.4
	2015	42.8	168.9	1,619.7
Gas Natural de Juárez	2011	71.1	510.1	1,740.6
	2012	67.4	482.2	1,642.8
	2013	65.9	471.5	1,605.9
	2014	62.3	446.8	1,524.6
	2015	51.1	366.8	1,251.7
Zia Natural Gas Company	2011	40.9	161.8	1,498.9
	2012	34.9	132.6	1,209.8
	2013	36.7	142.5	1,310.5
	2014	54.9	234.2	2,228.8
	2015	45.6	187.8	1,764.8

*Average September 2016 FIX exchange rate used for Ciudad Juárez. September 2016 = 100
Source: Texas Gas Service, DOF, and the New Mexico Public Regulation Commission, 2016

vides natural gas to Ciudad Juárez and has approximately 400 employees and more than 235,000 customers.²⁶³

Estimating average residential consumption of 6 Mcf per month, the gas sold by *Gas Natural de Juárez* is more expensive (excluding taxes) than Texas Gas Service and Zia Natural Gas Company. In the case of the commercial sector, the data illustrate a higher cost for Mexican consumers compared to U.S. consumers. Assuming an average monthly consumption of 30 Mcf, *Gas Natural de Juárez* is also more expensive than Texas Gas Service and Zia Natural Gas Company. Finally, the average price at 300 Mcf per month for the industrial sector exhibits that Texas Gas Service is slightly more expensive than *Gas Natural de Juárez* (Table 2).

B. The Electricity Markets

1. Regional Utilities

The entire grid system of North America, the fundamental physical infrastructure underlying its electricity markets, is divided amongst several major electrical grids. The Eastern Interconnection covers almost half of the U.S. and Canada, with approximately 120,000 miles of transmission lines, between the Atlantic Coast and the eastern borders of New Mexico, Colorado, Wyoming, Montana, and Alberta. From these state boundaries, westward to the Pacific Coast, the Western Electricity Coordinating Council (WECC) covers the rest of the U.S. and Canada, and even a part of Mexico, with more than 127,000 miles of transmission lines. The State of Texas has its own grid system, the Electric Reliability Council of Texas (ERCOT), with over 46,000 miles of transmission. These three grid systems, the Eastern and Western Interconnections, as well as ERCOT, while all separately managed,

must still comply with the reliability standards of the North American Electric Reliability Corporation (NERC). This corporation, headquartered in Atlanta, Georgia, is a non-profit corporation that ensures the reliability and delivery of electricity for the North American Bulk Power System (BPS). In the U.S., the FERC, since 2007, has been able to legally enforce these NERC reliability standards to these three grid systems. In Mexico, the reliability of the *Sistema Eléctrico Nacional* (National Electric System, SEN), with 37,500 miles of transmission, is governed by the *Centro Nacional de Control de Energía* (National Center for Energy Control, CENACE).

The Western Electricity Coordinating Council, responsible for maintaining reliability across various sub-regions across the western U.S. and Canada, including the northern part of Baja California in Mexico, covers the U.S. side of the Paso del Norte region. In particular, the sub-region within the WECC that most directly covers the El Paso Electric service area is known as the Southwest Electric Region, composed of far west Texas, most of New Mexico, all of Arizona, and southern Nevada. This electric region relies primarily on nuclear and coal generated base-load, supplemented by natural gas at peak demand.²⁶⁴ The Electric Reliability Council of Texas (ERCOT), which borders the eastern edge of the Paso del Norte region, ensures through its delegate, the Texas Reliability Entity (TRE), the reliability of approximately 90% of the state's electric grid. Unlike the WECC, ERCOT is also an Independent System Operator (ISO) that operates the grid independently of generators, facilitates open market access to the transmission of electricity, and regulates a wholesale market for qualified participants while the WECC does not.²⁶⁵

As part of the Energy Reform, the *Ley de la Industria Eléctrica* established the CENACE, which designs and implements reliability stan-

dards, based on NERC standards for the SEN. The *Centro Nacional de Control de Energía* coordinates the reliability of the Mexican grid amongst eight main control centers (located in Mexico City, Puebla, Guadalajara, Hermosillo, Gómez Palacio, Monterrey, Mérida, and Mexicali) for nine regions. Mexicali covers two regions in the States of Baja California and Baja California Sur that are not physically connected to the mainland SEN.²⁶⁶ The *Sistema Interconectado Nacional* (Interconnected National System, SIN) comprises seven interconnected regions, excluding Baja California and Baja California Sur. While grid reliability authorities in the U.S. and Canada, such as the WECC, are non-governmental actors (even if standards are legally enforceable), CENACE is wholly controlled by the Mexican federal government, primarily because, as stipulated in the Mexican Constitution, the transmission and distribution of electricity is both a public service obligation and strategically significant.

In both the U.S. and Mexico, an ever-growing need for electricity, particularly in the border region, is leading to an expansion of interest in transboundary interconnections between the grids and drawing the respective reliability authorities of into greater contact. Technically, two types of interconnections exist between the U.S. and Mexico, either bi-directional interfaces or emergency connections. Across the U.S.-Mexico border, there are eleven total interconnections divided between the supervision of the SEN in Mexico, and the WECC and ERCOT in the U.S., with each having specific technical and reliability standards which structure the exchange of electricity with Mexico.²⁶⁷ Along the Texas-Mexico border, the SEN and ERCOT share several connections, the most between any of the grids along the border, located in Presidio–Ojinaga, Eagle Pass–Piedras Negras (bi-directional), Laredo–Nuevo Laredo (bi-directional), Falcon–Falcón (bi-directional), Sharyland–Reynosa, Military Highway–Matamoros, and Brownsville–Mat-

Table 3
El Paso Electric Generation Facilities

Station	Net Dependable Generating Capability (MW)	Primary Fuel	Company Ownership Interest	Location
Newman	752	Natural Gas	100.0%	El Paso, TX
Copper	64	Natural Gas	100.0%	El Paso, TX
Montana	352	Natural Gas	100.0%	El Paso, TX
Rio Grande	276	Natural Gas	100.0%	Sunland Park, NM
Palo Verde	633	Nuclear	15.8%	Wintersburg, AZ
Renewables	1	Wind/Solar	100.0%	Hudspeth/El Paso Counties, TX

Source: *El Paso Electric*, 2016

amoros. To the west of Presidio, Texas, the SEN connects with the WECC where the EPE service area begins. Here, two interconnections export energy from EPE to the CFE in Ciudad Juárez on an emergency basis, one at Diablo–Anapra and the other at Azcárate–Riverena. Despite the numerous connections to Mexico across California and Texas, the total U.S. electricity trade with Mexico is a notably small amount, less than a hundredth of a percent of total U.S. electricity use.²⁶⁸

