Appendix G: Renewable Resources in Baja California

G.1 Characteristics of Baja California

The state of Baja California is located in the northwestern part of the Republic of Mexico. It shares an approximately 500 km border with the state of California. Its surface area is 70,113 km² which represents 3.75 percent of Mexico's total surface area Baja California is characterized by mountains, steep slopes, central valleys, and coasts, as well as a discontinuous littoral on the Pacific Ocean.

The northern portion of Baja California has a variable topography, with hills, mountain ranges, valleys and large deserts. The elevations range from sea level to high peaks (2,880 and 3,100 m for the Juarez and San Pedro Martir mountain ranges, respectively).

Mountain ranges run along the length of the peninsula, with abrupt slopes that frequently descend directly into the Gulf of California, while maintaining smooth slope on the opposite slope. In the northern part of the peninsula, the Juarez and San Pedro Martir ranges dominate the landscape, while in the southern part of the state, the Laguna range predominates. Additionally, the peninsular's geographic system meets the mountains of the Alta California, particularly at the Nevada mountain range (Rzedowski, 1978).

The Sonoran desert, north of the Gulf of California, makes up three quarters of state land and includes portions of Sonora, southeastern California, and southeastern Arizona (Turner and Brown, 1982).

The climate in Baja California is characterized by warm and dry temperatures during the spring, summer, and early fall seasons, while winter is characterized by relative humidity and mild-cold temperatures (Alvarez, 1983).

G.2 Baja California: An Isle of Energy

Baja California is geographically isolated from the rest of Mexico and has developed an interdependent energy relationship with California. Cross border electricity sales from Mexico to the U.S. and deliveries of natural gas to Mexico by pipelines from the U.S. accentuate the interdependence. Energy facilities in Baja California offer the potential to supply energy resources and reduce energy demand to address energy needs in the border region and western United States. Baja California anticipates several new natural gas-fueled power plants, renewable energy projects and two liquefied natural gas terminals that could partially supply electricity and fuel to California, although fears about energy exports to the U.S. causing higher domestic rates have been reported in the Mexican press, as well as Mexican concerns about the U.S. becoming too dependant on energy supplies from Mexico.

Annual electricity sales in Baja California have increased at an average rate of 7.1% over the last ten years and are expected to continue at this rate for 5-10 years in the future. San Diego's electricity demand growth is driven primarily by residential population increases, resulting in annual increases in electricity consumption generally ranging between 2-3 percent over the last ten years, which is expected to continue at this level into the future over the near-term. To meet the growing demand for electricity and natural gas, the cross-border transfer of significant amounts of electricity and natural gas is increasingly integrating the energy sectors of both California and Baja California.

Government Offices Involved in U.S.-Mexico Cross-border Energy Trade
Several Mexican federal, state and municipal government agencies are involved in the permitting and regulation of U.S.-Mexico cross-border energy trade. If government electric power infrastructure is used or proposed for development or enhancement, Comisión Federal de Electricidad (CFE), the government enterprise tasked with the ownership and operation of the public electric system infrastructure, is involved.

The importation and exportation of electricity by private sector entities is regulated by the Comisión Reguladora de Energia (CRE), an independent regulatory agency with jurisdiction over the electrical and gas industries. Upon establishing compliance with its requirements, the CRE issues import or export permits for electricity.

Any party interested in building a cross-border transmission line or pipeline must submit an Environmental Impact Assessment and a Risk Analysis of the project to Secretaria del Medio Ambiente y Recursos Naturales (SEMARNAT), the Secretariat of the Environment and Natural Resources. SEMARNAT, upon determining compliance with the law, will issue an environmental impact license and a risk license. Under SEMARNAT's jurisdiction, the following agencies are responsible for specific aspects of the permitting process and for the enforcement of regulations: the National Water Commission (Comisión Nacional del Agua) – water rights and use; the National Institute of Ecology (Instituto Nacional de Ecologia) – reviews adequacy of environmental reviews and grants approval of environmental impact assessments; and the Federal Solicitor for the Protection of the Environment (Procuradoria de la Proteccion del Ambiente – PROFEPA) – charged with the enforcement of environmental laws and regulations for management and disposal of hazardous waste and air emissions.

