SAN DIEGO DIALOGUE

ENERGY ISSUES IN THE SAN DIEGO/TIJUANA REGION

Briefing Paper

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Introduction

Energy is an indispensable lifeblood of the San Diego/Tijuana region. It makes homes and businesses comfortable, moves people and goods, operates the machinery of industry and powers the infrastructure that underpins the region's communities. This pervasive role makes energy a key issue in the binational region's future. Energy choices made today will have significant effects on tomorrow's economy, environment and quality of life.

The energy sectors in the United States (including California), Mexico and Canada are undergoing major changes that will affect the way energy is produced, transmitted, distributed and sold throughout North America. These changes will directly influence energy use and energy-related infrastructure in the San Diego/Tijuana region.

Among the major energy-related issues currently facing the binational region are:

- Meeting the demand for electric services in northern Baja California, which is expected to grow significantly over the next ten years.

- Taking full advantage of the new regulatory structures now in place in California, and evolving in Mexico, to meet the region's energy needs.

- Developing cross-border energy-related infrastructure associated with natural gas and power transfers.

- Creating the necessary administrative and regulatory mechanisms to plan and coordinate issues related to the energy sector.

- Developing new environmentally sensitive and sustainable sources of power for the region.

This paper analyzes the energy sectors in San Diego and Baja California and discusses issues related to meeting the future energy needs of the region. It summarizes the recent restructuring of California's electric industry, as well as recent energy-related legislation in Mexico, and reviews the status of alternative sources of energy for the region, particularly those opportunities that may lie in Baja California. Finally, it discusses the problems and opportunities for development of the energy sector in the San Diego/Tijuana region and offers recommendations for improving cross-border collaboration to meet the future energy needs of the region.

An Overview of the Region

To understand the energy sector in the cross-border region, it is important to examine the context within which energy services are utilized. The most important elements are the region's population and its expected growth, the region's economic activities and the environmental impacts of energy production, transmission and end use. Although this paper is focused on the San Diego/Tijuana region, one must include the broader California/Baja California binational area to gain a full picture of the energy sector. Our energy systems are integrated over much larger areas than just the two cities. In fact, today's energy markets are truly global, and a comprehensive analysis must recognize the global context of energy.

The term "border region" is not precisely defined. The La Paz Agreement between the United States and Mexico in 1983 defined the U.S.-Mexico border region as a zone stretching 100 kilometers on either side of the international boundary.[1] However, for the purpose of analyzing energy flows and environmental issues, such as air pollution, this definition is not particularly meaningful. Energy and transportation systems are not localized within a narrow region, and the cities in the border area all have important linkages to other regions throughout the United States, Mexico and Canada.

However, for the California/Baja California border region, the 100-kilometer (62-mile) zone includes all of San Diego and Imperial counties and the Mexican *municipios* (the rough equivalent of U.S. counties) of Tijuana, Rosarito, Ensenada, Tecate and Mexicali. This area encompasses all main population centers of the region and contains its principal energy-related infrastructure, so the La Paz definition of the border zone can serve as a useful guide to define the region.[2]

Population Growth

The population of the cross-border region has been expanding rapidly in recent years; forecasts predict that it will continue to grow substantially on both sides of the border. By 1998, San Diego County's population stood at nearly 2.8 million.[3] By 2020, the county's population is projected to grow by an additional million people, to over 3.8 million.

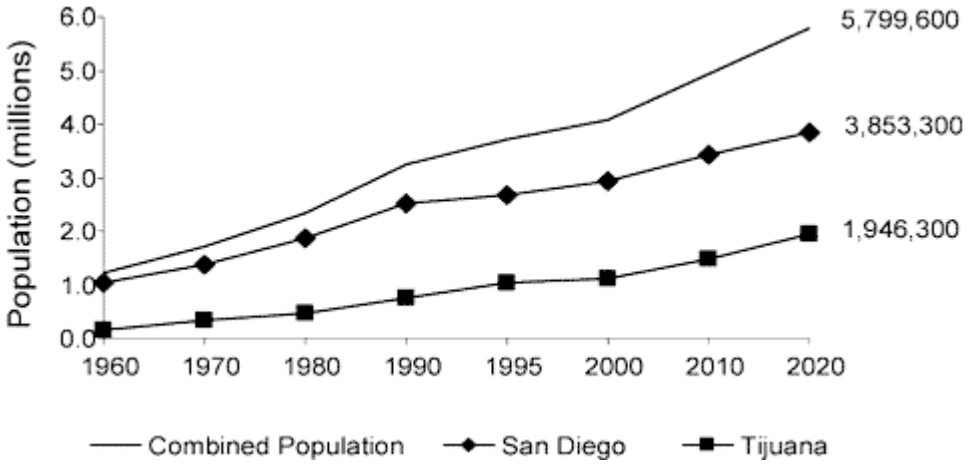
In 1998, metropolitan Tijuana's population was estimated at 1.2 million. Based on current demographic data and trends, the population of San Diego/Tijuana in 2020 is projected to be 5.8 million.[4] Table 1 and Figure 1 show historical and projected population growth from 1930 to 2020. This continued population growth, particularly on the Mexican side of the border, is the main driving force behind the region's growing energy needs.