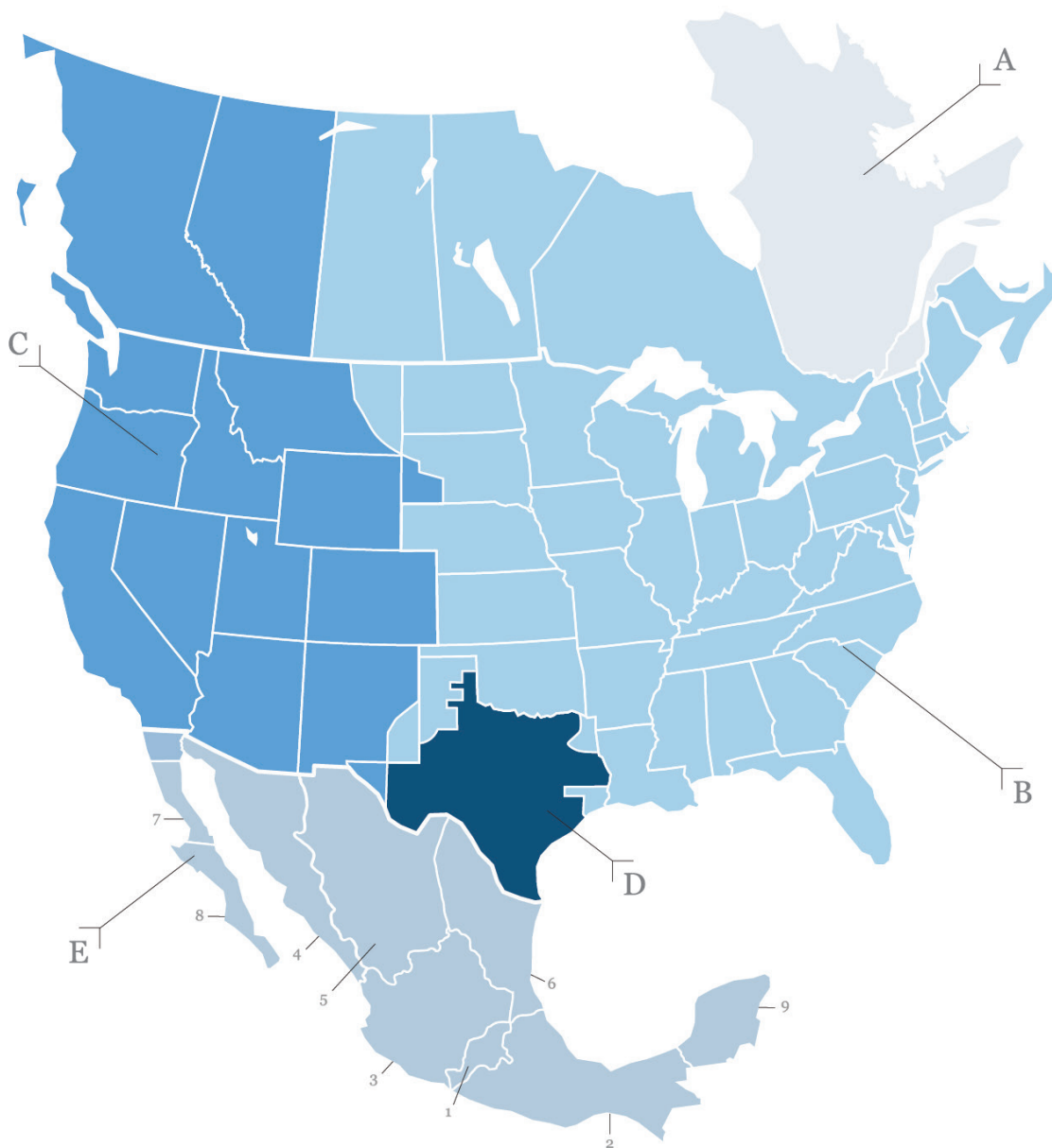
In the broader Paso del Norte region, the WECC shares boundaries with not only ERCOT, but with the Eastern Interconnection as well, which covers the southeastern portion of New Mexico and sits at the juncture of the three major North American grid systems (Map 8). In order to take advantage of this strategic juncture, a major transmission project, known as Tres Amigas, seeks to unite ERCOT with the Eastern and Western Interconnections. The project, by interconnecting these three power grids, aims to transfer vast, yet remotely located renewable assets such as solar, wind, and geothermal energy, abundantly present in the Paso del Norte region, to markets in Texas, the Midwest, and along the Pacific and Atlantic coasts. The Tres Amigas project is currently in development, with a lease of 14,400 acres of state land, in Curry County, New Mexico, near Clovis.²⁶⁹

In the Paso del Norte region, two electrical utilities dominate electricity generation, the El Paso

Electric Company (EPE) and the *Comisión Federal de Electricidad* (Federal Electricity Commission, CFE). El Paso Electric is a publically traded, investor-owned, vertically integrated utility, headquartered in El Paso, Texas, and the sole electricity provider to an area of approximately 10,000 square miles, extending from Doña Ana, Luna, Otero, and Sierra Counties in New Mexico through El Paso and parts of Culberson and Hudspeth Counties in Texas. El Paso Electric generates, procures, transmits, and distributes electricity via 1,829 miles of transmission lines, to reach approximately 300,000 customers in Texas and 94,000 customers in New Mexico, which account for 2.6% of total customers in Texas and 9.3% in New Mexico. By comparison, the closest other investor-owned utility to the Paso del Norte region, the Public Service Company of New Mexico (PNM), has approximately 500,000 customers in the Albuquerque-Santa Fe region, as well as in the southwest part of the state, namely, in Silver City, Lordsburg, and Deming.²⁷⁰

In 2016, the energy sources of electricity generation for EPE were nuclear (47%), natural gas (40%), and purchased renewable energy (13%), mainly from solar and wind generation facilities. The main source of this nuclear energy is the Palo Verde plant, owned in part by EPE and located in Wintersburg, Arizona. Energy produced with natural gas originates from four regional power stations: the Newman, Rio Grande, Copper, and Montana power plants (Map 9). In

Map 8 North American Electrical Grids



Principal North American Grid Systems (Interconnections):

- A. NPCC Québec
- B. Eastern Interconnection
- C. Western Electricity Coordinating Council (WECC)
- D. Electric Reliability Council of Texas (ERCOT)
- E. *Sistema Eléctrico Nacional*

Sistema Eléctrico Nacional (Sectors):

- 1. Central
- 2. Eastern
- 3. Western
- 4. Northwest
- 5. North
- 6. Northeastern
- 7. Baja California
- 8. Baja California Sur
- 9. Peninsular

Source: Own map with information from *Comisión Federal de Electricidad* and *North American Electric Reliability Corporation*, 2015

Table 4
El Paso Electric Real Franchise Fees*
(USD)

	Cities	
	El Paso	Las Cruces
2010	17,901,647	3,723,813
2011	22,180,277	3,340,757
2012	21,160,249	3,511,726
2013	20,684,707	3,344,870
2014	20,393,153	3,600,906
2015	20,008,204	3,635,121

* Franchise fees in 2016 Q3 terms

Source: *El Paso Electric*

July of 2016, EPE discontinued its use of the Four Corners Station, a coal-fired power plant located in the northwest of New Mexico, and became the first coal-free electric utility in Texas and New Mexico.²⁷¹ All of these generating facilities combine to yield a net dependable generating capability for EPE that is projected to be 2,078 MW by the end of 2016 (Table 3).²⁷²

