
**Arizona-Mexico Commission
Energy Committee**

**Bi-National Electricity
Transmission Opportunities
for Arizona and Sonora**

A White Paper



Submitted to:
Arizona Governor
Janice K. Brewer
and
Sonora Governor
Guillermo Padrés Elías



Submitted by:
Bi-National Electricity Transmission Task Force
at
The Arizona-Mexico Commission
Summer Plenary Session
June 14, 2013
Scottsdale, Arizona

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Introduction

On June 8, 2012, as part of the Arizona-Mexico Commission's Summer Plenary, Arizona Governor Janice K. Brewer and Sonora Governor Guillermo Padrés Elías discussed how recent changes in Mexico's energy laws could allow the Comisión Federal de Electricidad (CFE), Mexico's federally-operated utility to purchase energy from United States firms, either from conventional generation sources such as natural gas or renewable energy sources such as solar, in order to meet new Mexican policy objectives.

As Arizona's and Sonora's large desert areas offer some of the highest solar power potential in North America, this creates a cross-border opportunity, however large-scale bi-national transmission of electricity between the two states does not currently exist.

As a result, the governors asked the Arizona-Mexico Commission Energy Committee to form a Bi-National Transmission Task Force (Task Force) to examine transmission opportunities between the State of Arizona and the State of Sonora.

The 19-member Task Force was formed with representatives from the Arizona Governor's Office of Energy Policy, the Comisión de Energía de Sonora, Arizona Public Service Company (APS), CFE, Hunt Power (based in Dallas, Texas), Salt River Project (SRP), SolarScape of Mexico, Tucson Electric Power Company (TEP) and the Universidad de Sonora. In addition, the Secretario de Economía Moisés Gomez Reyna (Commerce Secretary of Sonora) requested and received a formal Request for Support from the CFE to assign a Task Force representative to provide information for this report.

- Arizona Governor's Office of Energy Policy: Leisa Brug; Olivia Doherty and Gloria Castro
- Comisión de Energía de Sonora: Jesus Luis Celaya Gortari; Carlos Aguiar and Julio Zamorano
- Arizona Public Service Company: Jason Smith
- Comisión Federal de Electricidad: Alejandro Reyna; Luis Miguel Cota and Felipe Valle
- Hunt Power: Bill Bojorquez
- Salt River Project: Rob Taylor and Hilén Cruz
- SolarScape de Mexico: Alvaro Knapp; David Rico and Mauricio Muñoz
- Tucson Electric Power Company: Larry Lucero; Ed Beck and Roberto Guevara
- Universidad de Sonora: Rafael Cabanillas

The Task Force held meetings in Hermosillo, Sonora, Mexico and in Nogales, Arizona, United States as well as a series of conference calls to identify opportunities and challenges to implementing future transmission between the two states.

Executive Summary

The following is a compilation of information that was discussed among the Task Force members during these meetings.

By way of background, there are three major utilities in Arizona, APS, SRP and TEP. Mexico and the State of Sonora have one federally operated utility called the CFE.

Over the years, the Arizona utilities have consistently added new transmission facilities to address reliability and ensure that they can meet load growth requirements; likewise Sonora's grid has been expanding in the last decade and is referred to as the Sonora-Sinaloa Node. (See map below) The Sonora-Sinaloa Node has been enhancing its connectivity to the balance of Mexico's grid since 2000.



Arizona utilities have sufficient capacity to meet current demand through owned and contracted generation. Arizona is also home to the Palo Verde trading hub, one of the largest trading markets in the West, presenting an opportunity to provide energy to Sonora.

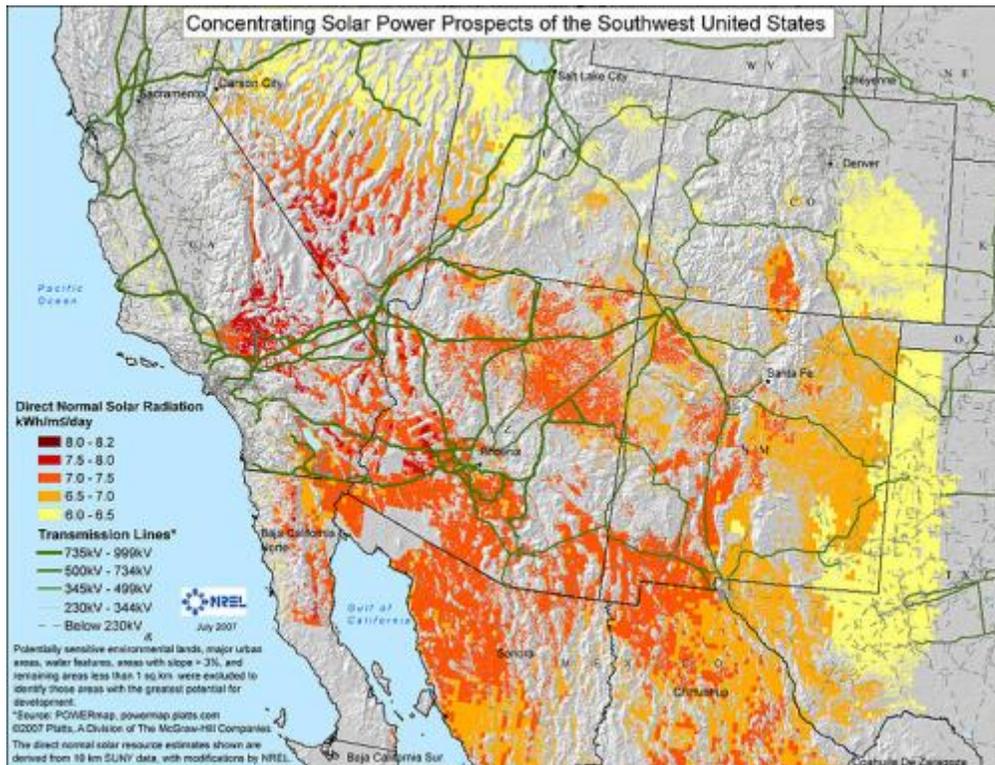
In the State of Sonora, the CFE has 11 electric energy generating central plants, with an effective capacity of 2,086.62 megawatts (MW), of which two are operated by independent producers. These resources are insufficient during summer peak demand periods, given the weather conditions and the great industrial activity of the region. Records show that in previous years, 680 MW have been imported to the Northwestern Area, mainly from the States of Durango and Nayarit. This has been accomplished notwithstanding the transmission capacity limitations between the State of Sonora and the Mexican States mentioned above.

Peak energy demand times vary between Sonora and Arizona, with Arizona’s peak demand occurring between 4:00 p.m. to 6:00 p.m. and Sonora’s experiencing two peak demands, due to cultural traditions, one between 2:00 p.m. to 4:00 p.m. and the other between 7:00 p.m. to 9:00 p.m.

Regarding renewable energy, APS and TEP, as investor-owned utilities have a renewable energy portfolio standard of 15 percent by 2025. These companies are subject to the regulatory oversight of the Arizona Corporation Commission. In addition, SRP has a similar sustainability goal of 20 percent by 2020 which was adopted by its elected board. Arizona utilities are well positioned and on schedule to meet their goals.

In 2012, Mexico passed its renewable energy portfolio standard of 35 percent by 2024. Estimates in 2010 of solar, wind, and biomass resources show large potential, however geothermal energy is the only renewable energy source (excluding hydropower at 19 percent) with a significant contribution to the energy mix (2 percent of total generation capacity).

As you can see from the map below, solar potential for Arizona and Sonora is strong. Independent developers are seeking to build numerous solar projects in Sonora as a way to address the gap in energy generation.





Regarding the transmission history between the two states, APS previously operated a Mexico Emergency Tie in Douglas, Arizona with the CFE in Agua Prieta, Sonora; however that tie has since been removed from service and no longer exists. (See page 49)

In 2000, TEP pursued a 345 kilovolt (kV) interconnection in Nogales, Arizona with the CFE in Nogales, Sonora. Before the project could move forward, a complex, permitting process had to be completed.

A Certificate of Environmental Compatibility (CEC) issued by the Arizona Corporation Commission took about a year to complete with a proposed transmission route.

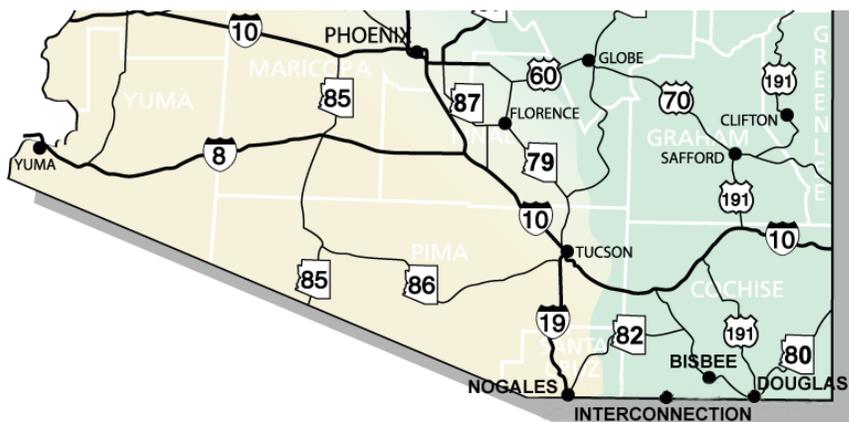
The U.S. Department of Energy became the lead agency to complete an Environmental Impact Statement (EIS) for this project, which was needed to obtain a Presidential Permit for the actual crossing of the U.S. border. This process delayed the project by four and a half years and established a different proposed route involving the U.S. Forest Service, the U.S Bureau of Land Management and several other agencies.

As a result, TEP spent more than \$9 million on permitting a project that was never constructed. (See page 43)

There are two existing ties between San Luis, Arizona and San Luis, Sonora. The first emergency-tie is a 20 MW tie through a 34.5 kV line that distributes electricity directly to the Mexican state of Baja California. The tie was last used in 2010 following an earthquake in the Baja area. APS provided approximately 20 MW of assistance totaling approximately 254 MW hours to the CFE over the course of 22.5 hours. The second tie serves approximately 8 MW of load to four industrial customers in San Luis, Sonora. (See Page 49)

Recommendation

Based on information compiled by the Task Force, we believe an opportunity to build a future Bi-National Transmission Line Interconnection to best serve the States of Sonora in Mexico and Arizona in the United States could be located at the U.S.-Mexico border vicinity between Nogales and Douglas, Arizona (see map below). According to the CFE's Projects and Investments Program 2012-2026, a new 400kV Double-Circuit Transmission Line is planned between Hermosillo to Nacoziari, Sonora by April 2014. This line could potentially be connected to a back-to-back interconnection.