Table 1: Historical and Projected Population Growth in San Diego and Tijuana

Year	San Diego	Tijuana
1930	209,659	11,000
1940	289,348	22,000
1950	556,808	65,000
1960	1,033,011	166,000
1970	1,367,200	341,000
1980	1,873,300	462,000
1990	2,520,500	747,381
1995	2,690,255	1,032,415
2000	2,896,900	1,125,200
2010	3,360,700	1,491,300
2020	3,791,400	1,946,300

Source: Ganster, Paul. *Tijuana, Basic Information***,** Institute for Regional Studies of the Californias, San Diego State University, 1999.

Figure 1: Population Growth in San Diego and Tijuana, 1960-2020



Tijuana Figures: Ganster, Paul. Sustainable Development in San Diego and Tijuana: A View from San Diego. May 15,1998.
San Diego Figures, 1960-1995: California Department of Finance, July 1 Estimates.
San Diego Figures, 1995-2020: SANDAG Regionwide 2020 Forecast.

Energy Use and the Regional Economy

Generally speaking, San Diego's economy can be broken down into several main sectors, including defense, telecommunications and biotechnology, and the international trade and visitors industry. None of these sectors is considered to be an intense energy consumer when compared with heavy industries such as steel or auto manufacturing, but they do require adequate energy services, mostly in the form of reliable and high-quality electric power. By contrast, Tijuana, with a growing industrial base, is in need of both adequate power and liquid and gaseous fuels, such as natural gas and liquid petroleum gas (used for industrial processes).

> **San Diego:** San Diego's former reliance on defense spending allowed the region to be somewhat immune from the rest of state and national economic trends. The transition in the 1990s away from reliance upon defense dollars into more commercial and international endeavors has made San Diego's economy much more entwined with the rest of California and the United States, as well as with Mexico and international markets.
>
> San Diego's continued economic expansion will push the gross regional product (GRP) beyond $90 billion before the end of the century. Since 1995, each year has established a new record in economic output for the county.[5]
>
> **Tijuana:** Tijuana's economy is structured quite differently from that of San Diego.[6] For energy use, the most important difference is the growing importance of the manufacturing sector, especially the large number of *maquiladoras*, which are large consumers of power, gaseous fuels and water. In 1998, there were 675 *maquiladoras* in Tijuana, with a work force of about 151,363 persons. The *maquiladora* sector is an important part of the local economy and accounted for about 48 percent of all job creation in Tijuana from 1980 to 1990.[7]

In both San Diego and Tijuana, the transportation sector absorbs the greatest amount of energy consumption. Although, in dollar terms, the economy of San Diego is estimated to be some 20 times larger than that of Tijuana, the rising population on the Mexican side of the border, coupled with the increasing industrialization in northern Baja California, will disproportionately drive the region's increased demand for energy services.

Some useful comparisons between San Diego County and Tijuana are given in Table 2.

Table 2: Comparing San Diego and Tijuana

	Tijuana	San Diego
Area in square kilometers	1,393	10,891
Total population (estimated 1995)	1,237,000	2,835,200
Inhabitants per square kilometer	710.2	260.3
Births per 1,000 inhabitants (1992)	31.6	19.3
Infant mortality per 1,000 inhabitants(1992)	26.9	7.1
Percent population with electricity (1992)	85.8	99
Paved roads (kilometers, 1994)	332,624	1,602,597
Solid waste generation (tons per day, 1995)	710	2,500
Per capita solid waste generation per day (kilos)	0.7	0.9
Municipal budget (U.S.$ millions, 1995)	49	3,031
Per Capita Energy Use (kWh, 1996)	**1,608**	**6,333**

Source: *Plan Municipal de Desarrollo 1996-1998* (Tijuana: COPLADEM)

Source: Ganster, Paul. *Tijuana, Basic Information*, Institute for Regional Studies of the Californias, San Diego State University, 1999. Per Capita Energy Use was determined by the author.