Additionally, a cross-border transmission (gas or electric) project sponsor will have to comply with all municipal regulations, including obtaining a land use license and, if applicable, a construction license.

The following private sector firms are currently involved in cross-border energy transfer activities:

Energia Azteca X S. de R.L. de C.V. (EAX), a subsidiary of Intergen, owns and operates part of the natural gas-fired combined-cycle facilities at the La Rosita Power Complex (LRPC). EAX's unit (LR-1) consists of three 160-MW gas turbines and one 270-MW steam turbine, for a total generating capacity of 750 MW of which 660 MW are contracted by CFE under a power purchase agreement and 90 MW are exported to California. Energia de Baja California (EBC) S. de R.L. de C.V. owns the other combined-cycle unit in LRPC (LR-2) consisting of one 160-MW gas turbine and one 150-MW steam turbine, for a total generating capacity of 310 MW exclusively dedicated to export.
Termoeléctrica de Mexicali (TDM), a Sempra subsidiary owns and operates a 650-MW combined cycle generating facility consisting of two 170-MW gas turbines and one 310-MW steam turbine. The power plant produces electricity exclusively for export to the United States, transmitted over a transmission line not connected to the CFE transmission system.

Transportadora de Gas Natural de Baja California, a joint venture of Enova International (Enova no longer exists – it was merged to become Sempra Energy in 1998), Pacific

International and Sempra Energy de Mexico, operates the Gasoducto Rosarito 30-inch pipeline from San Diego to Rosarito, B.C.

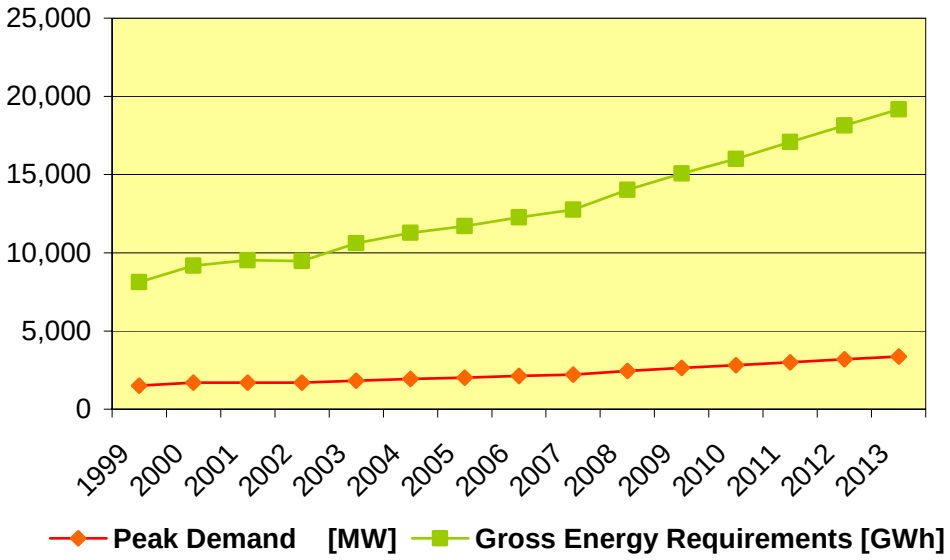
Gasoducto Baja Norte owns and operates the 30-inch pipeline by the same name from Algodones to Tijuana, Baja California. (This pipeline is owned by Sempra Energy International). In addition to these major players, there are 19 additional firms, holding current electric importation permits.