A back-to-back AC-DC Tie is appropriate for a bi-national interconnection due to the asynchronous characteristics of the two systems. An AC-DC-AC Tie consists of two high-voltage Alternating Current lines interconnected

through a Direct Current Converter Station. Due to the cost of a DC Converter Station and the modularity of such projects, the best approach is likely to construct such a project in phases.

Due to projected population and economic growth in Sonora, electricity demand is expected to increase. Because of the limited transmission infrastructure between Sonora and neighboring states in Mexico, and the planned construction of the 400 kV line from a zone close to the border and a high consumption center, the most feasible option for Sonora might be to import electric energy from Arizona.

The Task Force found that there is potential value in a bi-directional transmission link between Arizona and Sonora, from an energy, reliability and economic point of view. Both California and Texas have evidence of successful transmission links with Mexico that have benefited from increasing trade and emergency assistance. Arizona and Sonora are similarly situated with growing border towns and a diverse supply portfolio.

As such, the Task Force recommends that the Arizona-Mexico Commission Energy Committee evaluate electricity transmission opportunities between Arizona and Sonora on an on-going basis to identify viable future energy exchange potential, especially in renewable energy development. In addition, the Committee should continue energy information exchanges to boost energy markets and acknowledge that future cross-border transmission of electricity is a benefit to the region's environment and supports energy assurance on both sides of the border.



2013 BI-NATIONAL ELECTRICITY TRANSMISSION TASK FORCE



To solidify this commitment, representatives from the Arizona Governor’s Office of Energy Policy and the Secretaría de Economía del Estado de Sonora, signed a Declaration of Cooperation on June 14, 2013. The agreement was entered into solely by the governments of Arizona and Sonora and is independent of the 2013 Bi-National Electricity Transmission Task Force.



Existing Generation by Source, Capacity & Energy

Sonora

There are 11 electricity generating central units in Sonora; 76 percent of this installed capacity belongs to the CFE, the remaining 24 percent belongs to Independent Energy Producers (PIE).

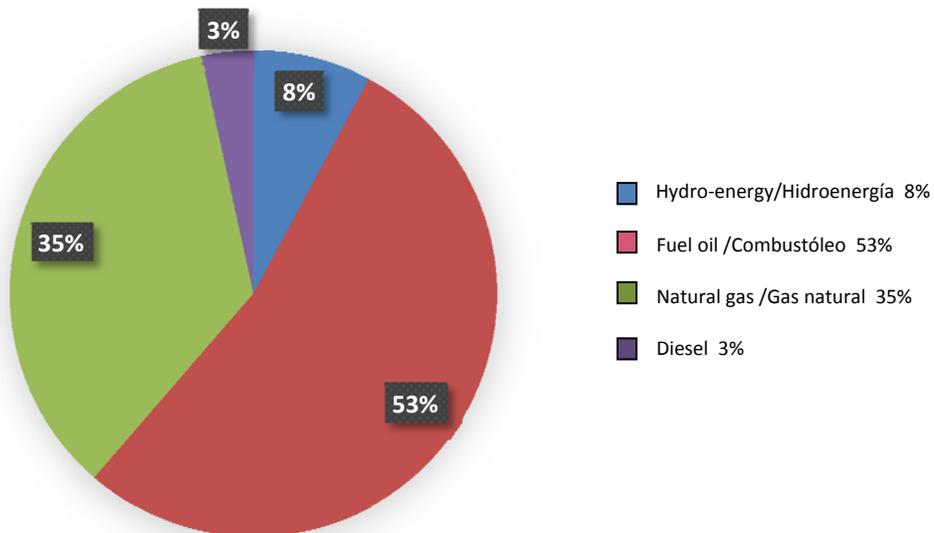
PIE represents the largest private participation scheme in Mexico, since the Electrical Energy Public Service Law was amended in 1992, allowing private capital in electricity generation.

The Spanish company Unión Fenosa has operated since 2001 in the State of Sonora and has two combined cycle central units under PIE, with a total capacity of 508 MW, effective capacity.

Name of plant	CFE/PIE	Type of energy Input	Effective Capacity (MW)	Location
Plutarco Elías Calles (El Novillo)	CFE	Hydro-energy	135.00	Soyopa
Oviáchic	CFE	Hydro-energy	19.20	Cajeme
Mocúzari	CFE	Hydro-energy	9.60	Álamos
Puerto Libertad	CFE	Fuel oil	632.00	Pitiquito
Carlos Rodríguez Rivero (Guaymas II)	CFE	Fuel oil	484.00	Guaymas
Hermosillo	CFE	Natural gas	227.02	Hermosillo
Hermosillo	PIE*	Natural gas	250.00	Hermosillo
Naco-Nogales	PIE*	Natural gas	258.00	Agua Prieta
Ciudad Obregón	CFE	Diesel	28.00	Cajeme
Caborca	CFE	Diesel	42.00	Caborca
Yécora	CFE	Diesel	1.80	Yécora
Total			2,086.62	

Source: Comisión Federal de Electricidad

Electricity Production by source source/Generación Eléctrica por fuente



According to the Energy Information System of the Secretary of Energy, the Gross Production of Electric Power is as follows:

Year	2007	2008	2009	2010	2011	2012
MWh	9,712,426.76	10,073,318.80	10,006,767.44	10,269,904.97	11,039,493.60	11,568,707.88

Source: Secretary of Energy



Existing Generation by Source, Capacity & Energy

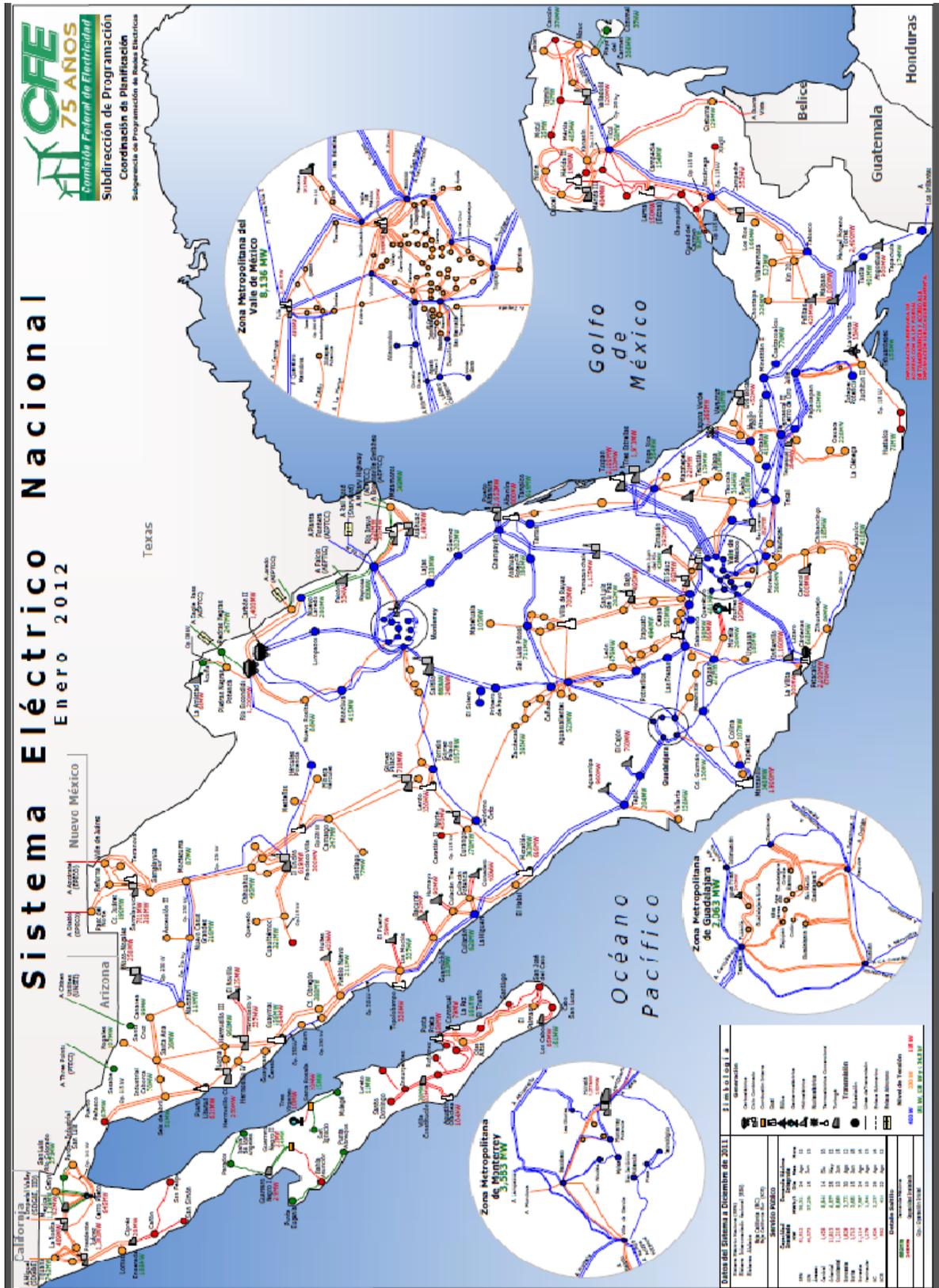
Arizona

APS and TEP Territory Only

Generation Capacity

Fuel Type	Capacity (MW)	
	APS ¹	TEP
Nuclear	1,146	0
Gas/Oil	3,362	829
Coal	1,753	1,395
Solar	11	109
Wind	28	50
Geothermal	10	0
Biomass	17	0
Long-Term Contracts	2,221	500
Total Existing Resources	8,548	2,883

¹ APS 2012 Integrated Resource Plan. March 2012.