The United States and Mexican Energy Sectors

The production, transmission, distribution and use of energy in the California/Baja California border region take place within the framework of the larger energy markets of California, the United States, Mexico and (to some extent) Canada. Energy infrastructure in North America is highly integrated. Power transmission grids and natural gas pipelines criss-cross the North American continent and link the energy systems of the three North American countries. High-power transmission lines routinely transmit electricity generated in Canada or Mexico for use in the United States, and vice-versa. Natural gas produced in Canada is transported to U.S. markets by trans-border pipelines, and trade in natural gas has begun to take place between the United States and Mexico.

To analyze the energy sector in the border region, it is therefore necessary to briefly discuss the larger North American energy context, focusing on the United States and Mexico. The structure of the energy sector in the United States and Mexico differ significantly from one another; how energy is used also differs markedly.

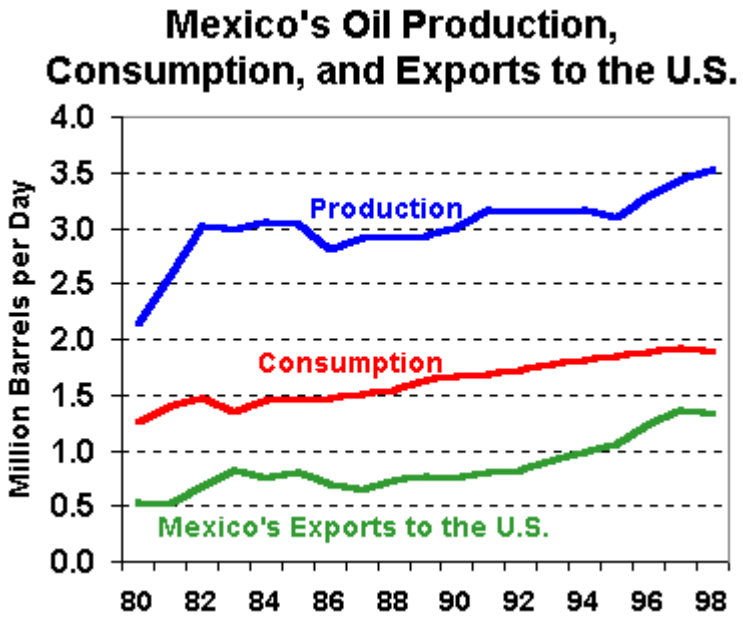
Energy Sources and Uses

The United States utilizes a broader spectrum of energy resources than Mexico, drawing on coal, oil, natural gas, nuclear and hydropower, as well as a small amount of renewable resources. Mexico, by contrast, is heavily dependent on oil and natural gas, with the notable exception of geothermal resources in the state of Baja California.

The United States is the world's largest oil consumer, consuming over 18 million barrels a day (bbl/d) in 1997; of these, 8 million bbl/d were imported, including 1.36 million bbl/d from Mexico.[8] Mexico, by contrast, is self-sufficient in petroleum. In 1998, Mexico produced about 3.52 million bbl/d and consumed about 1.9 million bbl/d. Net oil exports amounted to 1.5 million bbl/d, of which 1.33 million bbl/d went to the United States. Crude oil production increased by about 2.4 percent over 1997 levels, following a 5 percent increase from 1996.

Figure 2 shows Mexican petroleum production, consumption and exports to the United States from 1980 to 1998.

Figure 2



Source: United States Energy Information Administration, *Mexico Graphs*, April 1999.

The energy resources used in the generation of electricity also vary between the two countries. For the United States, coal is the principal fuel for electric generation, followed by nuclear, hydro, natural gas, oil and small amounts of renewable sources. Mexico's main electric generating fuel is oil, followed by hydro, natural gas, coal, geothermal and small amounts of nuclear and other renewables. The different mix of fuels for electric generation between the two

countries is important when considering energy use in the binational region. In San Diego, for example, natural gas and nuclear energy are the main energy resources for power generation; in Baja California, oil and geothermal energy are the principal energy resources.

The U.S. Energy Sector

The U.S. energy sector is for the most part owned and operated by private companies. Although in private hands, energy companies are regulated by state and federal agencies. The price of coal, oil and natural gas is largely determined by market factors, and relatively uniform prices exist across the United States. The price for electricity, however, has traditionally been established by state regulatory agencies and has not been determined directly by market forces until very recently. The retail price for electricity can vary by up to a factor of four across the country.

Retail electricity rates in California in general, and San Diego in particular, are among the highest in the nation. The comparatively high electricity prices in California was the prime motivating factor behind the restructuring of the state's electric industry, which went into effect in January 1998 (see Appendix I). A highly competitive and partially deregulated electric sector in California will have a significant impact on cross-border electricity trade with Mexico; in fact, Mexico's national electric utility has already begun purchasing electricity from the California grid.