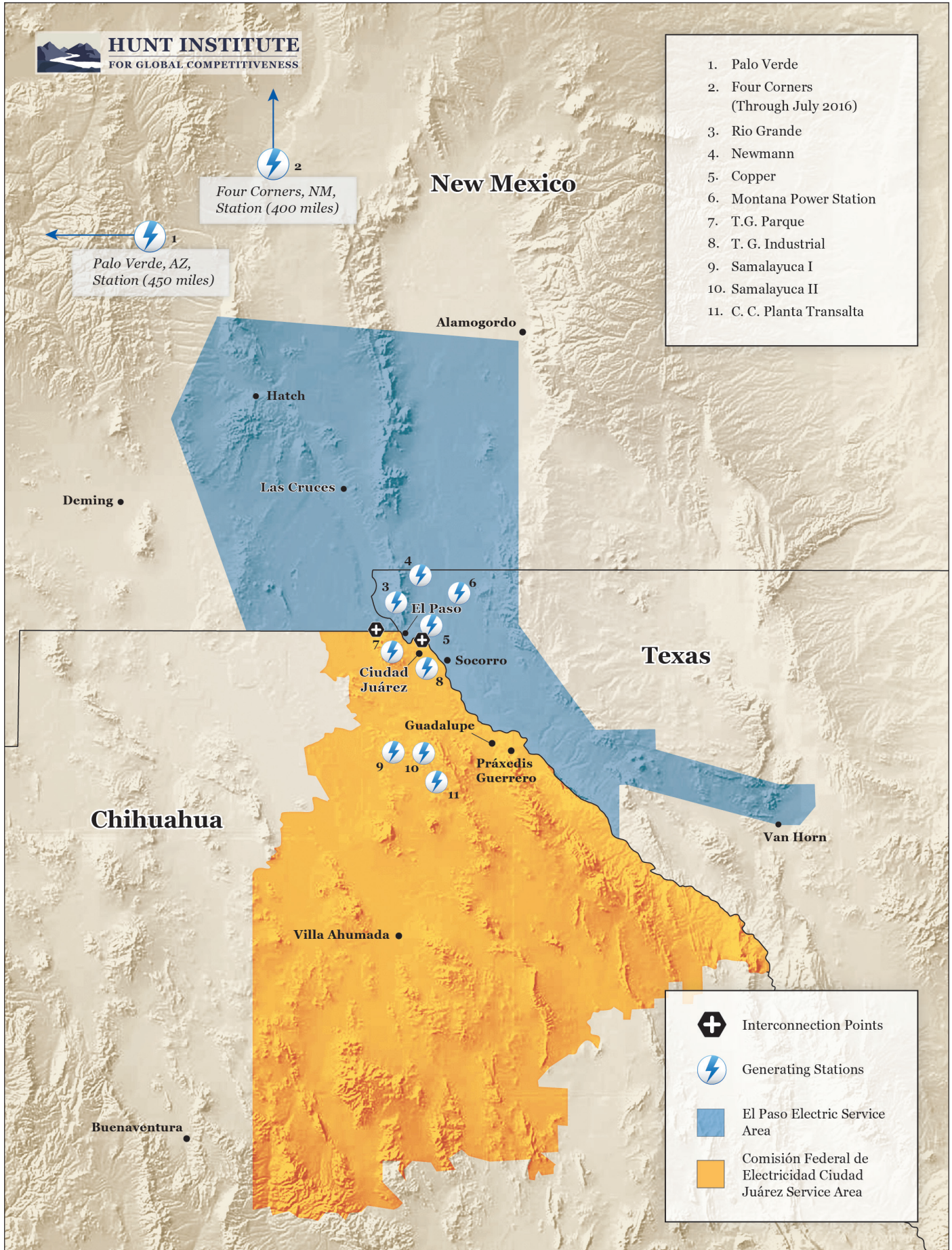
Two much smaller non-profit, member owned electric cooperatives distribute and supply electricity to the rural areas of the Paso del Norte region not covered by EPE. The first, to the east of the EPE service area in New Mexico and Texas is the Rio Grande Electric Cooperative. Formed in 1945, it is headquartered in Brackettville, Kinney County, Texas, southeast of Del Rio, with approximately 6,300 members and a service area of over 35,000 square miles. It has the largest contiguous service area for any electric cooperative in the continental U.S., serving twenty counties in total, two in New Mexico (Otero and Eddy Counties), and 18 in Texas (El Paso, Culberson, Hudspeth, Brewster, Crockett, Dimmit, Edwards, Jeff Davis, Kinney, Maverick, Pecos, Presidio, Reeves, Terrell, Uvalde, Val Verde, Webb, and Zavala Counties). To the north and west of the EPE service area in New Mexico, the Sierra Electric Cooperative, formed in 1941, and located in Elephant Butte, Sierra County, New Mexico, provides electricity to

approximately 3,100 members in a 4,200 square mile service territory. Its service area includes all of Sierra County and parts of Luna, Socorro, and Catron Counties. While neither Rio Grande nor Sierra generate any electricity, but rather distribute, the PUCT and the PRC must still approve the rates charged to users.

In Texas and New Mexico, utilities, in exchange for exclusive service, often have to pay franchise fees to use the municipality's right-of-way. Since 2005, El Paso Electric has had a franchise agreement with the City of El Paso that allows it to utilize the public rights-of-way. With the City of Las Cruces, EPE follows an implied franchise agreement that expired in 2009. Currently, the El Paso Electric franchise fees are based on a percentage of revenue, 4% for the City of El Paso (0.75% of which is dedicated to economic and renewable energy development) and 2% for the City of Las Cruces.²⁷³ While the franchise fees in real terms have continuously decreased for the City of El Paso since 2012 on an annual basis, those to the City of Las Cruces have increased since 2012 (Table 4).

While the U.S. electricity industry has over 3,000 public, private, and cooperative utilities, Mexico currently has only one major utility, the *Comisión Federal de Electricidad* (CFE). A broad expansion of utilities should result now that the recent Energy Reform allows for private generation of electricity, depriving the CFE of its long-held monopoly status.²⁷⁴ The *Comisión Federal de Electricidad* in Ciudad Juárez (CFE-Juárez) generates electricity from five plants with a total generating capacity of 1,183 MW (Table 5). A sixth plant, known as *Norte III*, is expected to be completed by 2017 and will have a generating capacity of 928 MW (Map 9).²⁷⁵ This utility provides service to approximately 392,000 customers in the municipalities of Ciudad Juárez, Praxedis G. Guerrero, Guadalupe, Villa Ahumada, and the eastern portion of Buenaventura.

Map 9 Paso del Norte Utility Service Areas and Electricity Generating Stations



Source: Own map with information from El Paso Electric and Comisión Federal de Electricidad, 2015

Table 5
Electricity Generating Facilities for CFE-Juárez

Station	Generating Capacity (MW)	Location
C.C. Samalayuca II	520	Juárez
C.C. Samalayuca I	316	Juárez
T.G. Parque	59	Juárez
T.G. Industrial	18	Juárez
C.C. Planta Transalta	270	Juárez
Total	1,183 MW	

Source: *Comisión Federal de Electricidad*

Across the Paso del Norte region, the CFE-Juárez service area has the highest number of residential customers, followed by the EPE service area in Texas and New Mexico (approximately 273,000 and 84,000, respectively) (Figure 5). Although EPE-Texas has fewer residential customers than CFE-Juárez, it supplies far more electricity (Figure 6).

As for non-residential customers, CFE-Juárez also had a larger customer base than that of EPE-Texas from 2008 to 2011 (Figure 7). In the first quarter of 2015, EPE supplied approximately 44,000 non-residential customers (33,000 for Texas and 11,000 for New Mexico). It is worth noting that during 2014 and up to the first quarter of 2015, non-residential customers for all three aforementioned markets have been increasing at a higher rate than residential customers. Non-residential customers in Texas and New Mexico have also been increasing at a steep rate since late 2010.

The 2008 global recession had a more adverse impact on the CFE-Juárez residential electricity than on that within the EPE service area. The growth rate for the number of residential customers in CFE-Juárez decelerated during 2009 and contracted from 2010 through a portion of 2013. In contrast, the number of EPE residential customers has increased since 2008 on a year-over-year basis.

Table 6
Paso del Norte Sales Segmentation (%) 2014

Type	Region	Residential Customers	Non-Residential Customers
Customers	El Paso	88.9%	11.1%
	Doña Ana	88.2%	11.8%
	Juárez	92.5%	7.5%
Sales (MWh)	El Paso	33.2%	66.8%
	Doña Ana	39.7%	60.3%
	Juárez	20.6%	79.4%

Source: *El Paso Electric and Comisión Federal de Electricidad*

Although EPE-Texas has fewer residential customers than CFE-Juárez, the former consumes far more electricity. As for the non-residential customers, the highest electricity consumption during 2014 was also for EPE-Texas, followed by CFE-Juárez and EPE-New Mexico (Figure 8).

Residential customers in the Paso del Norte region comprise the majority of all customers (88.9% for EPE-Texas, 88.2% for EPE-New Mexico, and 92.5% for CFE-Juárez). The consumption of non-residential customers dominates most electricity sales in all three utilities (66.8% for EPE-Texas, 60.3% for EPE-New Mexico, and 79.4% for CFE-Juárez) (Table 6). The consumption of the top ten industrial sector customers in Ciudad Juárez amounted to approximately 9% of total electricity volume sales in the city from January 2015 to August 2015 (Table 7). The majority of these customers are export-oriented assembly firms, principally engaged in the production of appliances and electronics. Peak demand is also expected to grow on average 1.6% for each year for the next six years for EPE and 5.2% per year for CFE-Juárez (Figure 9).