Energy Demand

In 2001, total electricity consumption in California was 253,614 GWh vs. 7785 GWh in Baja California —almost 33 times more in California than in Baja California. In its official 2004-2013 electricity demand forecast, CFE expects the demand growth for northern Baja California to continue, albeit at a slightly lower pace than in prior years. Energy sales in Baja California are expected to grow at an average 7.0 percent for the 2004-2013 planning horizon, versus 7.5 percent for the prior ten-years, but peak demand is expected to continue growth at 6.3 percent, the same rate experienced from 1993-2003. Figure G.1 illustrates the growth in energy sales and peak demand. (It should be noted that there are no independent peak demand and energy forecasts other than those published by CFE.)

In 2003, 52 percent of sales went to commercial and small to medium industrial establishments, 11 percent of all accounts. Residential sales accounted for 32 percent of all sales and 89 percent of all accounts. The remainder (11 percent) was sold to large industry, municipal service and agricultural users. In 2003, energy sales increased by 5.0 percent mainly as a result of residential and commercial growth.

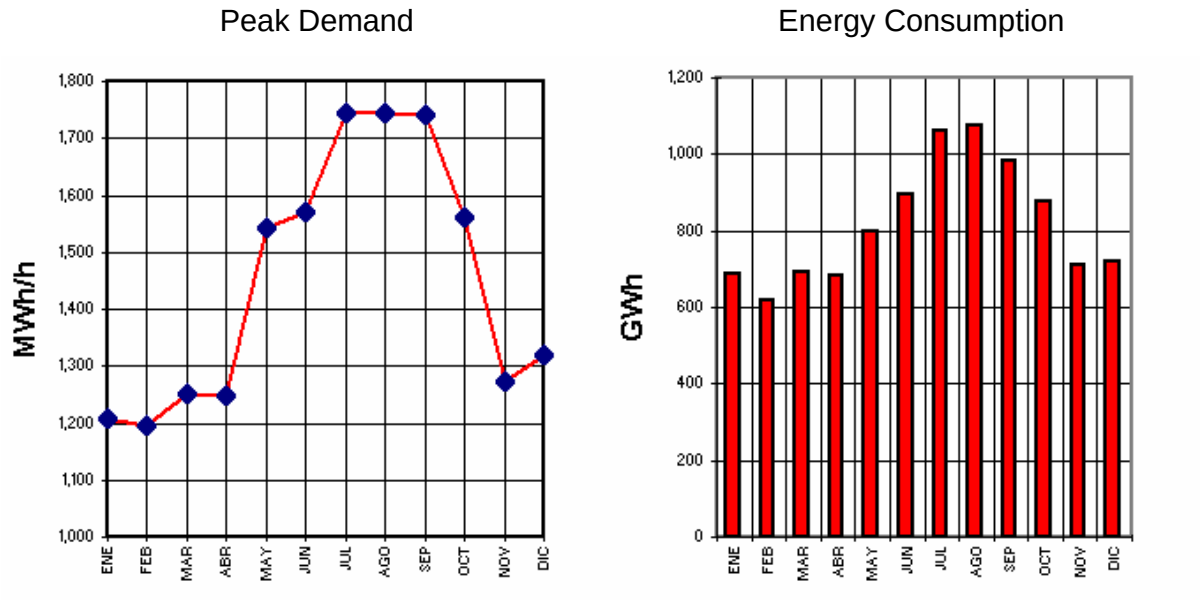
Figure G.1 Peak Demand and Energy – Baja California Norte[1]



[1] Comisión Federal de Electricidad, Mexico, 2005, Programa de Obras e Inversiones del Sector Eléctrico 2004-2013, Tables 1.7 and 1.8.

Sales are centered on the Tijuana and Mexicali urban and suburban areas, known as the Coast and Valley Zones. Overall demand in Baja California peaks in August (1,940 MW in 2004). The Coast and the Valley peak at different times of the year: the Coast in the winter (550 MW), while the Valley peaks in the summer (1,100 MW).[2] This seasonality and the location of the Baja California Norte generation resources dictates to a large extent the load flow patterns in the Baja California transmission system. It flows from Valley to Coast in the Winter (250-280 MW) and Coast to Valley in the Summer (150 – 200 MW).[3] Figure G.2 illustrates the Baja California Norte monthly load pattern for 2003.