Some of the agencies responsible for regulating the energy industries in the United States are the Federal Energy Regulatory Commission (FERC), the U.S. Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), and state public utilities commissions. In California, the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) are the principal agencies that oversee the energy sector. At the local level, city and county jurisdictions may have to grant approval for energy-related construction such as gas pipelines and power transmission lines. In San Diego, coordinating agencies such as the San Diego Association of Governments (SANDAG) also play an important role in long-range energy planning.

Mexico's Energy Sector[9]

In contrast to the way energy is handled in the United States, the production, distribution, and management of energy supplies in Mexico are, by and large, under the control of the federal government. The federal government also sets energy prices. The *Secretaría de Energía* (SE) is the key government ministry responsible for formulating energy policies. SE has direct oversight over the *Comisión Federal de Electricidad* (CFE, the national electric utility), *Petroleos Mexicanos* (Pemex, the state-run oil and gas monopoly), the *Comisión Nacional Para el Ahorro de Energía* (CONAE, the national energy conservation commission) and several energy related research institutes. A relatively new agency, the *Comisión Reguladora de Energía* (CRE), was established in 1993.

The power sector in Mexico is dominated by the state-controlled *Comisión Federal de Electricidad* (CFE). Like Pemex in the oil and gas industry, CFE has enjoyed a monopoly in the

electric power sector for decades, although reforms instituted in 1992 allow independent power producers (IPPs) and cogenerators to sell power to CFE.[10]

Pemex is the world's sixth-largest oil company, the single most important entity in the Mexican economy and a symbol of Mexican sovereignty and independence. Nationalized in 1938, it controls virtually all areas of the oil and gas sectors and provides a major source of government revenues.[11] Mexico's president, Ernesto Zedillo, has reaffirmed many times in recent years that Pemex will remain in state hands, despite the fact that the oil sector in Mexico is badly in need of modernization and investments.[12]

Mexico's electricity sector is at a crossroads as of 1999. In 1997, Mexico generated 164 billion kilowatt-hours (kWhrs) of electricity, and although this figure represents a large increase over the past decade, Mexico's electricity supply is not expected to meet projected demand growth (5.8 percent-6.0 percent annually) over the next 10 years. Even today**,** although about 95 percent of Mexican households are electrified, there are still approximately 83,000 rural towns without electricity. Given current grid capacity, electricity shortages in Mexico could soon occur.

Mexico's energy ministry (SE) has announced that about 13 gigawatts (GW) of electric generating capacity and about $25 billion of investment are needed through 2006 to keep pace with demand. Failure to make these investments could adversely affect the international competitiveness of key northern industrial regions, as well as possibly leading to occasional blackouts. Currently neither CFE nor the government has the funds for these investments. In fact, projected power investments are more than Mexico spends annually on education, health and social security combined. Moreover, Mexico's existing power distribution network is in need of extensive repairs and experiences transmission losses of more than 15 percent, about twice that of the United States.

In the near term, Mexico is moving rapidly to expand its capacity through new facilities and increased connections to the United States. This year, Mexico hopes to license nine new generation facilities, 11 transmission lines and four new connections with the U.S. electricity grid, the last aimed at quickly increasing power availability to the fast-industrializing Mexican side of the border. Over the long term, however, meeting Mexico's future energy needs will be closely tied to the successful reform of its energy sector.

Electricity Sector Liberalization in Mexico

In early February 1999, in an attempt to deal with these projected power shortfalls, President Zedillo sent legislation to Congress that would result in a wide-ranging overhaul of the country's electricity sector, ending decades of state domination. Several new laws have recently been introduced to open the Mexican energy sector to private investment. Proposed reforms to the Electrical Power Law and related legislation would open the electric sector to private investment in independent power production, self-supply cogeneration and small-scale production. These new laws will have important implications for the development of energy-related infrastructure in the border region, such as the construction of natural gas pipelines to supply U.S. gas to Mexicali and Tijuana.[13]

The proposal builds on 1992 electricity reforms that allowed private companies to generate electricity for their own use or for sale to the CFE. Under this new plan, private concerns would be allowed to distribute power under concessions of about 30 years. Currently, only state-owned entities are permitted to distribute electricity in Mexico. Zedillo's plan aims to open the door to increased competition, to increase Mexico's electricity supply, to lower consumer prices for electricity, and to modernize and expand the country's transmission and distribution systems. In the process, the role of the state would change from one of power-sector owner and operator to regulator, somewhat similar to what exists in the United States.[14]

Two major components of the reform effort include new opportunities for independent power producers (IPPs) and the further integration of Mexico's electricity grids with those of the United States and Canada.