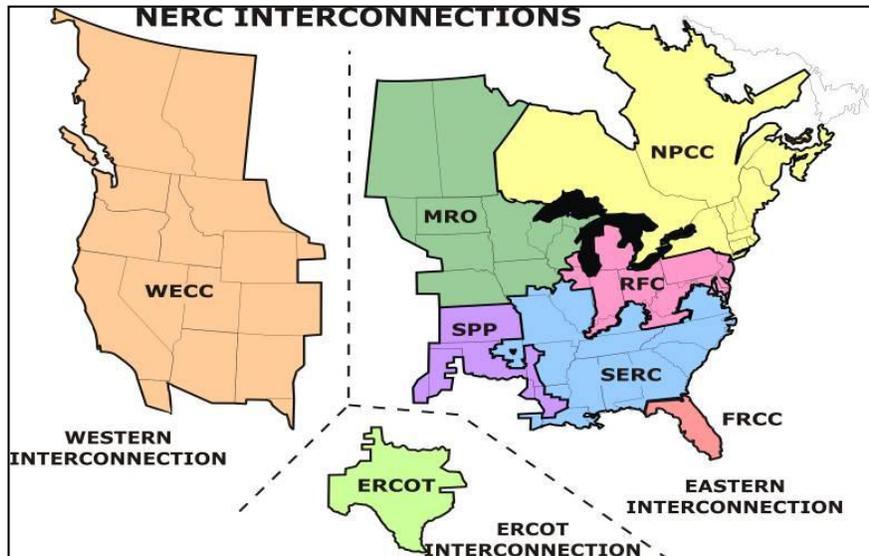


Source : Secretary of Energy based on data of Comisión Federal de Electricidad

Existing Transmission

Arizona

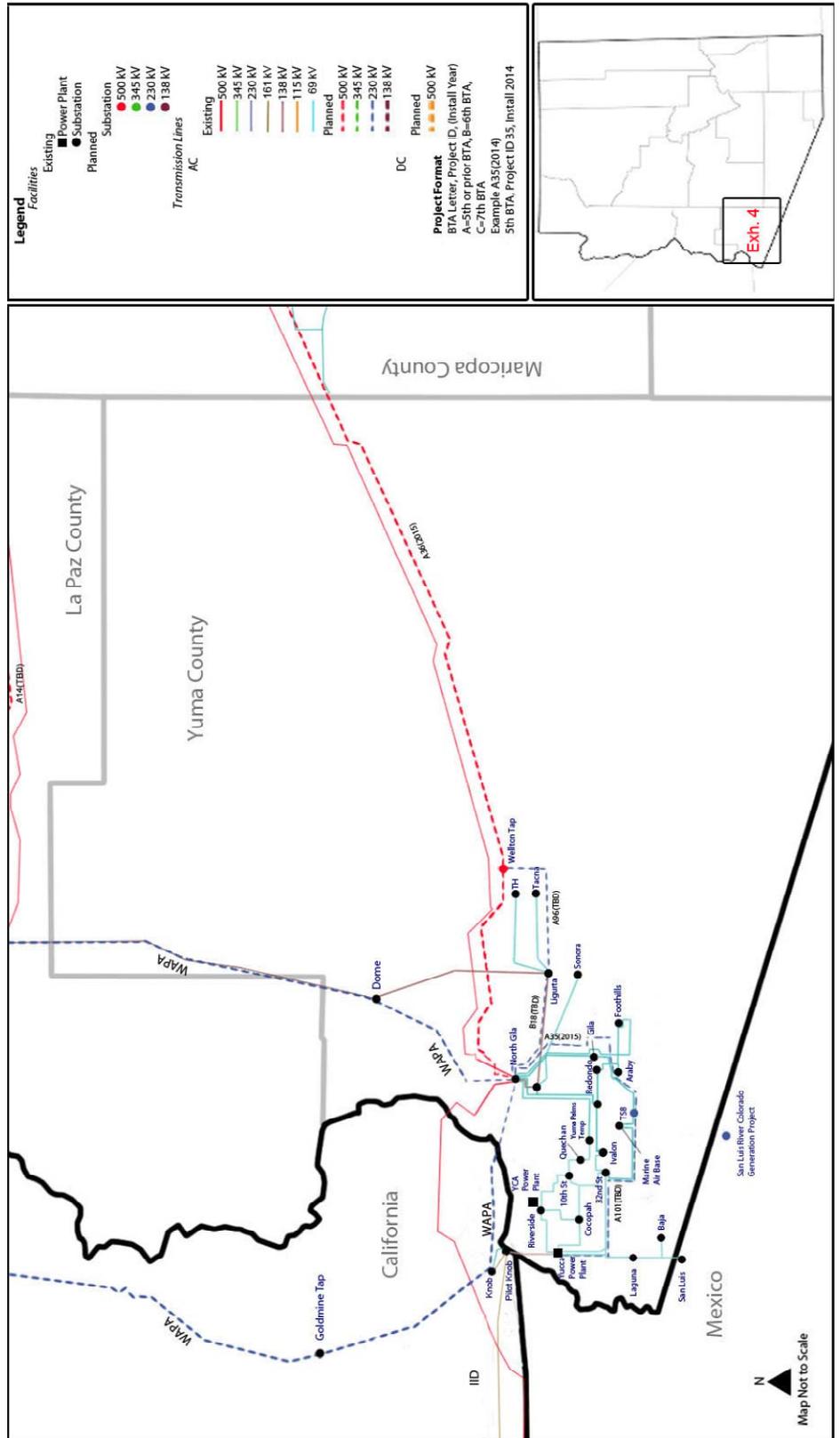
Arizona is located in the Western Electricity Coordinating Council (WECC) with interconnections to Canada and other regions in the U.S. (See map below) Arizona has transmission lines in the range of 69 kV through 500 kV.



See the following three pages to view transmission maps for Arizona.



TRANSMISSION MAP OF YUMA COUNTY





Energy Consumption by End User

Sonora

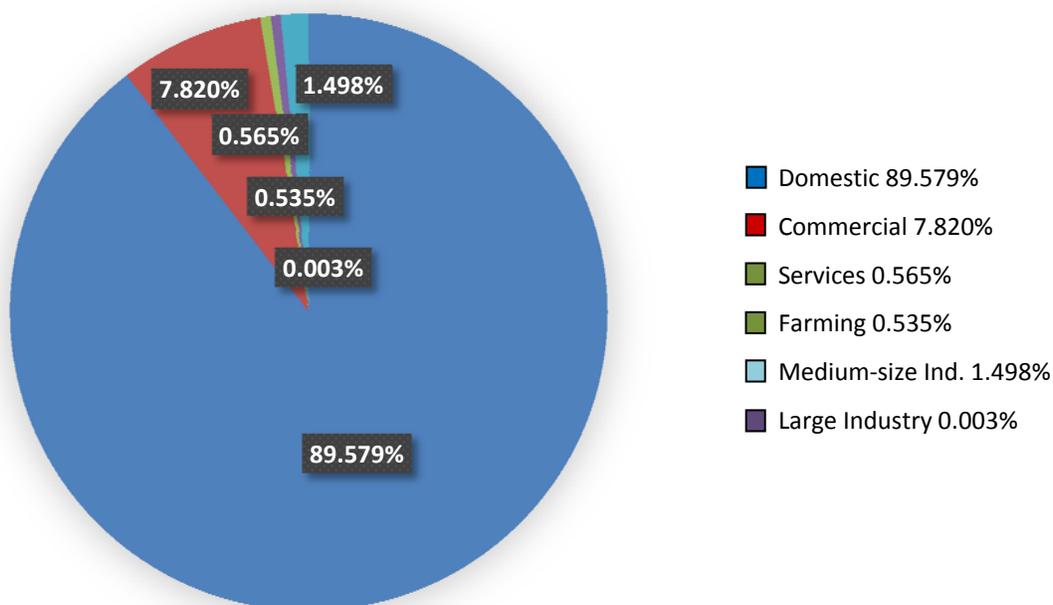
At the end of 2012, there were 957,369 users of national electric power in Sonora, all of whom are CFE customers.

Sector	2005	2006	2007	2008	2009	2010	2011	2012
Domestic	693,553	725,411	769,396	807,686	818,515	835,884	848,400	857,598
Commercial	62,959	65,372	70,401	73,547	73,255	74,393	74,785	74,862
Services	4,831	4,870	4,995	5,150	5,116	5,275	5,353	5,408
Farming	4,462	4,611	4,800	4,896	4,913	5,002	5,064	5,125
Medium-size Ind.	9,281	10,191	11,257	11,934	12,516	12,976	13,822	14,346
Large Industry	25	26	26	26	27	27	29	30
Total	775,111	810,481	860,875	903,239	914,342	933,557	947,453	957,369

Source: Comisión Federal de Electricidad

The following chart shows the number of users in the State of Sonora.

Users per Sector





Energy Consumption by End User

Arizona

APS and TEP Territory Only

2012 Energy Consumption by End User

Class	MWh	
	APS ²	TEP
Retail		
Residential	13,256,456	3,820,637
Commercial	12,531,865	1,973,931
Industrial	2,209,407	3,224,732
Irrigation	13,216	
Other	143,192	245,519
Total Retail	28,154,136	9,264,819
Wholesale		
Traditional Contracts	761,016	3,600,941
Off-System Sales	3,264,059	
Retail Load Hedge Mgmt	268,961	
Total	4,294,036	3,600,941
Total Electric Sales	32,448,172	12,865,760

² PNW 2012 Statistical Supplement



Price Differential kWh by type of service (in pesos)

Sonora

Special Rates:

Public Service:

Name	Application	Medium Tension	Low Tension
Rate 5	This rate only applies to electric energy supply for traffic lights, public lighting and season ornamental lighting, public streets, parks, plazas and gardens. In conurbations of the Federal District, Monterrey and Guadalajara.	\$2.545 per each kilowatt-hour	\$3.027 per each kilowatt-hour
Rate 5 A	This rate only applies to electric power supply for traffic lights, public lighting and season ornamental lighting, public streets, parks, plazas and gardens in the whole country, except for districts where rate 5 applies.	\$2.103 per each kilowatt-hour	\$2.503 per each kilowatt-hour
Name	Application	Fixed Rate	Energy
Rate 6	This rate applies to electric power supply for utilities such as pumping potable and black water	\$287.19 - regardless energy used	\$1.575 per each kilowatt-hour



Farming:

Name	Application	First 5,000 kWh	Subsequent 10,000 kWh	Subsequent 20,000 kWh	Additional kWh
Rate 9	This rate applies exclusively to low tension service using energy for pumping water used for irrigating land for growing crops and lighting for the pumping equipment facilities	\$ 3.414	\$ 3.800	\$ 4.150	\$ 4.550
Rate 9 M	This rate applies exclusively to medium tension service using energy for pumping water used for irrigating land for growing crops and lighting for the pumping equipment facilities	\$3.414	\$3.834	\$4.196	\$4.581