Figure G.2: Energy Load Pattern in Baja California Norte (2003)[4]



Natural gas

Demand for natural gas in Baja California is driven mainly by power generation. After a failed auction for the Tijuana LDC franchise, the only local distribution of natural gas can be found in Mexicali. Based on 2003 sales data, the Mexicali LDC sold an average 10.8 MMcfd to all its customers. This represents roughly 4.8 percent of the overall average natural gas demand for the Baja California Norte region. Power generation for the public sector (CFE) by CFE's own plants and independent power production under contract with CFE amounted to 140.6 MMcfd or 63 percent of the average demand for the region. Intergen's LRPC export-dedicated capacity plus Sempra's Termoelectrica de Mexicali accounted for the remaining 72.0 MMcfd or 32.2 percent of natural gas demand in Baja California Norte.

Table G.1 contains a simplified natural gas demand forecast using 2003 CFE sales as the forecasts baseline, CFE's generation expansion schedule,[5] and economic growth factors found in the Prospectiva del Mercado para el Gas Natural 2004-2013.[6]

[2] Personal communication CENACE Mexicali.
[3] Ibid.
[4] CFE-CENACE – 2003 load data.
[5] CFE, Mexico, 2004,Programa de Obras E Inversiones del Sector Electrico 2004-2013.
[6] Secretaria de Energia, Mexico, 2004, *Prospectiva del Mercado de Gas Natural 2004-2013.*

Table G.1: Forecast Natural Gas Demand – Baja California Norte (2003-2010)

Rosarito Load (CFE)	2003	2004	2005	2006	2007	2008	2009	2010
2x CC Units (496 MW) Units 7&8	53	62	62	65	66	66	68	68
2x Dual Units (320 MW) Units 5&6	24	13	53	55	56	56	58	58
Total Rosarito	**77**	**75**	**115**	**121**	**122**	**122**	**126**	**126**
			MMCFD					
Mexicali Load	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
InterGen Azteca 500 MW CC for CFE	74	65	63.1	74.3	74.3	74.3	74.3	74.3
InterGen Azteca 290 MW CC for SoCal (Mexicali II in 2008)	na	19	19.4	25.4	27.9	30.4	43.1	43.1
InterGen Azteca 310 MW CT for SoCal (BC II in 2010)	na	na	2.0	3.8	11.3	15.0	15.0	15.0
Total InterGen Azteca	**74**	**84**	**84.5**	**103.4**	**113.4**	**119.7**	**132.4**	**132.4**
		72.0						
Sempra Termoelectrica de Mexicali (600 MW)	**0**	**53**	**57.6**	**62.6**	**67.9**	**73.1**	**78.3**	**83.5**
Mexicali LDC (DGNM)		**11**	**11.0**	**11.5**	**11.9**	**12.4**	**12.9**	**13.4**
Total Mexicali		**148**	**153.2**	**177.5**	**193.2**	**205.2**	**223.6**	**229.4**
Total Baja Demand		**223**	**268.5**	**298.0**	**315.5**	**327.4**	**349.3**	**355.0**

Generating Stations

As of the end of 2004, the Baja California Norte power system had 3,862 MW of generation capacity in operation, of which 2,652 MW are dedicated to satisfy CFE's public service load and 1,210 MW are intended for export to the California market. Table G.2 lists the installed generation capacity at the end of 2004.