Figure 5
Average Residential Customers*
(Thousands)

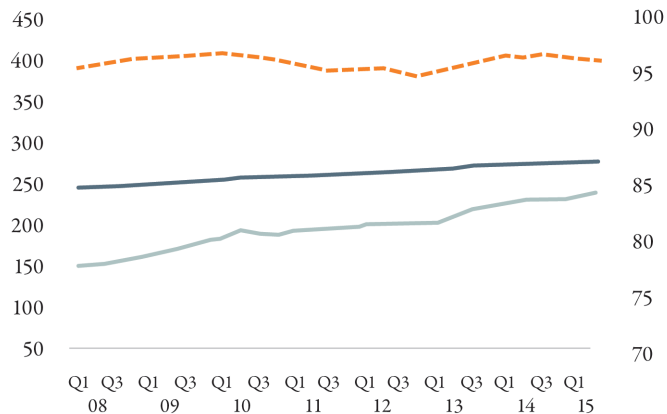


Figure 7
Average Non-Residential Customers
(Thousands)

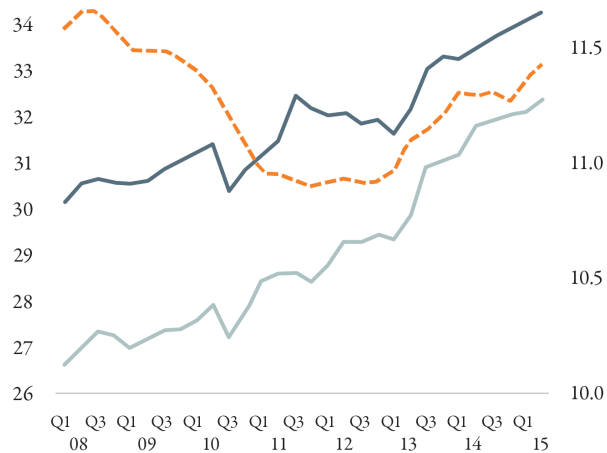


Figure 6
Residential Consumption
(MWh)*

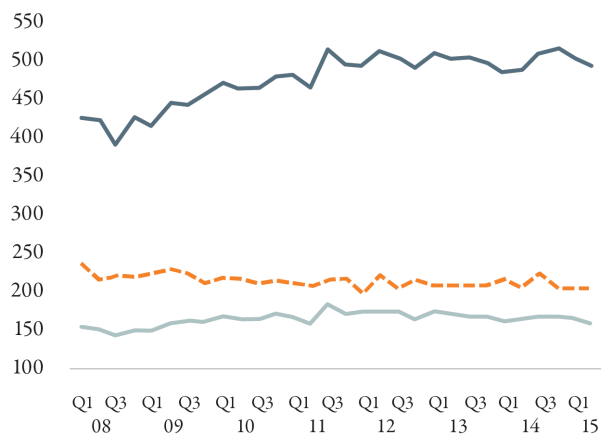
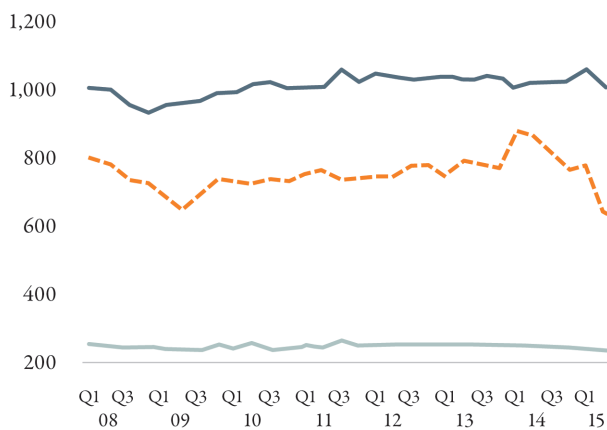


Figure 8
Non-Residential Consumption
(MWh)*



--- CFE - JZ — EPE - TX — EPE - NM

* Seasonally adjusted

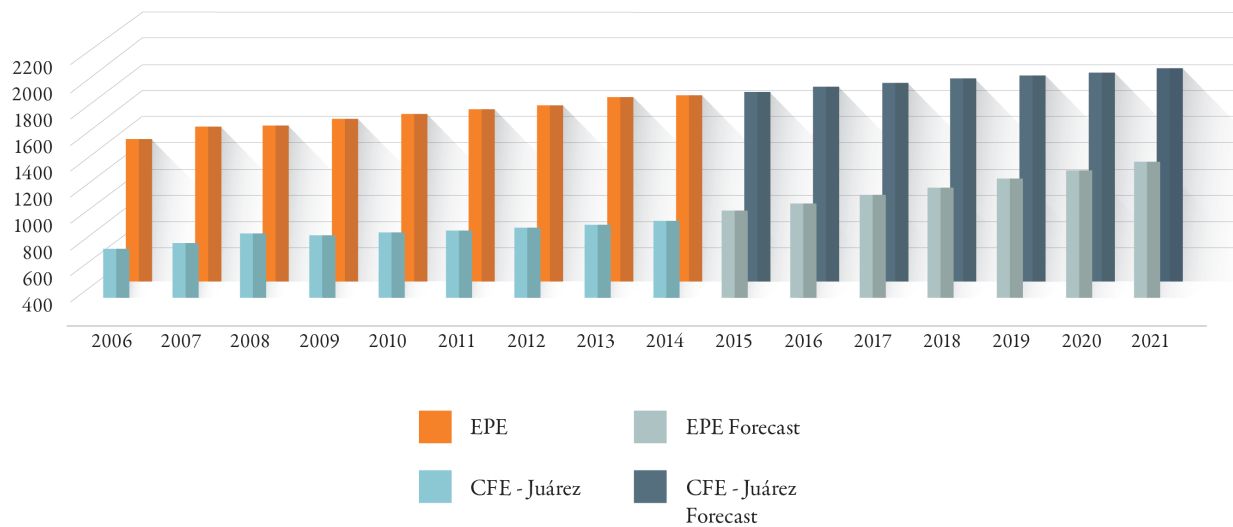
Source: Comisión Federal de Electricidad and Energy Information Administration, 2015

Table 7
Top 10 Customers in the CFE-Juárez Service Area

	Firm Name	Maquila (Yes/No)	Main Economic Activity	Jan-Aug 2015 (GWH)
1	Electrolux Home Products of México	Yes	Electronics	53.63
2	Grupo Cemento de Chihuahua	No	Concrete	45.89
3	Tecnología de Iluminación Automotriz	Yes	Automotive	35.26
4	Lexmark Internacional	Yes	Electricals	23.74
5	Flextronics	Yes	Electronics	21.64
6	Bel Manufacturera	Yes	Electronics	18.86
7	Robert Bosch Sistemas Automotrices	Yes	Automotive	18.54
8	Scientific Atlanta México	Yes	Electronics	17.86
9	PCE Technology de Juárez	Yes	Electricals	17.66
10	Cordis de México	Yes	Medical	14.30
			Total	267.39

Source: Index Juárez and Bloomberg Business

Figure 9
Native System Peak Demand (MW)