Name	Application	Energy
Rate 9-CU	This incentive rate applies to electric power used for operating pumping and re-pumping equipment for farming irrigation water by productive individuals listed in the crop/livestock energy beneficiaries, up to the Energetic Share provided by the Secretary of Agriculture, Cattle Raising, Rural Development, Fishing and Food.”	\$0.500 per each kilowatt-hour
Rate 9-N	This night incentive rate applies to electric power used for operating pumping and re-pumping equipment for farming irrigation water by productive individuals listed in the crop/livestock energy beneficiaries, up to the Energetic Share provided by the Secretary of Agriculture, Cattle Raising, Rural Development, Fishing and Food.” Registration under this rate shall be at the request of the user.	\$0.250 per each kilowatt-hour



Temporary:

Name	Application	Energy
Rate 7	This rate applies to all those services using energy temporarily for any application, exclusively where and when it is allowed by the capacity of the supplier facilities, including adequate distribution lines for providing such service.	\$4.322 per each kilowatt-hour

Fish Farming:

Name	Application	Energy
Rate EA	Incentive rates for electric energy used in fish farming facilities by productive individuals listed in crop/livestock energetic beneficiaries of SAGARPA.	Charges related to the resulting correlative rate, multiplied by the factor 0.50 (zero point five zero)

General Rates

Low tension

General Service up to 25 kW demand

Name	Application	First 5,000 kWh	Subsequent 10,000 kWh	Subsequent 20,000 kWh	Additional kWh
Rate 2	This rate applies to low tension service using energy for any application, with a demand up to 25 kilowatts, except for services under a special rate.	\$ 52.12	\$ 2,183	\$ 2,637	\$ 2,903

General services for higher than 25 kW demand

Name	Application	Peak demand charge	Additional charge for energy used
Rate 3	This rate applies to low tension service using energy for any application, with a demand higher than 25 kilowatts, except for services under a special rate.	\$ 236.53	\$ 1.656



Medium tension

Regular rate for general medium tension service under a lower than 100 kW demand

Name	Application	Region	Cost/kilowatt of measured peak	Cost/kWh-hour of energy used
Rate O-M	This rate applies to medium tension service using energy for any application, with a lower than 100 kW demand.	Baja California	\$130.63	\$1.114
		Baja California South	\$142.14	\$1.355
		B.C.S. (Summer)	\$159.69	\$1.836
		Central	\$163.12	\$1.360
		Northeast	\$150.01	\$1.271
		Northwest	\$153.12	\$1.262
		North	\$150.62	\$1.271
		Peninsular	\$168.40	\$1.300
		South	\$163.12	\$1.315

Hourly rate for general medium tension service under a 100 kW or higher demand

Name	Application	Region	Cost/kilowatt of billable	Costo/kWh of peak energy	Cost/kWh of intermediate	Cost/kWh of base energy
Rate H-M	This rate applies to medium tension service using energy for any application, with 100 kW or higher demand	Baja California	\$256.70	\$2.1433	\$1.0972	\$0.8619
		Baja California South	\$246.71	\$1.7196	\$1.5226	\$1.0775
		Central	\$177.87	\$2.0543	\$1.2151	\$1.0158
		Northeast	\$163.52	\$1.8974	\$1.1281	\$0.9241
		Northwest	\$167.02	\$1.9085	\$1.1193	\$0.9377
		North	\$164.33	\$1.9111	\$1.1389	\$0.9261
		Peninsular	\$183.79	\$2.0094	\$1.1415	\$0.9403
		South	\$177.87	\$2.0118	\$1.1609	\$0.9659



Hourly rate for general medium tension service under a 100 kW or higher demand, for short term uses.

Name	Application	Region	Cost/ kilowatt of	Cost/kWh of peak energy	Cost/kWh of inter-mediate	Cost/kWh of base energy
Rate H-MC	This rate applies to medium tension service using energy for any application, in Baja California and Northwest regions, with 100 kW or higher demand, which, given the use characteristics of their demand, request their registration under this service, which shall be effective for one year minimum	Baja California	\$231.08	\$3.1127	\$1.1420	\$0.8622
		Northwest	\$100.26	\$1.6087	\$1.5722	\$1.2019

Regular rate for general medium tension service, with a lower than 100 kW demand, and fixed charges

Name	Application	Region	Cost/kWh of energy
Rate OMF	This rate applies to medium tension service using electric energy for any application, with a lower than 100 kilowatt demand, provided user request their registration in this service. Application shall be submitted during the first 15 (fifteen) calendar days of any month of the year. Registration under this rate shall be effective for one year minimum, and it may not be terminated before the last continuity term under which the user has committed to a higher than 0 (zero) average power. Continuity term shall be understood as a 12 (twelve) consecutive calendar month period where the user is committed to an average power. Such continuity term may be renewed for new terms, where, starting the month following the month when the renewal application has been approved, new charges shall apply, adapting committed powers and energies.	Baja California (summer)	\$1.130
		Baja California (other than summer)	\$1.380
		B.C.S. (summer)	\$1.375
		B.C.S. (other than summer)	\$1.863
		Central	\$1.380
		Northeast	\$1.289
		Northwest	\$1.280
		North	\$1.289
		Peninsular	\$1.319
South	\$1.334		



Hourly rate for general medium tension service, with a 100 kW or higher demand, and fixed charges

Name	Application	Region	Cost/kWh of peak energy	Cost/kWh of inter-mediate energy	Cost/kWh of base energy
Rate H-MF	This rate applies to medium tension service using electric energy for any application, with a 100 kilowatt or higher demand, provided users request their registration in this service. Application shall be submitted during the first 15 (fifteen) calendar days of any month of the year. Registration under this rate shall be effective for one year minimum, and it may not be terminated before the last continuity term under which the user has committed to a higher than 0 (zero) average power. Continuity term shall be understood as a 12 (twelve) consecutive calendar month period where the user is committed to an average power. Such continuity term may be renewed for new terms, where, starting the month following the month when the renewal application has been approved, new charges shall apply, adapting committed powers and energies.	Baja California	\$2.1821	\$1.1088	\$0.8710
		Baja California South	\$1.7507	\$1.5387	\$1.0889
		Central	\$2.0915	\$1.2280	\$1.0266
		Northeast	\$1.9317	\$1.1401	\$0.9339
		Northwest	\$1.9430	\$1.1312	\$0.9476
		North	\$1.9457	\$1.1510	\$0.9359
		Peninsular	\$2.0458	\$1.1536	\$0.9503
		South	\$2.0482	\$1.1732	\$0.9761



Hourly rate for general medium tension service, with a 100 kW or higher demand, for short term uses, and fixed charges

Name	Application	Region	Cost/kWh of peak energy	Cost/kWh of inter-mediate energy	Cost/kWh of base energy
Rate H-MCF	This rate applies to medium tension service using electric energy for any application, with a 100 kilowatt or higher demand, in Baja California and Northwest, provided users request their registration in this service. Application shall be submitted during the first 15 (fifteen) calendar days of any month of the year. Registration under this rate shall be effective for one year minimum, and it may not be terminated before the last continuity term under which the user has committed to a higher than 0 (zero) average power. Continuity term shall be understood as a 12 (twelve) consecutive calendar month period where the user is committed to an average power. Such continuity term may be renewed for new terms, where, starting the month following the month when the renewal application has been approved, new charges shall apply, adapting committed powers and energies.	Baja California	\$3.1690	\$1.1541	\$0.8713
		North-west	\$1.6378	\$1.5889	\$1.2146



High tension

Hourly rate for general high tension service, sub transmission level

Name	Application	Region	Cost/ kilowatt of billable demand	Cost/kWh of peak energy	Cost/kWh of intermediate energy	Cost/kWh of base energy
Tariff H-S	This rate applies to high tension service, sub-transmission level, using energy for any application, which, given the use characteristics of their demand, request their registration under this service, which shall be effective for one year minimum	Baja California	\$ 212.21	\$ 2.5288	\$ 1.1575	\$ 0.9823
		B.C.S.	\$ 229.81	\$ 1.8098	\$ 1.6192	\$ 1.2122
		Central	\$ 117.80	\$ 2.3807	\$ 1.2287	\$ 1.0452
		Northeast	\$ 117.80	\$ 2.3807	\$ 1.2287	\$ 1.0452
		Northwest	\$ 117.80	\$ 2.3807	\$ 1.2287	\$ 1.0452
		North	\$ 117.80	\$ 2.3807	\$ 1.2287	\$ 1.0452
		Peninsular	\$ 117.80	\$ 2.3807	\$ 1.2287	\$ 1.0452
		South	\$ 117.80	\$ 2.3807	\$ 1.2287	\$ 1.0452

Hourly rate for general high tension service, sub transmission level, for long-term use

Name	Application	Region	Cost/ kilowatt of billable demand	Cost/kWh of peak energy	Cost/kWh of inter-mediate energy	Cost/kWh of base energy
Rate H-SL	This rate applies to high tension service, sub-transmission level, using energy for any application, which, given the use characteristics of their demand, request their registration under this service, which shall be effective for one year minimum	Baja California	\$ 318.21	\$ 1.9572	\$ 1.1170	\$ 0.9823
		B.C.S.	\$ 275.71	\$ 1.7060	\$ 1.5880	\$ 1.2122
		Central	\$ 176.69	\$ 1.7429	\$ 1.1759	\$ 1.0452
		North-east	\$ 176.69	\$ 1.7429	\$ 1.1759	\$ 1.0452
		North-west	\$ 176.69	\$ 1.7429	\$ 1.1759	\$ 1.0452
		North	\$ 176.69	\$ 1.7429	\$ 1.1759	\$ 1.0452
		Peninsular	\$ 176.69	\$ 1.7429	\$ 1.1759	\$ 1.0452
		South	\$ 176.69	\$ 1.7429	\$ 1.1759	\$ 1.0452



Hourly rate for general high tension service, transmission level

Name	Application	Region	Cost/ kilowatt of billable demand	Cost/kWh of peak energy	Cost/kWh of intermediate energy	Cost/kWh of base energy
Rate H-T	This rate applies to high tension service, transmission level, using energy for any application, which, given the use characteristics of their demand, request their registration under this service, which shall be effective for one year minimum	Baja California	\$ 198.43	\$ 2.4137	\$ 1.1381	\$ 0.9697
		B.C.S.	\$ 176.62	\$ 1.9426	\$ 1.5785	\$ 1.1777
		Central	\$ 104.46	\$ 2.3461	\$ 1.1059	\$ 0.9959
		Northeast	\$ 104.46	\$ 2.3461	\$ 1.1059	\$ 0.9959
		Northwest	\$ 104.46	\$ 2.3461	\$ 1.1059	\$ 0.9959
		North	\$ 104.46	\$ 2.3461	\$ 1.1059	\$ 0.9959
		Peninsular	\$ 104.46	\$ 2.3461	\$ 1.1059	\$ 0.9959
		South	\$ 104.46	\$ 2.3461	\$ 1.1059	\$ 0.9959