Table G.2: Existing Generating Capacity – Baja California Norte

	Public Service				
Generating Station	Location	Type	Generating Units	Fuel	Power Installed MW
Presidente Juarez	Rosarito	Steam	4 x 75 and 2 x 160	Oil	620
Presidente Juarez	Rosarito	Combined Cycle	2 x 248	NG	496
Mexicali (IPP-LRPC)	Mexicali	Combined Cycle	1 x 489	NG	489
Tijuana	Tijuana	GCT	2 x 30 and 1 x 150	Oil	210
Mexicali	Mexicali	GCT	1 x 26 and 2 x 18	Oil	62
Cipres	Ensenada	GCT		Oil	55
Cerro Prieto I	Mexicali	Geothermal	4 x37.5 and 1 x 30	Renewable	180
Cerro Prieto II	Mexicali	Geothermal	2 x 110	Renewable	220
Cerro Prieto III	Mexicali	Geothermal	2 x 110	Renewable	220
Cerro Prieto IV	Mexicali	Geothermal	4 x 25	Renewable	100
	Export Facilities				
La Rosita	Mexicali	Combined Cycle	2x60 + 1x150 + 90/3	NG	560
Termoeléctrica de Mexicali	Mexicali	Combined Cycle	2 x 170 and 1 x 310	NG	650

Sources: a) Public Service - Comisión Federal de Electricidad, Unidades Generadoras en Operacion, March 2004, p.65.; b) Export Facilities – Imperial-Mexicali DEIS, May 2004, p.S-5.

With 720 MW of geothermal generating capacity, Baja California satisfies a significant portion of its energy needs with renewable energy, while the balance of its energy comes from natural gas-fired combined cycle facilities (985 MW), oil-fired steam cycle plants (620 MW) and oil-fired gas turbines (326.9 MW).

Between 2008 and 2013, CFE plans to build an additional 1,282 MW of generating capacity in Baja California Norte. The role of natural gas in generation will continue to grow as most planned generation capacity is likely to be natural gas-fired. Table G.3 shows CFE's generation expansion plan schedule most likely scenario.

Table G.3: Electricity Supply/Demand Balance – Baja California Norte[7]

	2005	2006	2007	2008	2009	2010	2011	2012	2013
In Operation									
Retirements									
Presidente Juarez					(150)				
Presidente Juarez							(150)		
New Entrants									
Baja California (Mexicali II) Rosarito				220					
Pte. Juarez GCT/CC Conversion						81			
Baja California II GCT (Ensenada)						247			
Baja California III (w/25MW SLRC)							245		
Baja California IV GCT (Tijuana)								247	
Baja California V (Mexicali) /1									242
Total Capacity	2,652	2,652	2,652	2,872	2,722	3,050	3,145	3,392	3,634
Gross Demand	2,024	2,125	2,217	2,443	2,635	2,805	3,008	3,190	3,373
Reserve Margin /2	31%	25%	20%	18%	3%	9%	5%	6%	8%

/1 Either new generating plant or PPA

/2 Minimum reserve margin for BC - after planed outages - the larger of: the largest gen unit or 15% of peak demand