> **Independent Power Projects:** The CFE announced in early 1999 that it plans to tender five projects in 1999 for independent power producers with generation capacity of 2,800 MW. The IPPs would enter operation between 2001 and 2004, with a combined investment of $2.1 billion. Due to CFE budget restrictions, the CFE has begun favoring the use of IPPs that sell power to CFE for distribution.[15]
>
> **Integration of electricity grids with the United States and Canada:** Proposals for liberalizing Mexico's electricity sector have implications for integration with the United States and Canada, as well as a possible "Yukon to Yucatan" electricity grid. Currently there is a shortage of transmission link-up capabilities between the United States and Mexico. In a landmark ruling in late April 1998, the U.S. Federal Energy Regulatory Commission required utilities to open their long-distance transmission lines to competing power providers. Before this ruling, U.S. border utilities controlling interconnections with Canadian and Mexican utilities were able to bar competitors easy access to foreign power markets.[16]
>
> Mexico is seen as an especially lucrative power marketing opportunity, given its fast-growing demand for electricity. Demand growth in Mexico is more than three times that of the United States.[17] Energy Minister Luis Tellez has stated that he would like the CFE to enter into agreements with U.S. utilities for medium-term contracts to import power. Tellez also would like to connect northeastern and east-central Mexico to the Texas and Arizona power grids. Tellez has stated his belief that power imports would increase competition in the Mexican electric power sector and would lead to lower prices. Importing power from the United States would allow Mexico to invest its capital in transmission and distribution.

Zedillo's proposals have been met positively by the Mexican private sector, as well as by U.S. and other international energy companies. International companies (especially from the United States) are expected to play a major role in bringing online the new generating capacity that CFE will need, especially in northern Mexico, including Baja California. Power companies have long sought greater involvement in Mexico's electricity sector. U.S. generators are particularly

optimistic about these proposals, as liberalized markets would allow producers to generate and produce power in the United States, strengthen interconnection between the two countries' grids and increase cross-border transmission of electricity.

International companies, however, will need to see the rules outlined very clearly before they invest heavily. The Mexican government also will need to create a regulatory framework to clarify the position of IPP projects granted under the existing regime. Zedillo's plan would entail amending Articles 27 and 28 of the Mexican Constitution, and could face significant political opposition. Along with concerns about job security, labor unions have voiced objections to foreign domination and threats to the national sovereignty of the country's electricity sector.

NAFTA and Energy[18]

The treatment of the energy sector in the North American Free Trade Agreement (NAFTA) is perhaps most significant for what it lacks. Pursuant to the restriction in the Mexican Constitution that reserves to the Mexican federal government all ownership of Mexico's basic energy resources, NAFTA does not create significant new opportunities for private investment in oil, gas, refining, basic petrochemicals or direct delivery of electricity. These activities remain controlled by Pemex and CFE. Nevertheless, NAFTA does provide new opportunities for private energy companies, particularly those in the electric power industry. Under NAFTA, foreign companies can acquire, establish and operate electric generation facilities in Mexico. Electricity generated at these facilities can be used at the site or sold to CFE. Moreover, the opening of the Mexican government procurement market will create opportunities for foreign companies to compete with Mexican entities for supply and service contracts with Pemex and CFE.

NAFTA reserves to the Mexican State goods, activities, and investments in the oil, gas, refining, basic petrochemicals, nuclear and electricity sectors. Consistent with Mexico's move to greater privatization of industries and resources, however, NAFTA opens many downstream activities in the energy sector to greater private investment, both foreign and domestic.[19] NAFTA also expands on Mexico's current Build-Lease-Transfer ("BLT") program, which permits foreign companies to build an energy facility while leasing the site during construction and then to transfer the plant back to the government shortly before commercial operation. With the full implementation of NAFTA, foreign companies will be able to own the plants and earn profits on sales of power back to the CFE for the life of the facility. In addition, NAFTA's gas provisions potentially enable U.S. owners of gas-fired cogeneration facilities and other gas-fired facilities in Mexico to arrange for competitive gas supplies from U.S. gas companies.

NAFTA aims for more open markets in the energy sector, but it remains unclear whether those markets will provide sufficient returns to support increased investment. Still to be worked out are:

- the rates that CFE will pay for electricity sold by the foreign-owned facilities.

- the extent to which the Mexican government may regulate and modify the rates and terms of power sale agreements with the CFE. Deals will be very limited or impossible if these arrangements fail to ensure a guaranteed payment stream to cover the debt service.
- the level of taxes that may be imposed on such operations in Mexico.
- the role of Pemex in importing gas for gas-fired electric power facilities.

Genuinely open oil and gas markets are not created under NAFTA, and the effect of the agreement's electricity provisions will depend greatly on how they are implemented. This will depend, in turn, on the extent to which the Mexican administration succeeds in bringing reform and a market-oriented spirit to Pemex and the CFE.