Hourly rate for general high tension service, transmission level, for long term use

Name	Application	Region	Cost/ kilowatt of billable demand	Cost/kWh of peak energy	Cost/kWh of intermediate energy	Cost/kWh of base energy
Rate H-TL	This rate applies to high tension service, sub-transmission level, using energy for any application, which, given the use characteristics of their demand, request their registration under this service, which shall be effective for one year minimum	Baja California	\$ 297.71	\$ 1.8805	\$ 1.0980	\$ 0.9697
		B.C.S.	\$ 264.89	\$ 1.6619	\$ 1.5263	\$ 1.1777
		Central	\$ 156.72	\$ 1.7090	\$ 1.0840	\$ 0.9959
		Northeast	\$ 156.72	\$ 1.7090	\$ 1.0840	\$ 0.9959
		Northwest	\$ 156.72	\$ 1.7090	\$ 1.0840	\$ 0.9959
		North	\$ 156.72	\$ 1.7090	\$ 1.0840	\$ 0.9959
		Peninsular	\$ 156.72	\$ 1.7090	\$ 1.0840	\$ 0.9959
		South	\$ 156.72	\$ 1.7090	\$ 1.0840	\$ 0.9959



Hourly rate for general high tension service, sub transmission level, and fixed charges

Name	Application	Region	Cost/kWh of peak energy	Cost/kWh of intermediate energy	Cost/kWh of base energy
Rate H-SF	This rate applies to high tension service, sub-transmission level, using electric energy for any application, with a 100 kilowatt or higher demand, in Baja California and Northwest, provided users request their registration in this service. Application shall be submitted during the first 15 (fifteen) calendar days of any month of the year. Registration under this rate shall be effective for one year minimum, and it may not be terminated before the last continuity term under which the user has committed to a higher than 0 (zero) average power. Continuity term shall be understood as a 12 (twelve) consecutive calendar month period where the user is committed to an average power. Such continuity term may be renewed for new terms, where, starting the month following the month when the renewal application has been approved, new charges shall apply, adapting committed powers and energies.	Baja California	\$2.4994	\$1.0792	\$0.9159
		B.C.S.	\$1.7888	\$1.5097	\$1.1303
		Central	\$2.3530	\$1.1456	\$0.9745
		Northeast	\$2.3530	\$1.1456	\$0.9745
		Northwest	\$2.3530	\$1.1456	\$0.9745
		North	\$2.3530	\$1.1456	\$0.9745
		Peninsular	\$2.3530	\$1.1456	\$0.9745
		South	\$2.3530	\$1.1456	\$0.9745



Hourly rate for general high tension service, sub transmission level, and fixed charges

Name	Application	Region	Cost/kWh of peak energy	Cost/kWh of intermediate energy	Cost/kWh of base energy
Rate H-SLF	This rate applies to high tension service, sub-transmission level, using electric energy for any application, with a 100 kilowatt or higher demand, in Baja California and Northwest, provided users request their registration in this service. Application shall be submitted during the first 15 (fifteen) calendar days of any month of the year. Registration under this rate shall be effective for one year minimum, and it may not be terminated before the last continuity term under which the user has committed to a higher than 0 (zero) average power. Continuity term shall be understood as a 12 (twelve) consecutive calendar month period where the user is committed to an average power. Such continuity term may be renewed for new terms, where, starting the month following the month when the renewal application has been approved, new charges shall apply, adapting committed powers and energies.	Baja California	\$1.9046	\$1.0414	\$0.9159
		B.C.S.	\$1.6601	\$1.4806	\$1.1303
		Central	\$1.6960	\$1.0964	\$0.9745
		Northeast	\$1.6960	\$1.0964	\$0.9745
		Northwest	\$1.6960	\$1.0964	\$0.9745
		North	\$1.6960	\$1.0964	\$0.9745
		Peninsular	\$1.6960	\$1.0964	\$0.9745
		South	\$1.6960	\$1.0964	\$0.9745



Hourly rate for general high tension service, transmission level, and fixed charges

Name	Application	Region	Cost/kWh of peak energy	Cost/kWh of intermediate energy	Cost/kWh of base energy
Rate H-TF	This rate applies to high tension service, transmission level, using electric energy for any application, provided users request their registration in this service. Application shall be submitted during the first 15 (fifteen) calendar days of any month of the year. Registration under this rate shall be effective for one year minimum, and it may not be terminated before the last continuity term under which the user has committed to a higher than 0 (zero) average power. Continuity term shall be understood as a 12 (twelve) consecutive calendar month period where the user is committed to an average power. Such continuity term may be renewed for new terms, where, starting the month following the month when the renewal application has been approved, new charges shall apply, adapting committed powers and energies.	Baja California	\$2.3856	\$1.0611	\$0.9041
		B.C.S.	\$1.9200	\$1.4717	\$1.0980
		Central	\$2.3188	\$1.0311	\$0.9285
		Northeast	\$2.3188	\$1.0311	\$0.9285
		Northwest	\$2.3188	\$1.0311	\$0.9285
		North	\$2.3188	\$1.0311	\$0.9285
		Peninsular	\$2.3188	\$1.0311	\$0.9285
		South	\$2.3188	\$1.0311	\$0.9285



Hourly rate for general high tension service, transmission level, and fixed charges

Name	Application	Region	Cost/kWh of peak energy	Cost/kWh of intermediate energy	Cost/kWh of base energy
Rate H-TLF	This rate applies to high tension service, transmission level, using electric energy for any application, provided users request their registration in this service. Application shall be submitted during the first 15 (fifteen) calendar days of any month of the year. Registration under this rate shall be effective for one year minimum, and it may not be terminated before the last continuity term under which the user has committed to a higher than 0 (zero) average power. Continuity term shall be understood as a 12 (twelve) consecutive calendar month period where the user is committed to an average power. Such continuity term may be renewed for new terms, where, starting the month following the month when the renewal application has been approved, new charges shall apply, adapting committed powers and energies.	Baja California	\$1.8299	\$1.0237	\$0.9041
		B.C.S.	\$1.6172	\$1.4231	\$1.0980
		Central	\$1.6631	\$1.0107	\$0.9285
		Northeast	\$1.6631	\$1.0107	\$0.9285
		Northwest	\$1.6631	\$1.0107	\$0.9285
		North	\$1.6631	\$1.0107	\$0.9285
		Peninsular	\$1.6631	\$1.0107	\$0.9285
		South	\$1.6631	\$1.0107	\$0.9285

Source: Comisión Federal de Electricidad



Following is a summary of rates and their average costs:

Sector	Rate	Tension Supplied	Billing	Average Cost* (pesos/kWh)
Domestic	1A a 1F	Low	Bimonthly and Monthly	1.1797
	DAC	Low	Bimonthly and Monthly	
Services	5 y 5A	Low and Medium	Monthly	2.0643
	6	Low and Medium	Monthly	
Farming	9 y 9M	Low and Medium	Monthly	0.5791
	9-CU y 9-N	Low and Medium	Monthly	
Commercial	2	Low	Bimonthly and Monthly	2.9221
	3	Low	Monthly	
Medium-Size Company	O-M	Medium	Monthly	1.6469
	H-M y H-MC	Medium	Monthly	
Large Industry	H-S y H-SL	High Transmission	Monthly	1.2734
	H-T y H-TL	High Transmission	Monthly	



Price Differential kWh by type of service

Arizona

APS and TEP Territory Only

Average 2012 Retail Rates by Customer Class

Class	¢/kWh	
	APS ³	TEP
Retail		
Residential	11.97¢	10.30¢
Commercial	10.18	11.56
Industrial	7.86	7.82
Irrigation	11.42	6.15
Avg. Retail	10.87	9.87

³ PNW 2012 Statistical Supplement



Projected Sales and Demand

Sonora

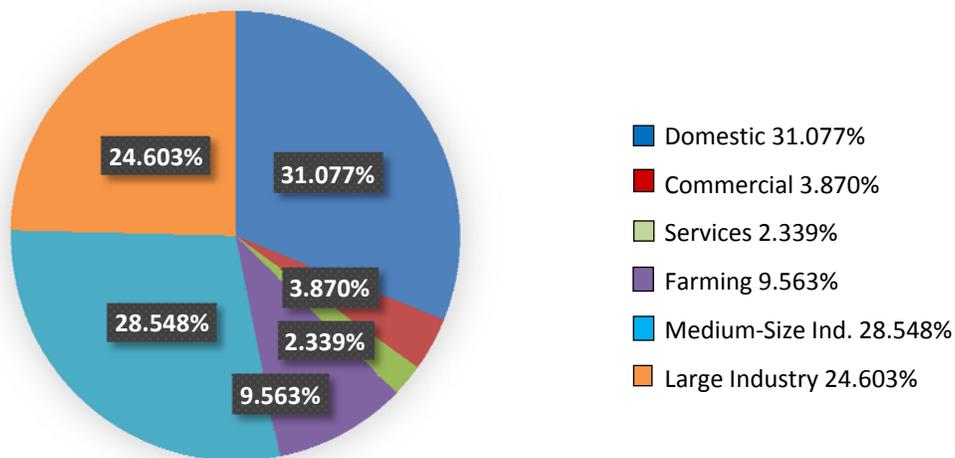
Sales

Total sales reached in 2012 amounted to 11,048,977 MW hours, which represents \$14, 088, 600,000 pesos: Following is the sales record of CFE in the State of Sonora in MW hours:

Sector	2005	2006	2007	2008	2009	2010	2011	2012
Domestic	2,551,652	2,731,778	2,863,543	2,988,241	3,084,643	3,151,188	3,331,604	3,433,669
Commercial	426,722	438,250	438,001	438,148	429,271	420,317	425,241	427,615
Services	134,232	147,190	150,229	163,674	240,163	243,717	255,987	258,409
Farming	903,541	906,155	939,387	931,468	1,013,978	945,445	1,058,239	1,056,607
Medium-Size Ind.	2,461,361	2,609,782	2,773,409	2,831,115	2,693,149	2,775,638	2,976,383	3,154,275
Large Industry	2,552,734	2,247,994	2,332,119	1,959,462	1,661,553	1,638,409	2,475,226	2,718,401
Total	9,030,242	9,081,149	9,496,688	9,312,107	9,122,758	9,174,714	10,522,680	11,048,977

Source: Comisión Federal de Electricidad

Sales per Sector





Projected Sales and Demand

Sales projections for electric energy for the next five years is an internal estimation, based on sales records of CFE and economic growth rates of each sector in the State of Sonora.