Source: El Paso Electric Company and Comisión Federal de Electricidad

2. Consumption and Rates

The various governments of the Paso del Norte region exercise strict regulatory authority over electricity rates in the region. The States of Texas and New Mexico, in accordance with their right to regulate and control public utilities, prescribe, through the PUCT and the PRC, reasonable rates for the sale of electricity to the public.²⁷⁶ In these types of markets without rate competition, the governing principle for determining rates to be charged by a public utility is the right of the public on the one hand to be served at a reasonable charge and the right of the utility to a fair return.²⁷⁷ And, although consumers within the same class of service should be subject to substantially similar rates, a rate-making authority may establish different classifications of service, and different rates for each class, based on reasonable distinctions, such as the amount of electricity consumed.²⁷⁸ Furthermore, because its transmission crosses state lines, the rates EPE charges are subject to federal interstate oversight and regulation, governed by the FERC. The Texas and New Mexico regulators, the PUCT and the PRC, most recently approved electricity rates in 2016.²⁷⁹

By comparison, ERCOT, the ISO that operates and manages the reliability of the Texas grid, also manages open and competitive day-ahead and real-time markets for electricity tariffs in its service area. The day-ahead market is a voluntary, financially-binding forward energy market. The day-ahead market matches willing buyers and sellers, subject to network security and other constraints. It provides a platform to hedge congestion costs in the day-ahead and instruments to mitigate the risk of price volatility in real-time.²⁸⁰ During real-time, ERCOT dispatches resources based on economics and reliability to meet the system demand while observing resource and transmission constraints.²⁸¹ El Paso Electric, a bundled utility in the Southwest Electric Region completely within

the boundaries of the WECC, does not participate in the wholesale market structure available within ERCOT.

El Paso Electric categorizes electricity rates according to five categories: Residential, Commercial, Industrial, Agricultural, and Public Service. Respective costs are classified based on the contribution to system-coincident peak demand or non-coincident peak demand (kW), energy consumption (kWh), and customer characteristics such as voltage level.²⁸² El Paso Electric structures its rates accordingly:

- Fixed Monthly Customer Charge covers meter, meter reading costs, billing, record keeping, and customer service costs (\$6.90 in Texas and \$7 in New Mexico);
- Energy Charge, per kWh, covers the costs associated with producing and distributing electricity minus fuel and customer charges (this rate is common among smaller energy users and considers the time of use or seasonal energy rates);
- Blocked Energy Rates charge per kWh, for demand, and function as a proxy for time of use by charging energy rates in blocks of kWh (this rate includes a customer charge and demand charge); and,
- Demand Metered Pricing charges per kW, for demand, and may be differentiated by time of use and include optional real time energy pricing (this rate also includes a customer charge and a demand charge).

Apart from those charges included in residential billing, non-residential costs typically include a demand charge which recovers a portion of EPE's tax burden as well as its fixed investment

Table 8
El Paso Electric Charges and Fees

Type of Charge	Texas		New Mexico	
	Residential Customers	Non-Residential Customers	Residential Customers	Non-Residential Customers
Customer Charge	✓	✓	✓	✓
Energy Charge	✓	✓	✓	✓
Demand Charge		✓		✓
Energy Efficiency Cost Recovery Factor	✓	✓		
Efficient Use of Energy Recovery Factor			✓	✓
Fixed Fuel Factor Charge	✓	✓		
Franchise Fees			✓	✓
Fuel and Purchased Power Cost Adjustment			✓	✓
Military Base Discount Recovery Factor	✓	✓		
Taxes		✓	✓	✓

Source: *El Paso Electric*

and operating costs associated with generation, transmission, and distribution facilities (Table 8).

Residential customers in the EPE-Texas service area pay other fees, too. A fuel tariff recovers the cost of fuel associated with generating electricity and is known as the Fixed Fuel Factor, currently \$.02057 per kWh. Also, in the EPE-Texas service area, a military base recovery factor (which recovers the total base rate discount provided to federal military base facilities) and other miscellaneous services charges apply. Effective October of 2016, EPE will charge residential customers with certain new surcharges that have been approved by the PUCT. The first of these surcharges is the Four Corners Incremental Rate Rider at \$.00125 per kWh, the second is the Relate Back Revenue Surcharge at \$.00307 per kWh, and the third is the Rate Case Expense Surcharge at \$.00033 per kWh. These charges will apply to all consumers, although they vary by category.

In July of 2016, the PRC ordered all fuel costs for residential and non-residential customers in EPE-New Mexico service area to be included in a separate line from the base rate, the Fuel and Pur-

chased Power Cost Adjustment Clause (FPPCAC). After reconciling for actual fuel and purchased power costs on a monthly basis, EPE refunds or recovers these costs to customers in the second succeeding month. Residential customers in the EPE-New Mexico service area are also charged for the franchise fees that the utility pays to the City of Las Cruces.

In Mexico, the rates in the electricity market, post Energy Reform, have two main categories, basic and qualified users. Basic users are residential and commercial consumers and their electricity rates are still mostly regulated by the federal government and set by the *Comisión Reguladora de Energía* (Energy Regulatory Commission, CRE). A regulated subsidized market for users of the basic supply will continue to exist while an open market for those who are qualified users, based on high demand, will start to take shape. Qualified users, those that consume large amounts of electricity, can now participate in the new wholesale electricity market as power generators, qualified users, suppliers (for basic, qualified, or last resort users) or non-supplying traders.²⁸³

Retail service providers will sign contracts to buy electricity from generators or from the grid and resell it to customers in the regions where the retailers operate. The law provides for three types of retail service providers. All retail service providers will require a permit from the CRE and must be registered as market participants. Basic service providers will only be permitted to sell power to basic service users and will be required to enter into power hedge agreements. For the time being, it is expected that only the CFE, through a retail subsidiary, will provide these services.

For qualified users, the *Ley de la Industria Eléctrica* (Electricity Industry Law, LIE), along with several other new laws, now allows for the private actors to participate freely in the generation and sale of electricity through a wholesale market.²⁸⁴ The *Comisión Reguladora de Energía*, in turn, establishes the regulations governing the electricity market to ensure quality, continuity, reliability, and the safety of the national electric system, and also issues permits to wholesale electricity market participants. The *Centro Nacional de Control de Energía*, the grid operator, in turn, oversees the wholesale electricity market, guarantees open access, and fosters the expansion and modernization of both the national transmission grid and the elements of the general distribution grid that correspond to the wholesale electricity market.²⁸⁵

In Mexico, the classification of residential, i.e., basic user, rates varies according to the minimum average temperature during summer in eight subsidized regions, from 1A to 1F. The first, 1A, is a region with the highest electricity rates whereas 1F is a region with the lowest rates. Northern Mexico, which includes Ciudad Juárez, is generally classified under 1C rate, except for the municipality of Buenaventura municipality, in which the 1A rate applies (Table 9). The *Comisión Federal de Electricidad* also categorizes electricity rates according to five client types, Residential, Commercial,

Table 9
Electricity Rate Structure for CFE

Rate	Minimum Average Temperature	DAC Threshold (per month)
1	< 77.0 °F	250 kWh
1A	77.0 °F	300 kWh
1B	82.4 °F	400 kWh
1C	86.0 °F	850 kWh
1D	87.8 °F	1,000 kWh
1E	89.6 °F	2,000 kWh
1F	91.4 °F	2,500 kWh

Source: *Comisión Federal de Electricidad, 2016*

Industrial, Agricultural, and Public Service.

For each region, different rates apply to either the summer or winter seasons and by blocked electricity consumption. The electricity demand charges vary per kWh consumed in a season, and one or more electricity consumption rates may apply. A high consumption electricity charge, the *Doméstica de Alto Consumo* (High Consumption Residential Rate, DAC), applies to every kWh when it exceeds a threshold based on the customer's average kWh consumed in the last six months. For the Ciudad Juárez service area, the DAC applies only after the 850 kWh threshold is reached. In order to remove the DAC charge, the residential customer must have an average electricity consumption less than their corresponding rate threshold for two consecutive billing cycles (Table 9).

Residential Rates

Both El Paso Electric and the *Comisión Federal de Electricidad* classify residential rates depending on the season and have set the summer period as the months of May through October and winter as the remaining months. These utilities also have rate categories according to usage.