The Energy Sector in the California/Baja California Region[20]

The outstanding characteristic of energy use in the binational area is the almost total dependence on energy resources from outside the region. With the notable exception of the geothermal fields located south of Mexicali, virtually all of the energy consumed in the region originates from distant places. These "imported" energy resources are in the form of petroleum products (gasoline, diesel, jet fuel, liquefied petroleum gas and fuel oil), natural gas, uranium and imported electricity. For example, approximately $3 billion per year left the San Diego economy to pay for this energy in 1994, the latest year figures were available.[21] All of Baja California's transportation, industrial and residential fuels must be transported long distances from refineries located far to the south in Mexico. Moreover, the electric power grid in Baja California is not connected to the main Mexican power system and the state has no natural gas pipeline system, with the exception of a small distribution system in Mexicali.

The salient features, then, of the energy sector in the binational region are:
- the lack of indigenous or nearby energy resources for both San Diego and Baja California
- the relatively high cost of electricity in San Diego
- the isolation of the Baja California power grid from the rest of Mexico
- the absence of a natural gas pipeline system in Baja California
- the growing demand for energy services resulting from the increasing industrialization and population in Northern Mexico and San Diego.

These facts help to provide a rationale for developing increased cooperation in the energy field between California and Baja California.

With these general observations, we now turn to a detailed description of the energy sectors of Baja California and San Diego.

Energy Sector of Baja California

Baja California derives its energy from basically two sources: petroleum products and geothermally generated electricity. All of the petroleum products are imported to the region from other parts of Mexico, especially from north-central Mexico and the Peninsular Area.[22] There are

no oil refineries in Baja California; most petroleum products enter the region via a products terminal at Rosarito, brought there by tankers.[23]

The transportation sector in Baja California uses leaded and unleaded gasoline and diesel. Liquid petroleum gas (LPG) substitutes for natural gas and is used mostly in the residential sector, but also in the industrial and commercial sectors. Like San Diego, the transportation sector in Baja California is the largest user of energy. The main fuels currently consumed are gasoline and diesel fuel. By 1995, unleaded gasoline (Magna Sin) was in widespread use in Baja California and constituted the principal gasoline fuel for cars and light-duty trucks. This has resulted in a corresponding drop in lead emissions to the atmosphere. Diesel fuel is used mostly by buses and heavy-duty trucks.

Electric Power in Baja California

Baja California's electrical energy infrastructure consists of two large power-generating facilities (about 620 megawatts each), several smaller generating plants and appropriate transmission lines. The power grid is connected to San Diego via two 240 kV lines, one near Tijuana and the other Mexicali. Installed capacity for Baja California is shown in Table 3.

Table 3: Installed Capacity (megawatts/MW), Baja California, Mexico

Type	Location	Capacity (MW)
Geothermal	CP (Mexicali)	620
Thermoelectric	Rosarito	620
Gas Turbine	Mexicali	62
Gas Turbine	Tijuana	60
Gas Turbine	Ensenada	55
Internal Combustion	San Felipe	5
Total Installed Capacity		**1422**

The main power plant supplying power to Tijuana—the 620-MW plant in Rosarito, just 24 kilometers from the border—burns heavy oil and is the largest fixed source of air pollution in the region. One of the most important energy-related issues facing the San Diego/Tijuana region is to proceed with plans to convert this power plant to natural gas, consistent with Mexico's stated industrial energy policy to convert a significant percentage of Mexico's thermoelectric plants to natural gas by 2005.

The only indigenous energy source utilized on a large scale in Baja California is geothermally generated electricity, located south of Mexicali at Cerro Prieto.[24] Until a few years ago, power from Cerro Prieto was exported to Southern California under a contract with Southern California Edison (SCE) and SDG&E. These exports peaked in 1987 and 1992, and accounted for 12

percent and 10 percent, respectively, of San Diego's electricity supply in those years. Electric imports from Mexico to San Diego ended in 1996, as supply in Baja California has barely kept up with growing internal demand.

Between 1996 and 1998, electric consumption increased 22 percent for the state of Baja California and 25.8 percent for Tijuana. These are very large increases and have put a significant strain on the CFE's generating capacities in Baja California. (By comparison, electric use in San Diego County increased by only 7.4 percent in the same two-year period.[25]) In Tijuana, the industrial and residential sectors are the major users of electricity. This is different from electric use patterns in San Diego, where the commercial and residential sectors consume more electricity than the industrial sector. The difference in electric energy use between Tijuana and San Diego reflects the fact that manufacturing and assembly activities form a larger part of the economy in Tijuana than they do in San Diego. Consumption of electricity by sectors for Baja California for the period 1994 to 1996 (latest available) is provided in Appendix II.