Sector	2013	2014	2015	2016	2017	2018
Domestic	3,559,857	3,680,483	3,801,109	3,921,735	4,042,361	4,162,987
Commercial	423,978	422,541	421,104	419,667	418,230	416,792
Services	294,031	315,105	336,178	357,252	378,325	399,399
Farming	1,072,883	1,095,890	1,118,896	1,141,903	1,164,910	1,187,917
Medium-Size Ind.	3,135,396	3,213,397	3,291,399	3,369,400	3,447,402	3,525,403
Large Industry	2,193,780	2,192,789	2,191,798	2,190,808	2,189,817	2,188,827
Total	10,679,924	10,920,204	11,160,484	11,400,764	11,641,044	11,881,324

Source: Internal estimation

In August 2011, there was a peak demand of 3,772 MW, which represented a 4.29 percent increase compared to the previous year.

There are currently 941 MW installed in hydro-electric plants in the Northwestern Area of the CFE; however, water stored in the reservoirs is used mainly for irrigation, so only a fraction of such capacity may be used to serve the peak demand of the Area. Water in reservoirs is controlled by the National Water Commission (CONAGUA), the entity which provides a monthly share in use volume to the CFE.

With respect to thermal generation, the effective installed capacity reaches 2,787 MW in the Area. During the summer during Sonora's peak demand, the actual available capacity is reduced nearly 8 percent due to the effect of ambient temperature, maintenance, failures of the same units or water availability.

Peak demand in the Area shows up during the summer, distinguished by the ambient temperature increase and the behavior of the industrial sector, particularly mining and fish-farming activities. Such situations cause power flows in the main transmission network.

In 2011, during peak demand conditions, 680 MW were imported, of which nearly 60 percent was conducted through the Mazatlán-Tepic link, and the remainder through Mazatlán-Durango. 21 MW were imported through the Nacozari-Moctezuma link.

Upon the recent increase in the Area's demand, and considering the current electric infrastructure, it is projected that several transformation banks could reach the rated capacity of 230/115 kV.

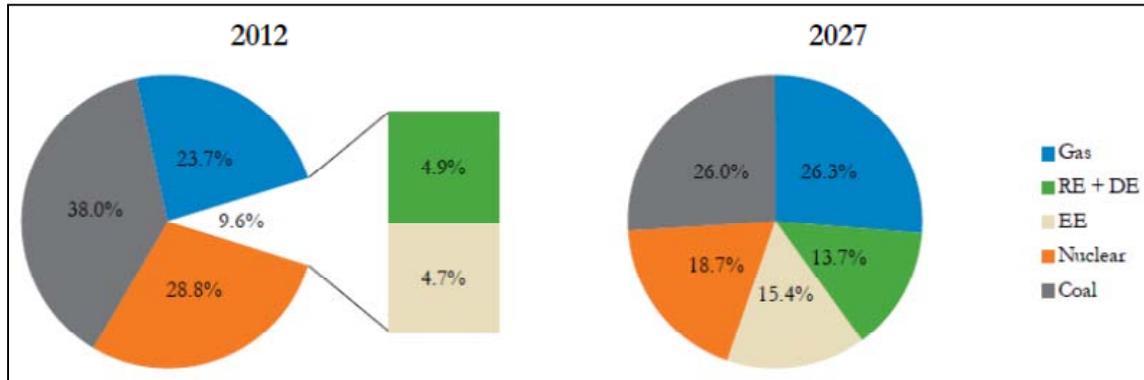
As part of the development of the main network, in April 2014, the first circuit between the substations of Nacozari and Hermosillo will be built, (201 km long, isolated, 400 kV) which will increase the transmission capacity among the regions of Hermosillo and the north border of the State.

Source: Work and Investment Program of the Electric Sector 2012-2026 (POISE)

Projected Sales and Demand

Arizona

APS ONLY - Current and Future Energy Mix⁴

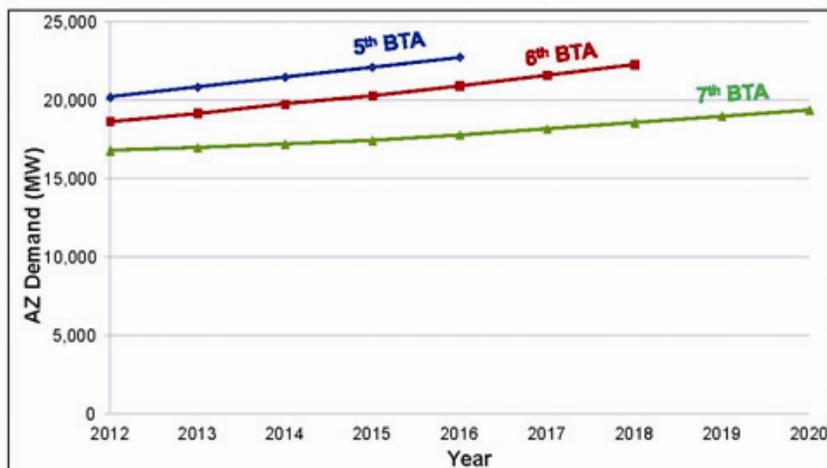


APS ONLY - Load Forecast, net of EE/DE (2013-2027)⁴

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Peak Load (MW)	7,102	7,183	7,207	7,340	7,496	7,652	7,838	8,002	8,140	8,398	8,643	8,883	9,122	9,379	9,649
YOY % Change		1.1%	0.3%	1.8%	2.1%	2.1%	2.4%	2.1%	1.7%	3.2%	2.9%	2.8%	2.7%	2.8%	2.9%

APS ONLY - 2012 System Peak Load⁵ - 7,207 MW

Figure 1: Change in Arizona Demand Forecast



As shown in Figure 1, the statewide demand forecast has shifted by about six years since the Sixth BTA. This is two years longer than the shift that was observed between the Fifth BTA and Sixth BTA, and is indicative of the continuing impact of the national economic recession on electrical demand.

⁴ APS 2012 Integrated Resource Plan. March 2012.

⁵ PNW 2012 Annual Report



Permitting Process

Sonora

The following permits or approvals are required for the construction of a transmission line:

- Compatibility of the Project before Federal, State and City entities (depending on the location of the project).
- Approval of the Statement of Environmental Impact (MIA) by the Secretary of Environment and Natural Resources (SEMARNAT).
- Approval by INAH (if applicable).
- Approval of the Change of Use of Land (ETJ) by the Secretary of Environment and Natural Resources (SEMARNAT).
- Construction license by the City or Cities.
- Approval of crossings with communication means by the Secretary of Communication and Transportation (SCT).
- Access easement by each land owner being affected by the path of the transmission line.

Source: Comisión Federal de Electricidad

Arizona

- Arizona Corporation Commission – Certificate of Environmental Compatibility
 - Every utility planning to construct a thermal or nuclear plant greater than 100MW or a transmission line of 115kV or above, or both shall first file an application for a Certificate of Environmental Compatibility with the Commission. .
- U.S. Department of Energy (DOE) - Presidential Permit (duration of permits may last decades).
 - Under Executive Order (EO) 10485 of September 3, 1953, as amended by EO 12038 of February 3, 1978, no one may construct, connect, operate, or maintain facilities at the U.S. international border for the transmission of electric energy between the United States and a foreign country without first obtaining a Presidential Permit from the DOE.
 - To obtain a Presidential Permit, an Environmental Impact Study must be completed.
 - TEP has one in the Nogales, AZ area and one at Lochiel, AZ. Both at the Distribution level.
 - APS has one in San Luis, AZ at the Distribution level.
- Federal Issues: Transmission siting in Arizona must take into account a great deal of federal land and tribal reservation land. In addition, at the Federal level National Electric Transmission Corridor (NIETC) designations have been identified by the U.S.



In 2007, the DOE designated two corridors, the Mid-Atlantic Area national corridor, and the Southwest Area corridor. Using a source-and-sink approach, the DOE determined areas of significant transmission network congestion and electricity demand (sink), then examined likely areas of nearby generation (source). The possible paths between these sources and sinks defined the highest priority regions where transmission lines need to be built. In designating an NIETC corridor, the DOE does not specify preferred routes for projects, just the general region where such projects are eligible for federal permits. Further, DOE did not exclude federal or state lands from the regions but right of eminent domain by a FERC permit would not apply to them. Although Congress did not specify that national corridors expire, the Secretary of Energy set a limit of 12 years for the Southwest and Mid-Atlantic corridors, subject to revision at any time after giving notice and opportunity for public comment. Designated corridors in Arizona are located in La Paz, Maricopa and Yuma counties.

- Specific permits from various land agencies, depending on location of the project.

Permit Comparison Table: Mexico vs. U.S.

PERMIT TYPE	MEXICO	U.S.
Export, Import, Int. Sale, Co-Generation, etc. For 500kV and above.	CRE	PRESIDENTIAL PERMIT
Environmental Impact Statement	MIA	EIS – NEPA Process



Regulatory Issues

Sonora

The Energy Regulating Commission, decentralized entity of the Secretary of Energy, has technical, operating, management and decision authority with respect to its activities.

The Commission promotes the efficient development of the following activities:

- Supply and sale of electric energy to public service users.
- Generation, import and export of electric energy, by private individuals.
- Acquisition of electric energy used for public service.
- Conduction, transformation and delivery services of electric energy among the entities which are in charge of providing the public service of electric energy, among the latter and the holders of permits for the generation, export and import of electric energy.
- Among others, related to other types of energy.