Table 10
Paso del Norte Summer Residential Rates per kWh* (USD) 2016

Summer 2016			
	EPE-NM	EPE-TX	CFE-Juárez**
1 kWh - 150 kWh	0.07528	0.09455	0.03689
151 kWh - 300 kWh	0.07528	0.09455	0.04351
301 kWh - 450 kWh	0.07528	0.09455	0.05558
451 kWh - 600 kWh	0.07528	0.09455	0.14831
≥ 600 kWh	0.09338	0.09956	0.14831
Fuel Charge per kWh***	0.034444	0.02057	N/A
Customer Charge	7.00	6.90	N/A
DAP	N/A	N/A	1.05863

* Only base bill and fuel factor charges shown for El Paso Electric

** Average FIX exchange rate for October 2016 used

*** For New Mexico, the fuel rate charged in August 2016 was used

Source: El Paso Electric Company and Comisión Federal de Electricidad

El Paso Electric has higher residential electricity rates in the summer compared with the winter. It has two block rates for residential customers in summer, either below or above 600 kWh consumption, and only one block rate for winter. Considering only EPE total base bill and fuel charges, New Mexico customers pay less than those in Texas whenever their consumption is less than 600 kWh. After 600 kWh, Texas customers pay more for these charges (Tables 10 and 11).

The *Comisión Federal de Electricidad* provides subsidies for residential customers, which increase during the summer season. During the summer, CFE-Juárez charges the lowest residential electricity rates across the Paso del Norte region, except when the residential energy consumption is more than 450 kWh, in which case CFE-Juárez residential customers are charged the most, except for CFE-Juárez in the DAC category. During the winter, when electricity consumption does not reach 175 kWh, residential customers in the CFE-Juárez service area face the lowest electricity rates in the region. After passing this use consumption threshold, these residential rates increase considerably, becoming the most expensive across the re-

gion, except for CFE-Juárez customers in the DAC category. Residential customers in the CFE-Juárez service area are also charged a fixed street lighting service fee (*Derecho de Alumbrado Público*, DAP) of \$1.05863 (Tables 10 and 11).

CFE-Juárez customers under the DAC rate, those that have consumed more than 850 kWh in the last six months, pay a flat rate per kWh consumed (\$0.1931), and therefore, face the highest residential rates across the Paso del Norte region. In addition, they pay the highest DAP charge per month across Juárez residential customers (\$3.1759) (Table 12). On average, real residential rates per kWh have fallen since 2008 for most markets within the Paso del Norte region (Figure 10). Fluctuations observed are attributable to the change in rates that occur during the seasons of summer and winter. Residential customers in the EPE-New Mexico service area have historically experienced the highest average rates in the region, followed by EPE-Texas and CFE-Juárez residential customers. Across seasons, EPE-Texas residential rates per kWh are much more stable than those of EPE-New Mexico or CFE-Juárez.

Table 11
Paso del Norte Winter Residential Rates per kWh* (USD) 2016

Winter 2016			
	EPE-NM	EPE-TX	CFE-Juárez**
1 kWh - 75 kWh	0.06528	0.08455	0.04197
76 kWh - 175 kWh	0.06528	0.08455	0.05060
≥ 175 kWh	0.06528	0.08455	0.14831
Fuel Charge per kWh***	0.034444	0.02057	N/A
Customer Charge	7.00	6.90	N/A
DAP	N/A	N/A	1.05863

* Only base bill and fuel factor charges shown for El Paso Electric

** November 2016 rates using the average FIX exchange rate for October 2016

*** For New Mexico, the fuel rate charged in August 2016 was used

Source: El Paso Electric and Comisión Federal de Electricidad

Non-Residential Rates

El Paso Electric's non-residential customers fall into three categories, Small Commercial, General Service, and Large Power. Non-residential bills are typically subject to tariff schedule components such as customer charge, energy charge, and demand charge. While the energy charge is based on the amount of kWh consumed, the demand charge is assessed per billed kW and varies by category.

El Paso Electric determines maximum demand as the highest measured kW load, averaged over a thirty-minute use period in order to set the non-residential service categories. Small Commercial customers' maximum demand should not exceed 15 kW in Texas during the current month and the previous eleven-month period.²⁸⁶ The Small Commercial Service rate in New Mexico is limited to customers whose maximum demand is no greater than 50 kW.²⁸⁷ In addition, these customers' maximum demand should not exceed 15 kW for Texas or 50 kW for New Mexico for two consecutive months. General Service users are those whose maximum demand during the current month and in any month of the

Table 12
CFE High Consumption Residential Rates 2016*

Rate Type	Charge
USD/kWh	0.1931
Customer Charge	4.9740
DAP	3.1759

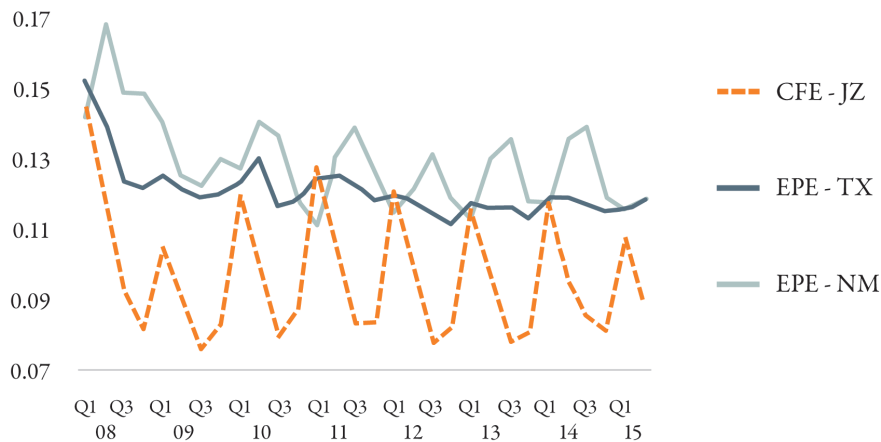
* November 2016 rates using the average FIX exchange rate for October 2016

Source: Comisión Federal de Electricidad

previous eleven-months, was greater than 15 kW in Texas or 50 kW in New Mexico, in any month, and did not exceed 600 kW in Texas or 800 kW in New Mexico, for two consecutive months. Those consumers categorized as Large Power users have an expected monthly demand greater than 600 kW for Texas or 800 kW for New Mexico and remain on this rate for twelve consecutive months (Table 13).

El Paso Electric provides different Small Commercial rates for summer and winter in Texas and New Mexico. While energy and fuel charges per kWh are higher for EPE Small Commercial customers in Texas than in New Mexico (with a rate differential of \$0.064/kWh), a demand charge

Figure 10
Average Real Residential Rates per kWh*
(USD)



* U.S. CPI December 2015 = 100 and average monthly FIX exchange rate used.
Source: Comisión Federal de Electricidad and Energy Information Administration

per billing kW applies only to New Mexican Small Commercial customers who also face a higher customer charge (Table 14).²⁸⁸

The General Service and Large Power rates further classify rates per type of voltage delivery to customers.²⁸⁹ Voltage is the pressure or tension at which electricity is transmitted. Primary voltage is one of EPE’s standard voltages between 2,400 volts and 64,000 volts, secondary voltage for voltages below 480 volts, and transmission voltage for voltages above 69,000 volts. El Paso Electric bills the Texas General Service Rate customers according to secondary or primary voltage, season, demand per kW, fuel per kWh, and blocked kWh consumption, which is a function of the maximum measured demand, except when consumption is higher than 350 kWh (Tables 15 and 16).²⁹⁰ El Paso Electric bills New Mexico General Service Rate customers according to voltage, season, kWh consumed, fuel per kWh, and demand per billing kW.²⁹¹ Additionally, a fixed customer charge of \$27.5 and of \$26 applies to Texas and New Mexico General Service customers, respectively. Although El Paso Electric

New Mexico General Service Rate customers experience a lower rate per kWh and a lower customer charge than those in Texas, their fuel charge per kWh and demand charge per kW are higher.