In Mexicali, residential electric consumption is more than twice that of Tijuana, even though Mexicali's population is less than Tijuana's. Mexicali has some of the highest temperatures in Mexico, with daily average outdoor temperatures well above 90ºF for July and August. It also has very energy-inefficient housing infrastructure, mainly due to the poor shell characteristics of the housing stock and the low efficiency of the electric devices used for air-conditioning. In fact, Mexicali has the highest per-capita residential energy use in Mexico. The inefficient air-conditioning sector in Mexicali is an obvious area where improvements could be made. Reduced air-conditioning loads would result in a reduction in demand for electricity in Baja California. Several programs are under way to increase the energy efficiency of the housing stock and reduce air-conditioning loads in Mexicali. [26]

Although per-capita electric use in Baja California is greater than the Mexican average, it is still much less than San Diego's. For Baja California as a whole, per-capita electric use for 1996 was only 2,147 kWh, only one-third that of San Diego (6,333 kWh). For Tijuana, per-capita electric use was only 1,608 kWh, only one fourth of San Diego's. Mexicali, with 3,268 kWh per capita, is the highest per-capita consumer in Baja California.

It is important to note, however, that demand for electricity in Mexico has increased at a much higher rate than in the United States and will continue to do so. The CFE estimates that demand for electric services will increase at an annual rate of 5.7 percent between now and 2005 for northern Mexico, compared with 4.7 percent for the country as a whole. Should these high rates of growth continue, this implies a doubling of demand for electric services in just 12 years.

The Future Energy Needs of Baja California

The process of estimating future energy needs and planning to meet those needs in Mexico is quite different from the process in California. There are no counterpart agencies in Mexico or Baja California to the Public Utilities Commission, the California Energy Commission or the San Diego Association of Governments. Future electricity demand has traditionally been estimated

by the CFE based more or less on historical growth patterns, rather on than a detailed analysis of the different electricity-consuming sectors.

A more detailed analysis of future electric demand was carried out by researchers at the *Universidad Autónoma de Baja California* (UABC) in 1994, the latest available.[27] This analysis took into account market development, energy reserves and alternative energy resources in Baja California. The study estimated annual electric sales growth rates of 4.6 percent for the next decade, somewhat lower than estimated by the CFE, but still at least more than double what is expected in San Diego. To meet this expected demand, an additional 960 MW of installed capacity will be needed, representing an increase of 78 percent relative to 1994. New electric customers are expected to grow by 5 percent per year. By the year 2003, Baja California will have 796,000 electric customers, 90 percent of whom will be in the domestic sector.

To help meet this demand, CFE hopes to add 450 MW by 2002 to the existing 620 MW facility at Rosarito, 100 MW at the geothermal plant at Cerro Prieto this year, and a combined cycle plant of 225 MW in Mexicali by 2004. This would total 775 MW of new capacity, still 185 MW short of expected demand. Even these additions, however, are a long way from actual implementation, partially due to oil prices that were much lower than expected oil prices this year, significantly limiting Mexico's ability to invest in its electric infrastructure.

Instead of increasing generating capacity within Baja California, expected demand might be met by purchasing more electricity from the North American power system and integrating Baja California more fully into the electric transmission system of the United States. As noted earlier, the Baja California power grid is isolated from the Mexican national system but is connected to the California system at two points. This permits a limited amount of power transfers between the western North American system and Baja California. As restructuring of the California electric sector gains momentum, electric customers and energy brokers will be searching all over North America for the cheapest power available. It may prove cost-effective for the CFE in Baja California to both buy and sell power within this very large electric market. Large consumers of power in Baja California, such as industrial parks, may find it cheaper to purchase power from the United States than from the CFE. Similarly, customers in San Diego may find it less costly to obtain power from the CFE in Baja California or from independent power producers in Mexico, rather than from local generators in the United States.

Baja California's Natural Gas Market

As mentioned earlier, Baja California has no direct access to the abundant natural gas resources of Mexico because of its location relative to the sources of Mexican natural gas. There is, however, a growing recognition that natural gas would be an ideal fuel to meet the region's growing demand for industrial heat and electric generation and that the United States, and perhaps Canada, can serve as a source of natural gas for Baja California if appropriate cross-border pipelines are constructed.

The use of natural gas for power generation in Baja California is of particular importance to the San Diego/Tijuana region. Since the principal thermal power plant in the Baja California is just

24 kilometers south of the border and burns heavy fuel oil, supplying that plant and its planned additions with natural gas could improve air quality in the region while, at the same time, providing natural gas to industries and residents of Tijuana. Gas-fired electrical generation produces almost no sulfur oxides and is generally more efficient than an oil-fired plant.