In order to comply with the above, the Energy Regulating Commission has the following authorities:

- Participate in determining rates for supply and sale of electric energy.
- Approve criteria and bases for determining the amount of contributions by the governments of the states, cities and beneficiaries of the public service of electric energy, to carry out specific works, extensions or modifications, requested by the former for the supply of electric energy.
- Verify that in regard to the public service of electric energy, the lowest cost energy shall be acquired for the entities in charge of providing such public service, providing maximum stability, quality and security for the national electric system.
- Approve methodologies for the calculation of considerations for the acquisition of electric energy used for public service.
- Approve methodologies for the calculation of considerations for conduction, transformation and delivery services of electric energy.
- Express their view, at the request of the Secretary of Energy, on the preparation and follow-up of the sectoral program in energy matter; on the needs to grow or substitute the generation capacity of the national electric system; on the convenience for CFE to execute projects or to call private individuals to participate in supplying electric energy, and if applicable, on the terms and conditions of announcements and bidding bases.
- Grant and revoke permits and approvals which, under legal provisions applicable, are required for the performance of regulated activities.
- Approve and issue models of adhesion agreements and contracts for regulated activities.
- Propose updating the legal framework of the scope of the jurisdiction of the Secretary of Energy, as well as the terms upon which the Commission may participate together with the competent entities in preparing projects for legislative bills, decrees, regulating provisions and Mexican official standards with respect to regulated activities.
- Among others, related to other types of energy.



Regulatory Issues

Arizona

If, for purposes of obtaining a Presidential Permit or for activity on Federal Land, it is determined that a proposed project would constitute a major Federal action that may have a significant impact on the environment within the meaning of the National Environmental Policy Act of 1969 (NEPA), 42 United States Code (U.S.C.) §§ 4321 et seq. the project must have an Environmental Impact Statement developed for the project. The Draft Environmental Impact Statement (EIS) should evaluate potential environmental impacts from the proposed Federal action and reasonable alternatives, including the No Action Alternative.

Section 102(2)(c) of NEPA, Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] 1500-1508), and DOE NEPA Implementing Procedures (10 CFR 1021) are the guiding documents. DOE, The U.S. Department of Agriculture Forest Service (USFS), the Bureau of Land Management (BLM) of the U.S., the Department of the Interior, and the U.S. Section of the International Boundary and Water Commission, U.S. and Mexico (USIBWC), are all agencies that typical will require an EIS to the extent lands or activities they control are impacted. Each of these organizations will use the EIS for its own NEPA purposes as described in their purpose and need and authorizing action documents.



Legal Issues

Sonora

Article 27 of the Political Constitution of the Mexican United States reads as follows: “it is the Nation which is solely in charge of generating, conducting, transforming, distributing and supplying electric energy for public service. As to this matter, no concessions shall be granted to private individuals and the Nation shall use those public resources required for such purposes.”

The Public Service of Electric Energy Law refers to Article 27 of the Political Constitution of the Mexican United States, for the purpose of this Law. Such public service of electric energy includes:

- Planning the national electric system
- Generation, conduction, transformation, distribution and sale of electric energy, and;
- Execution of all works, installations and activities which require planning, execution, operation and maintenance of the national electric system.

This same law refers that the CFE shall be the entity in charge of providing the public service of electric energy in behalf of the Nation. This entity shall provide the public service of electric energy in terms of the points mentioned earlier; therefore, the CFE shall be authorized to sell electric energy.

The following is not considered as public service of electric energy by the Public Service of Electric Energy Law:

- Generation of electric energy for self-supply, cogeneration or small-scale production;
- Generation of electric energy by independent producers for sale purposes to CFE ;
- Generation of electric energy for export purposes, derived from the generation, independent production and small-scale production;
- Importing electric energy by individuals or companies, to be used solely for their own use; and
- Generation of electric energy used for emergencies caused by interruptions of the public service of electric energy.

In this regard, the Secretary of Energy, considering the criteria and regulations of the national energy policy and attending the opinion of CFE, shall grant approvals for self-supply, co-generation, independent production, small-scale production, as well as importing or exporting electric energy.

Source: Political Constitution of the Mexican United States and the Public Service of Electric Energy Law.



Legal Issues

Arizona

Acquiring land for transmission lines in Arizona can be challenging for a variety of reasons. First, as you can see from the following map a significant percentage of Arizona's lands are owned or held in trust by the federal government. As a result, constructing projects on federal lands requires that the project proponent comply with the National Environmental Policy Act (NEPA) as discussed above. The NEPA process can be very lengthy and expensive. Additionally, each federal agency and their respective land managers may have different mandates and goals related to the use of the lands held by that agency. For example, the U.S. National Park Service may be more intent on protecting certain scenic or recreational opportunities that may be perceived as incompatible with a transmission line. While another agency like the U.S. Bureau of Land Management, may accommodate multiple uses for the lands they manage. Under either circumstance, working with the respective agencies can be a challenge for project developers.

In addition, to the challenges on federal lands, transmission developers also face challenges on private lands. Permitting on private lands avoids the complications associated with the NEPA process but raises another series of issues. Transmission developers must work with landowners to address a range of concerns including economic (appropriate compensation for land use and impacts), continuing compatible uses of the land, perceived health impacts, visual impacts and impacts to adjacent land owners and compatibility with future development. These issues can generally be addressed through direct negotiations for an easement or other rights-of-way. Also, in some cases, land can be acquired through court proceedings, such as condemnation.



Tucson Electric Power Company Case Study

Benefits

Tucson Electric Power Company (TEP) pursued a 345 kV interconnection with the CFE beginning in 2000. TEP had identified at least three key items that the project would promote from TEP's perspective:

1. Improved reliability to both the southern U.S. transmission system as well as the northern CFE system. Nogales, AZ is at the edge of the U.S. system and relies on an extensive transmission system from the north. Nogales, Sonora lies along the northern edge of the CFE system and relies on an extensive transmission system from the south. Interconnection would provide greatly improved reliability for both sides of the border.
2. Load and Resource diversity between the two countries would provide an opportunity for economic exchange of power that would benefit both sides of the border.
3. The project would provide for a strong fiber optic communication system between the two countries.

Challenges

The process for developing such a project requires:

- A Certificate of Environmental Compatibility (CEC) that is issued by the Arizona Corporation Commission (ACC).
- A Presidential Permit from the U.S. Department of Energy (DOE) for the actual crossing of the U.S. border.
- Specific permits from various land agencies.

To obtain a Presidential Permit an Environmental Impact Statement (EIS) must be completed. For the proposed project the DOE became the lead agency for the EIS process with participation by the U.S. Forest Service (USFS), Bureau of Land Management and several other agencies. This process turned out to take the most time of any. TEP was able to obtain the CEC from the ACC in approximately one year based to a large extent on the compelling story regarding reliability and economic value to Arizona customers. The EIS took four and a half years to complete. The most challenging aspect of the EIS process was with the USFS, which provided very little guidance throughout the process. TEP spent in excess of \$9 million dollars on the permitting process for the project, which never was constructed. The original estimate for the project was \$70 million, based on a synchronous interconnection with CFE. This was plausible in the early 2000s but is no longer feasible due to increased interconnectivity between Sonora and other states in Mexico. Today, such an interconnection will require a DC tie to link the two countries, and the project cost would be significantly greater.



Additional History

TEP first participated in an 11-month joint study between the U.S. and Mexico that was documented in a report in March of 1991 titled United States/Mexico Electricity Trade Study (Trade Study) regarding the feasibility and value of interconnecting the two countries. The study identified significant technical and economic issues to consider. The study identified that a major interconnection between Arizona and CFE's Noroeste (Sonora-Sinaloa) region could increase electricity trade between the two countries. Further, the study pointed out that firm capacity sales, economy transactions, seasonal diversity exchanges and emergency assistance between U.S. utilities and CFE should be pursued. It was left to the individual utilities to pursue such potential opportunities. TEP began an extensive study of the southern Arizona area to look at possible routing for a project to Mexico.

Citizens Utilities proposed construction of a 115 kV line, in 2000, to meet a mandate from the Arizona Corporation Commission to build a second line to Nogales. TEP recognized that due to the sensitive nature of the region it was likely that only one line could get sited in Southern Arizona, and to the extent it was a 115 kV line it would preclude a future larger line that would accommodate interconnecting to Mexico. At that time TEP had discussions with Citizens Utilities and reached agreement on a joint project that would fulfill their needs while accommodating TEP's interests in connecting to Mexico.

The parties then began the siting process for a 345 kV line from Tucson to Mexico via Nogales, Arizona.

The parties identified the following issues with a joint project:

- First was a reliability improvement to Citizens Utilities that was in accordance with the ACC order.
- Second was reliability improvement for TEP by adding connectivity to the south of its system.
- Third, potential resource exchanges between the U.S. and Mexico could provide economic value on both sides of the border.
- Fourth, it would meet a goal that TEP had been working on since the early '90s to interconnect with Mexico as analyzed in the Trade Study.
- Fifth, the project would provide an opportunity to develop a strong fiber optic communication infrastructure that would add additional benefits to Nogales and potentially down into Mexico.
- And sixth, the most important aspect from TEP's perspective was to meet a long-range planning look at the needs of southern Arizona. TEP was proposing a project that would meet the needs of the region for the next 20 to 30 years as opposed to a stopgap project that would fit the short-term needs of Citizens Utilities alone.

Some takeaways from TEP's look at connecting to Mexico included: TEP's load peaks at approximately 15:30 hours, and the load drops off at a relatively steep angle. The CFE load shape in the Sonora region of Mexico had a load peak around 14:30, and then had a secondary peak around 21:30. The real opportunity for some diversity exchanges, the way we termed it, was on the second CFE peak. To the extent CFE load is high and the U.S. load is dropping off, there's more energy available in U.S. systems for sales to Mexico. Similarly, looking at a typical winter day, TEP has two peaks, one in the morning



hours and one in the afternoon and evening hours, whereas CFE has no peak in the morning. They ramp up to a peak that occurs mid-afternoon to evening while the morning had that reversed. TEP has the peak in the morning, CFE's load shape goes to a peak in the afternoon and evening. In that instance, CFE has the opportunity, where their load is not at their peak, to sell energy to the north on that first peak in the morning.

Since there is diversity, there is a benefit to both CFE customers and U.S. customers. In some generation-modeling studies TEP had done, TEP determined that approximately 30 percent of the time Mexico would be selling energy into the U.S. and approximately 70 percent of the time the U.S. would be selling to the south into Mexico, related primarily to the diversity factors.

One of the major reasons for TEP to interconnect with CFE is to provide more reliability to the Tucson system. CFE has approximately 27 percent of its generation from hydro in the Sonora region, and hydro is one of the best resources for meeting ramping requirements. To be able to connect into a system that has that much hydro would have been very beneficial to the TEP system. Also, the fact that TEP currently relies so much on the transmission system from the north means that another feed from the south would be a big improvement to TEP's overall reliability.