El Paso Electric bills Texas and New Mexico Large Power Service Rate customers according to season, voltage type (secondary, primary, or transmission voltage), fuel, and peak energy charges (Tables 17 and 18).²⁹² On-peak demand runs from 12:00 PM through 6:00 PM MDT on weekdays during the months of June through September. Off-peak charges occur on all other hours that are not part of the on-peak demand period. Considering energy and fuel charges per kWh, EPE Large Power Service customers in Texas experience higher on-peak rates per kWh than their counterparts in New Mexico, but not for off-peak periods. In contrast, EPE Large Power Service customers in New Mexico face higher customer charges than those in Texas, during all seasons and at all voltages (except for the transmission voltage category).

Table 13
El Paso Electric Non-Residential Rate Structure

	Texas	New Mexico
Small Commercial	≤ 15 kW	≤ 50 kW
General Service	> 15 kW	> 50 kW
	< 600 kW	< 800 kW
Large Power	≥ 600 kW	≥ 800 kW

Source: *El Paso Electric, 2016*

Table 14
EPE Small Comercial Service Rates* (USD) 2016

Energy Charge	Summer		Winter	
	Texas	New Mexico	Texas	New Mexico
All kWh	0.11407	0.03553	0.10407	0.02543
Fuel Charge per kWh**	0.02057	0.034444	0.02057	0.034444
Demand Charge per kW***	N/A	17.36	N/A	15.11
Customer Charge	9.95	14.00	9.95	14.00

* Only base bills and fuel based rates shown

** For New Mexico, the fuel rate charged in August 2016 was used

*** Applicable only for New Mexico customers and per billing KW

Source: *El Paso Electric*

In the CFE-Juárez service area, non-residential customers are divided into three categories that are a function of voltage utilized (Table 19). Seven rates are then derived for these customers based on their maximum demand and voltage needs. Demand is estimated by measuring the maximum demand in a fifteen-minute interval regardless of the time of use. Sixty percent of the electricity sales from CFE-Juárez non-residential rates are derived from HM rate customers, those who own their substation units (as any medium or high voltage user) and who have a minimum energy load of 100 kW. Customers under HM rate pay a minimum charge of 10% of the contracted demand, set initially by the customer. Contracted demand should be no less than 60% of the energy capacity load, 100 kW, or the largest installed device capacity. HM rates consist of billing demand and energy charges. Energy charges vary by season and by time of use, either basic, intermediate, or on-peak (Table 20).

Billing demand and energy charges differ by region. Northern Mexico, where Juárez is classified, faces one of the lowest billing demand charges. Only in the northeastern region of Mexico are billing demand charges lower. The northern region ranks second lowest for basic kWh energy charges, while for intermediate and on-peak kWh energy charges it ranks fourth lowest (Table 21). The average cost per kWh for non-residential customers is highest for CFE-Juárez customers, followed by EPE-New Mexico and EPE-Texas. Overall, the price per kWh for non-residential customers in the region has decreased over time since 2008 through the first quarter of 2015 (Figure 11).

As mentioned, the new Mexican wholesale electricity market will offer new competitive pricing structures for qualified users, which will certainly include large industrial users. This new market is comprised of three separate markets: the hour-ahead, day-ahead, and real-time markets. Here, the market participants will make offers to

Table 15
El Paso Electric Summer General Service Rates* (USD) 2016

Type of Voltage	Energy Charge	Texas	New Mexico
Secondary Voltage	0 kWh - 200 kWh**	0.06927	0.01933
	201 kWh - 350 kWh**	0.05038	0.01933
	For all additional kWh	0.03664	0.01933
	Fuel Charge per kWh***	0.02057	0.034444
	Demand Charge per kW	12.21	19.19
	Customer Charge	27.50	26.00
Primary Voltage	0 kWh - 200 kWh**	0.05513	0.01933
	201 kWh - 350 kWh**	0.04008	0.01933
	For all additional kWh	0.02914	0.01933
	Fuel Charge per kWh***	0.020099	0.033643
	Demand Charge per kW	10.95	18.06
	Customer Charge	27.50	26.00
Transmission Voltage	0 kWh - 200 kWh	N/A	0.01933
	201 kWh - 350 kWh	N/A	0.01933
	For all additional kWh	N/A	0.01933
	Fuel Charge per kWh***	N/A	0.032818
	Demand Charge per kW	N/A	13.31
	Customer Charge	N/A	26.00

Table 16
El Paso Electric Winter General Service Rates* (USD) 2016

Type of Voltage	Energy Charge	Texas	New Mexico
Secondary Voltage	0 kWh - 200 kWh**	0.03408	0.01233
	201 kWh - 350 kWh**	0.02479	0.01233
	For all additional kWh	0.01803	0.01233
	Fuel Charge per kWh***	0.02057	0.034444
	Demand Charge per kW	8.50	16.44
	Customer Charge	27.50	26.00
Primary Voltage	0 kWh - 200 kWh**	0.02712	0.01233
	201 kWh - 350 kWh**	0.01973	0.01233
	For all additional kWh	0.01435	0.01233
	Fuel Charge per kWh***	0.020099	0.033643
	Demand Charge per kW	7.24	15.31
	Customer Charge	27.50	26.00
Transmission Voltage	0 kWh - 200 kWh	N/A	0.01233
	201 kWh - 350 kWh	N/A	0.01233
	For all additional kWh	N/A	0.01233
	Fuel Charge per kWh***	N/A	0.032818
	Demand Charge per kW	N/A	10.56
	Customer Charge	N/A	26.00

* Only base bills and fuel based rates shown

** Multiplied by maximum measured demand for EPE-TX service area

*** For New Mexico, the fuel rate charged in August 2016 was used

Source: El Paso Electric

Table 17
Large Power Summer Service Rates* (USD) 2016

Type of Charge	Secondary Voltage		Primary Voltage		Transmission Voltage	
	Texas	New Mexico	Texas	New Mexico	Texas	New Mexico
On-Peak Energy Charge per kWh	0.12100	0.08782	0.11818	0.08782	0.11529	0.08782
Off-Peak Energy Charge per kWh	0.00812	0.00458	0.00793	0.00458	0.00774	0.00458
Fuel Charge per kWh**	0.02057	0.034444	0.020099	0.033643	0.019604	0.032818
Demand Charge per kW	22.04	23.40	21.30	23.04	18.84	20.64
Customer Charge	100.00	127.00	100.00	127.00	200.00	127.00

Table 18
Large Power Winter Service Rates* (USD) 2016

Type of Charge	Secondary Voltage		Primary Voltage		Transmission Voltage	
	Texas	New Mexico	Texas	New Mexico	Texas	New Mexico
Off-Peak Energy Charge per kWh	0.00812	0.00458	0.00793	0.00458	0.00774	0.00458
Fuel Charge per kWh**	0.02057	0.034444	0.020099	0.033643	0.019604	0.032818
Demand Charge per kW	17.85	15.54	17.11	15.18	14.65	12.78
Customer Charge	100.00	127.00	100.00	127.00	200.00	127.00

* Only base bill and fuel based rates shown. No On-Peak winter charge for Texas and New Mexico

** For New Mexico, the fuel rate charged in August 2016 was used

Source: El Paso Electric

Table 19
CFE Commercial and Industrial Rates

	Voltage	Rate	Demand
Low Voltage	1 - 1,000 volts	2	≤ 25 kW
		3	> 25 kW
Medium Voltage	1,001 - 35,000 volts	OM	< 100 kW
		HM	≥ 100 kW
High Voltage	35,001 - 220,000 volts	HS	Sub-transmission level
		HSL	Sub-transmission level
	> 220,000 volts	HT	Transmission level

Source: Comisión Federal de Electricidad

Table 20
HM Rates by Times of Use in the CFE-Juárez Service Area

Season	Day of the Week	Charge Type		
		Basic	Intermediate	On Peak
Summer	Monday-Friday	0:00 - 6:00	6:00 - 20:00 22:00 - 24:00	20:00 - 22:00
	Saturday	0:00 - 7:00	7:00 - 24:00	N/A
	Sunday*	0:00 - 19:00	19:00 - 24:00	N/A
Winter	Monday-Friday	0:00 - 6:00	6:00 - 18:00 22:00 - 24:00	18:00 - 22:00
	Saturday	0:00 - 8:00	8:00 - 19:00 21:00 - 24:00	19:00 - 21:00
	Sunday*	0:00 - 18:00	18:00 - 24:00	N/A

* Includes Holidays.