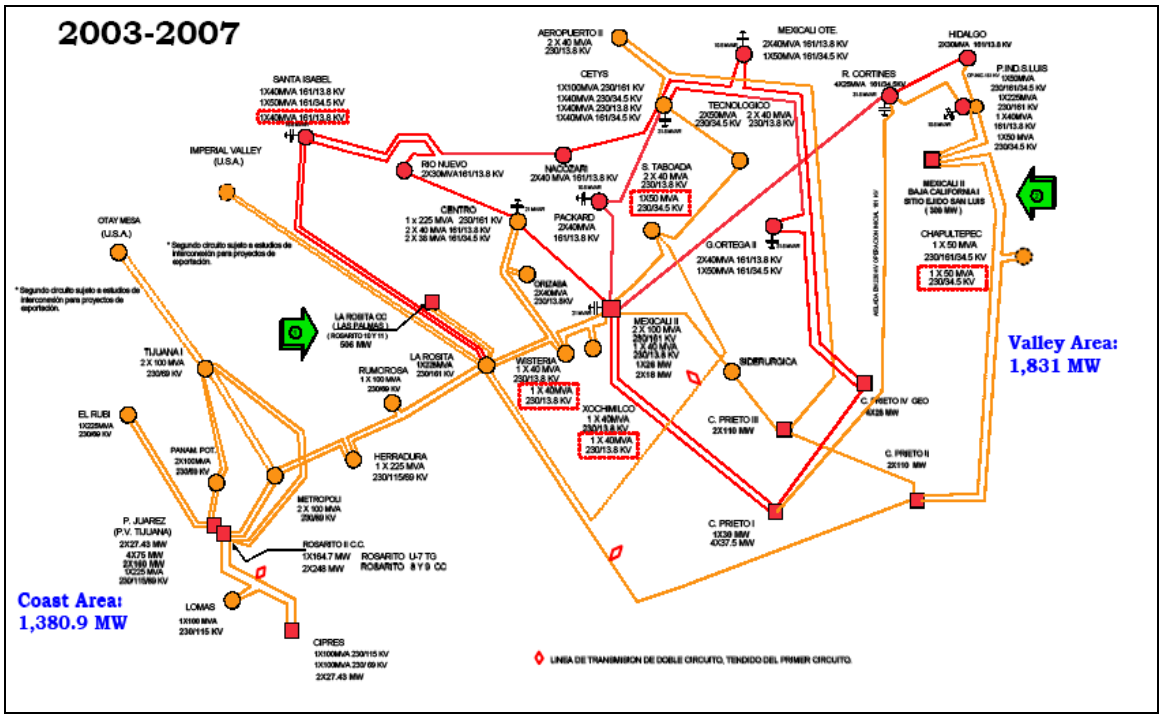
To address the current concentration of generation capacity in the Valley zone, CFE plans to locate a significant share of the new generation within the Coastal zone. Placing all new generating capacity through 2010 in Rosarito, Tijuana, and Ensenada will reduce east to west transmission load on the La Rosita – 230-kV transmission corridor during the winter months.

G.3 Transmission Lines

The backbone of the transmission system in the Baja California Norte area lays in the 230-kV East- West lines connecting the Coastal and Valley zones as illustrated in Figure G.3. In its current configuration, the Coastal-Valley two-line 230-kV transmission path has a capacity limit of 368 MW. During the winter months, east to west peak flows of 250 to 280 MW are a result of the excess geothermal generating capacity flowing to the Coastal areas to meet its winter peak. During the summer, 150 to 200 MW flow from the Coast to the Valley to meet summer air conditioning peak loads.

[7] Comisión Federal de Electricidad, Mexico, 2005, *Programa de Obras e Inversiones del Sector Eléctrico 2004-2013*.

Figure G.3: Transmission System – Baja California Norte[8]



Except for additional transformer capacity at several substations, the only major transmission line addition planned between 2008 and 2013 is a second 230-kV circuit between the Metropoli Potencia and Tijuana I substation (2 x 1113ACSS). This line is associated to the new 220 MW combined-cycle generating facility to begin service in 2008 at Rosarito to supply incremental energy needs of Tijuana and Ensenada.[9]

Because the border areas with significant renewable potential are mostly located at or east of La Rumorosa along Path 45, which is currently significantly constrained, it would be necessary to expand the La Rosita-Tijuana east-west and the Tijuana-San Miguel south to north transmission capacities to develop these resources. This would require reevaluation of the constraints at the Miguel substation and to find ways for CFE to expand its east-west transmission capacity to accommodate non-native needs. Given the technical, economical and political issues surrounding these constraints, a joint working group should be considered to take a fresh look at Path 45 expansion options.