Hunt Power Case Study

Texas – Mexico Electric Interconnections

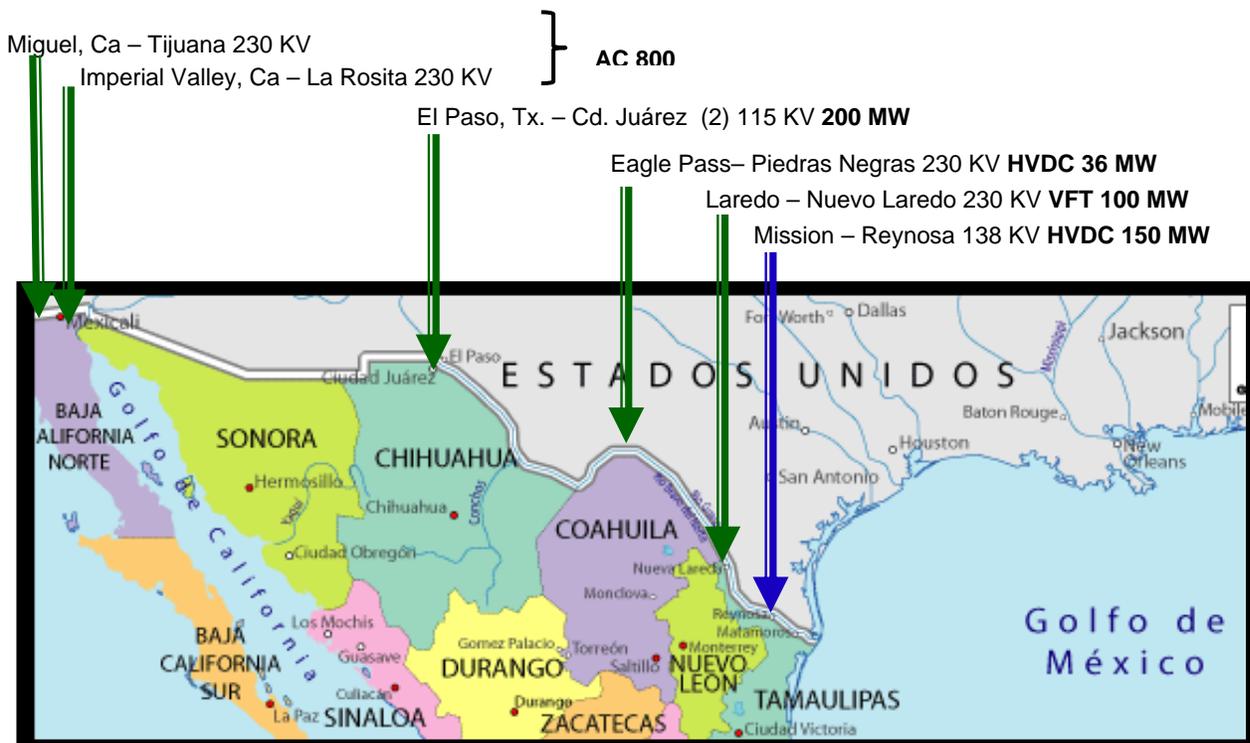
Background

There are three electric interconnections between the Electric Reliability Council of Texas (ERCOT) and the CFE that are used for commercial and reliability purposes. All three of these interconnections are capable of providing continuous safe electricity transfers, in either direction, without degrading reliability on the neighboring grids and without customer interruptions at any point in the dispatch of electricity.

Railroad Tie - owned by Sharyland Utilities – which is associated with Hunt Power – The Railroad DC-Tie is a 150 MW back-to-back HVDC converter located at Sharyland Utilities' Railroad substation and connects the ERCOT Region with CFE in Mexico (Cumbres station). The purpose of the tie is to provide bi-directional energy transfers between completely independent power grids and exchange emergency power, among other benefits. This tie has been in operations since 2007 and Sharyland Utilities is currently constructing an additional 150 MW HVDC converter resulting in a total transfer capacity of 300 MW at the Railroad Tie by summer of 2014.

Laredo Tie - owned by American Electric Power (AEP) – The Laredo DC-Tie is a 100 MW Variable Frequency Transformer located at the AEP Laredo VFT station and connects the ERCOT Region with CFE in Mexico. Although the interface is not a back-to-back HVDC converter, it provides the same operations and reliability benefits of a DC-Tie. The VFT started operations in early 2007.

Eagle Pass Tie - owned by AEP –The Eagle Pass DC-Tie is a 36 MW back-to-back HVDC converter located at the AEP Eagle Pass Substation which connects the ERCOT Region with CFE in Mexico. This DC-Tie is Black Start capable and it was commissioned in the year 2000.



Electric interconnections between Mexico and the United States

The Public Utility Commission of Texas (PUCT) Project No. 20948, initiated in October 1999 and completed in February 2000 (*“Investigations of Issues Relating to Open-Access Interconnections Between ERCOT and México”*), outlines the benefits of new transmission interconnections with México. In 2003, a CFE/ERCOT Interconnection Study was published identifying the three interconnections identified above as providing significant reliability benefits. According to the report:

“...immediate consideration of support to the ERCOT transmission system along the Texas border where older inefficient generation is no longer economical to operate. In addition, synchronous ties may allow new block load support in remote areas where lengthy transmission additions are required.”

Following the publication of the CFE/ERCOT study, Sharyland Utilities and AEP formally proposed the addition of the Railroad HVDC tie and the Laredo VFT, in Texas, to the ERCOT membership and to the PUCT. The PUCT agreed the ties capital equipment, operation and maintenance expenses incurred by the ERCOT transmission providers are to be included in ERCOT transmission cost of service (TCOS) rates. CFE’s costs included all of its substation and transmission costs on the Mexican side of the border.

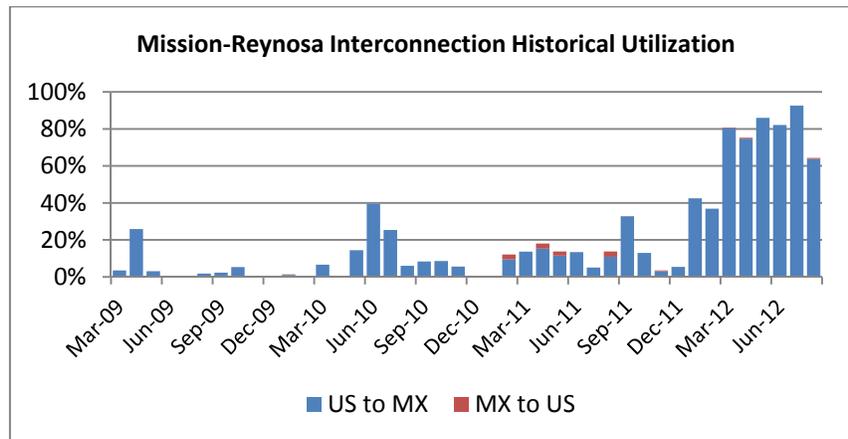


Texas – Mexico DC Ties utilization

Before 2009, the three interconnections along the Texas border were being used primarily for emergency situations. In 2009, CFE started to conduct commercial transactions with U.S. wholesalers. The following chart indicates the growth of power moved across the Texas-Mexico interconnections through time.

Texas - CFE Power transactions													
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GWh	9	6	26	0	0	0	1	3	3	57	168	262	1000+

Transactions began in 2009 but increased in 2010, especially during the summer. In 2011, commercial transactions were consistent throughout the year. In 2012, the interconnections saw a consistent and high usage of their capacity due to the increased activity between CFE and its U.S. counterparties. The following graph shows the usage of the Railroad tie through time.



Emergencies

The interconnections have been very useful in emergency situations, like the February 2nd, 2011 freeze in Texas or the summer of 2011, which had CFE sending power to ERCOT to help alleviate the critical conditions. During summer 2011, ERCOT experienced record-breaking heat waves with months of average maximum temperatures over 100 degrees. At the highest peak levels recorded in ERCOT’s history in August of the same year, several units in ERCOT became unavailable due to drought conditions and forced outages. CFE was able to support ERCOT’s peak demand during emergency conditions.

In 2012, most of the energy flows were southbound into Mexico due to very attractive pricing of wind and natural gas-fired generation in ERCOT. This trend continues as CFE’s demand is increasing along the border region.



Arizona Public Service Company Report on Existing and Prior Ties with Mexico

Transmission

Arizona Public Service Company (APS) has two existing, one potential, and one previously existing Mexico-interfacing transmission/distribution facilities. A brief description of each follows:

Existing Ties

Mexico Emergency Tie. Located between San Luis R.C., Mexico and San Luis, Arizona, just south of Yuma, Arizona, this 34.5 kV tie allows for bi-directional emergency response of up to 30 MW for either APS or CFE-Baja, although due to resource limitations the tie provides approximately 20 MW of contingency response in practice. Further, due to a difference in phase angle between the two systems, certain feeders from the entity taking electricity must be blocked to eliminate a continuous path into the other parties system. The tie was last used on April 4, 2010 following an earthquake in the Baja area. APS provided approximately 20 MW of assistance or approximately 254 MWh to CFE over the course of roughly 22.5 hours.

San Luis Industrial Park. APS currently serves four industrial customers that consume approximately 8 MW at peak in San Luis R.C., Mexico via an underground feed from the U.S. side of the border through a single duct bank. Service is provided primarily through a 34.5 kV line out of the Sonora substation owned by Western Area Power Administration (WAPA) with a tie to the San Luis substation owned by APS. These customers are exclusively connected to APS facilities and are not connected to the CFE-Baja system. The four customers equally fund all maintenance performed on these facilities. APS manages operations and management work north of the border; the customers manage any work south of the border.

Previously Studied Ties

Wires to Wires Interconnection Request (North Branch Resources' San Luis Rio Colorado Project). APS and WAPA have studied this interconnection request which has since been withdrawn, however intermittent interest still persists. As previously proposed, the approximately 600 MW combined cycle plant located south of Yuma, on the Mexico side of the border, would interconnect through two new 230 kV lines into the Gila substation, owned by WAPA, and then into the APS system at the North Gila substation by way of a wires-to-wires connection. WAPA would construct, own and operate the portion of the lines from Mexico up to the Gila substation and continuing on to the North Gila Substation (i.e., the entire transmission lines). WAPA would also own the portion of the substation build-out at Gila. The North Gila build-out could be owned by APS, San Diego Gas & Electric, and/or Imperial Irrigation District or some combination thereof, or even be owned by a joint-venture between WAPA and one or a combination of the three aforementioned entities.

Prior Ties

Douglas: APS and CFE-Sonora previously used an emergency response tie between Douglas, Arizona and Agua Prieta, Mexico, but that tie has since been removed from service and no longer exists.