Source: *Comisión Federal de Electricidad*

sell or purchase electricity at local marginal prices, as with a nodal market. The *Centro Nacional de Control de Energía*, which is the grid operator, decides the electricity output needed to match the demand load, at the lowest possible cost, while taking into consideration transmission costs and limitations. The wholesale market also includes medium and long-term markets and auctions, including a market for the sale and purchase of uncommitted capacity, which will operate on a year-ahead basis and is intended to promote the reliability of the system.

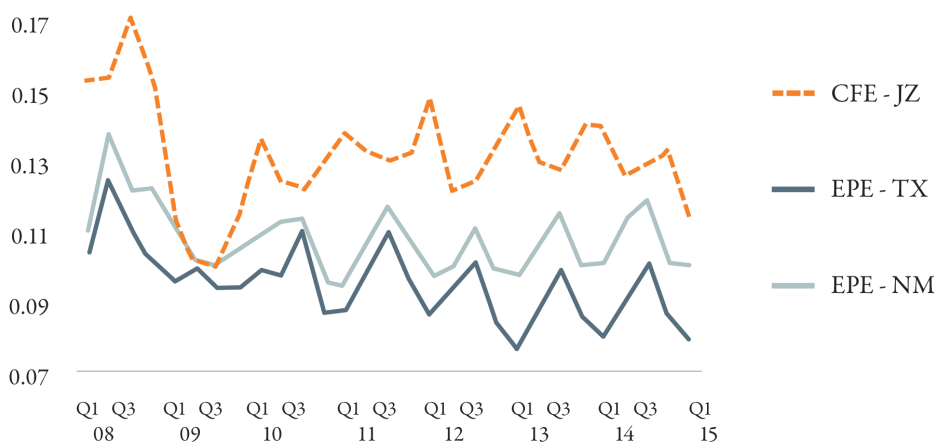
The wholesale market also has the ability to facilitate the purchase and sale of imported and exported electricity. For example, an offer by a generator to export or import electricity from, or into, the national grid must be made to CENACE, which accepts the export offers with the highest prices and the import offers with the lowest prices. Nevertheless, market participants are prohibited from acquiring extended rights to import or export electricity into and out of Mexico.

Table 21
CFE HM Rates by Region (USD)* 2016

Region	Billing Demand (per kW)	Energy Charge (per kWh)		
		Basic	Intermediate	On-Peak
Baja California	15.4887	0.0326	0.0414	0.1058
Southern Baja California	14.8859	0.0407	0.0575	0.0849
Central	10.7314	0.0384	0.0459	0.1014
Northeastern	9.8666	0.0349	0.0426	0.0937
Northwest	10.0762	0.0354	0.0423	0.0942
Northern	9.9126	0.0350	0.0430	0.0944
Peninsula	11.0899	0.0355	0.0431	0.0992
South	10.7314	0.0365	0.0438	0.0993

* Average rates from January 2016 to November 2016 using the average FIX exchange rate for October 2016
Source: *Comisión Federal de Electricidad*

Figure 11
Average Real Non-Residential Rates per kWh*
(USD)



* U.S. CPI December 2015 = 100 and average monthly FIX exchange rate used.

Source: *Comisión Federal de Electric and the Energy Information Administration, 2015*

CONCLUSION

Over the last several decades, binational trade routes and supply chains have transformed the Paso del Norte region into a major, geostrategic center of industrial and logistical activity. These supply chains that span across the U.S. and Mexico have, in turn, given rise to a complex framework of physical structures and regulatory principles governing the sources of energy that fuel and power their growth. Binational industrial corridors have now become binational energy corridors, and the Paso del Norte region sits at the nexus of both.

Yet, in light of this binational integration, the energy markets still find themselves at a point of simultaneous convergence and divergence. As the material trade in fuels and electricity intensifies and as the energy interdependence grows between the U.S. and Mexico, the relevant regulatory principles and structures, diverging across federal, state, county, and even municipal jurisdictions, ultimately collide along the U.S.-Mexico border. This divergence results in a multiplicity of regulatory agencies that exercise significant control over the costs and pricing of all forms of energy in geographically and economically proximate regions. As a consequence, significant imbalances arise in the presence and efficiency of the physical structures that support the generation, transmission, and commercialization of energy in the two countries.

The root of these divergences emerge not only from the differing concepts that underlie property and contract law in the U.S. and Mexican legal systems, but also from the disparate theories that structure the reach and oversight of their federal governments and constituent states. In the U.S., the various states have original jurisdiction in the regulation of the energy sector and the jurisdiction of the federal government is only triggered in certain circumstances, such as when federal land

or interstate commerce is implicated. In Mexico, though, the federal government has plenary and exclusive authority to regulate all aspects of the energy sector, including the possession of original title to all oil, gas, and geothermal deposits. So, while energy development in the U.S. enjoys greater freedom from governmental oversight, it must nevertheless deal with a multitude of local state laws and regulatory agencies. Mexico, on the other hand, has one uniform system that applies nationally.

While some basic similarities do exist across the jurisdictions that comprise the Paso del Norte region, such as a regulated electricity market, the overall legal and regulatory asymmetries create a fractured energy market that is concurrently divided between multiple federal and state sovereigns. No permanent cross-border political, legal, or regulatory structure exists in the Paso del Norte region to harmonize any aspect of the energy sector at any level of government. The absence of any meaningful cross-border regulatory structure, both regionally as well as binationally, generates varying cost structures that pervade the upstream, midstream, and downstream development of hydrocarbon and renewable energy sources. The communities of the Paso del Norte region, like other similarly situated border communities, not only manifest these varying costs, but also continue to bear their burden.

The burdens that then result from these territorial divisions and regulatory asymmetries fracture what could otherwise be a substantial economy of scale in the Paso del Norte region. When its constituent parts are looked at holistically, no nearby city, nor any other along the U.S.-Mexico border, possesses comparable levels of commercial, industrial, and demographic magnitude and

growth. Yet, the investment needed to develop the energy sector across the borders in the Paso del Norte region faces substantial and prohibitive costs and risks associated with these divergent legal and regulatory structures. Such divergence not only hinders the efficient and scalable deployment of capital to foster the development of the energy sector, but also has a substantial impact on disparate upstream, midstream, and downstream costs across the region's jurisdictions. As a consequence, these differing legal principles, physical structures, and pricing constraints pull the regional energy sector apart in centrifugal fashion.

While these divergences certainly bear upon the local, cross-border economy of the Paso del Norte region, they also impact the binational, U.S.-Mexico relationship as a whole. As the inexorable integration of the U.S. and Mexico advances, particularly in the energy sector, the need to find

legal and regulatory commonalities, beyond mere tariff harmonization, has taken on ever-greater importance. Finding and implementing such commonalities would certainly benefit the locally situated Paso del Norte region as well as other border communities. More importantly, though, regulatory commonalities would strengthen the local cross-border economy and thereby preserve and enrich the strength and resilience of the Paso del Norte region as the geostrategic nexus of overland trade between the U.S. and Mexico. For a region that occupies this unique geographic, political, economic, and historical position, the ability of the communities of the Paso del Norte region to create common regulatory structures in light of such opposing frameworks represents a tremendous opportunity to add value and vitality to the social and economic development of the U.S. and Mexico at both the regional and binational levels.

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