Cross-Border Electricity Exchange

Nine transmission lines connect California with Mexico. Two 230 kV lines connect the Cerro Prieto Geothermal Plant in northern Baja California and San Diego. SDG&E is also connected to Tijuana and Tecate, Mexico, by two 12 kV lines. In mid-2003, Sempra and Baja California Power began transmitting electricity generated from newly constructed natural-gas-fired plants near Mexicali, Mexico, to California over two 230 kV lines terminating at the Imperial Valley Substation. Three 34.5 kV lines connect Calexico to Baja California.

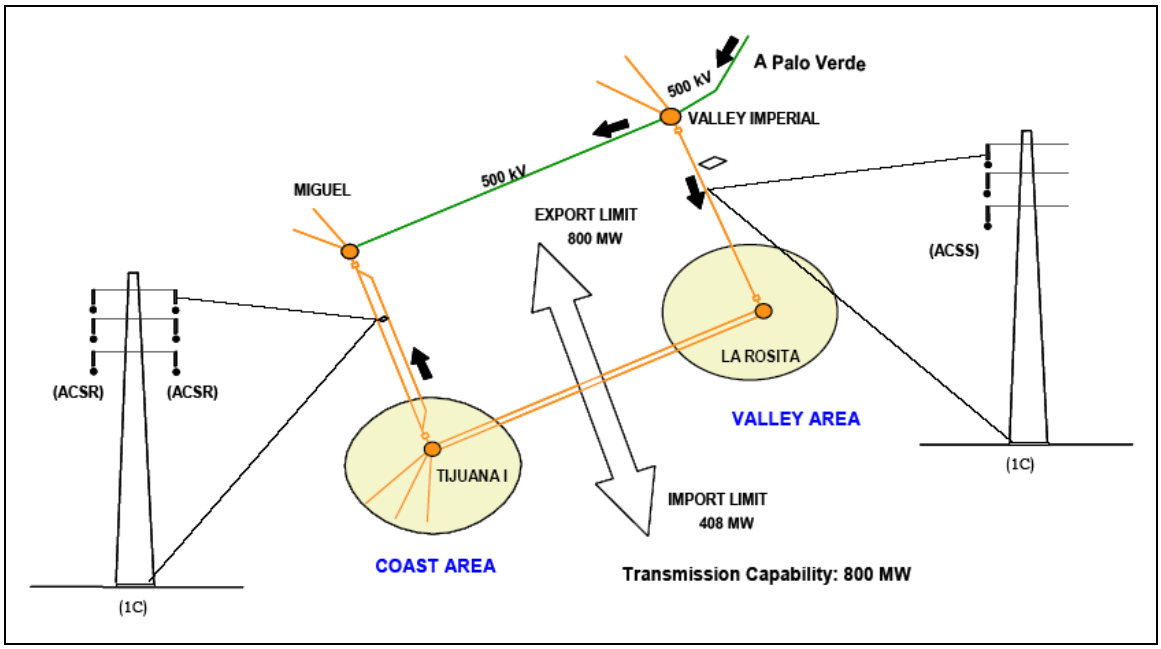
[8] Source: CFE Planning Subdirection.
[9] Ibid. CFE.

Table G.4 shows electricity exchange between California and Baja California during the period 1992 to 2003. As shown on Table G.4, current cross-border transmission capacity between Baja California and California on Path 45 is 800 MW in a northbound direction and 408 MW southbound. Due to recent withdrawals of merchant-generation applications to upgrade Path 45, SDG&E does not plan to increase path 45's northbound rating above 800 MW at this time.[10]

Table G.4: Transborder Energy Exchange (1992-2003)

GWh												
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Mexico to California	2023	1995	1947	1920	1258	17	45	31	66	112	164	765
California to Mexico	24	44	166	228	355	406	480	646	927	82	311	45

Figure G.4: Cross-Border Transmission Interconnections



Source: CFE Planning Subdirection

[10] Kelly Morton, April 1, 2005, Status Report of San Diego Gas & Electric Company for March 2005, submitted to the California Public Utilities Commission, Investigation 00-11-001.

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