In July 1997, a Swedish-Japanese joint venture won a $244 million contract to build a 450 MW expansion to the Rosarito power plant. If completed, the total installed capacity at the site would be 1,160 MW.[28] The plans called for the plant to utilize natural gas. In August 1998, Sempra Energy (formed by the merger of SDG&E and Southern California Gas), won the contract to supply natural gas to the Rosarito site. Sempra Energy will spend about $40 million to build the 23-mile pipeline and hopes to generate about $1 billion in revenues by supplying natural gas over the next 10 years.

A similar project has already been completed to bring natural gas from California to Mexicali. In March 1996, the Mexican government, through its Energy Regulatory Commission, called for bids to construct a pipeline system to supply natural gas to Mexicali. The project was awarded to a consortium of three companies: Enova, Pacific Enterprises (now Sempra Energy) and Proxima, a Mexican company based in Mexicali. The consortium, known as *Distribuidora de Gas Natural de Mexicali* (DGN), has a 12-year exclusive contract for the distribution of natural gas to more than 25,000 users in Mexicali.

For the first time in Baja California's history**,** natural gas is now available via a pipeline crossing the border east of Calexico, near the recently opened truck crossing facilities. As of May 1999, 50 industrial customers, 32 commercial businesses and 350 residences have been connected to this distribution system.[29]

Renewable Sources of Energy

It was noted earlier that both San Diego and Baja California are heavily dependent for energy supplies on fossil fuels (petroleum products and natural gas) that originate far from the region. Not only does this represent an outflow of regional capital, but also the burning of fossil fuels is a major source of air pollution. It is, therefore, of interest to examine the potential for development of indigenous and renewable sources of energy in the border area as a long-term replacement for fossil fuels.

Although Baja California has an impressive array of renewable energy resources, very few of these resources have been developed to produce significant amounts of energy. The main reasons for the lack of renewable energy development in Baja California are the same that plague renewable energy development everywhere: relatively low costs for oil and natural gas coupled with relatively high initial capital costs for most renewable energy projects. These factors present even more of an impediment for the development of most renewable projects in Mexico, because of the plentiful supply of oil and gas and the lack of capital.

Renewable energy resources in Baja California consist of geothermal, microhydroelectric, biomass, wind, solar, and tidal. With the exception of geothermally generated electricity, none of these renewable resources has been significantly exploited to date.

Geothermal: Baja California is home to some of the largest geothermal reserves in Mexico.[30] These considerable resources are located at Cerro Prieto in the Valley of Mexicali, about 30 kilometers from the international border. An intriguing potential source of even greater geothermal energy than that found in the Valley of Mexicali might be in the form of geopressurized deposits (high-temperature, high-pressure water located beneath the sea bed)**,** located in the northern part of the Gulf of California. This region displays characteristics found nowhere else in the world for the development of marine geothermal resources. The initial geothermal potential has been estimated to be tens of times greater that that of Cerro Prieto.[31]

Geothermal Binary Cycle: There is potential to use heat from the residual brine that results from the operation of the geothermal fields at Cerro Prieto. The fields have an installed capacity of 620 MW and, when in full operation, produce 12,000 tons of residual water per hour with a temperature range of 120ºC to 135ºC. This represents an important amount of useful energy for a binary cycle operation. Estimates suggest that as much as 246 MW of additional power could be produced in this fashion.[32]

Microhydroelectric Power: An interesting renewable technology that could prove practical in Baja California is microhydroelectric power generation in the Valley of Mexicali. This is based on capturing the energy in the flow of water from the extensive irrigation system that exists in the agriculture-intensive region surrounding the city of Mexicali. Estimates as high as 80 MW have been suggested for microhydroelectric generation.[33]

Solar, Wind and Biomass: Although the potential contribution to the region's energy mix from solar (thermal and electric), wind power and biomass could be significant, there are no comprehensive studies that have quantified the energy potential of these resources.

San Diego's Energy Sector

The last comprehensive analysis of the energy sector in San Diego was carried out by SANDAG in 1995.[34] Although the regulatory framework of the energy sector has changed dramatically since that time, the underlying energy supply, distribution and end use for the region are about the same as they were when the SANDAG study was carried out.

The main features of the energy sector in San Diego are the dominance of the transportation sector in terms of energy consumption, the high proportion of electricity imported from outside the region, and relatively high electricity and gasoline prices. Transportation accounts for over 60 percent of end-use energy consumption in San Diego, followed by the residential, commercial, and industrial sectors. This energy consumption pattern reflects the structure of the San Diego economy; most San Diego residents commute to work in private automobiles with

one or two occupants. Moreover, most of the rapid population growth during the last 10 years has occurred in the northern sections of the county, resulting in longer commutes from home to work.

In 1997, close to two-thirds of the electricity consumed in San Diego was purchased outside the region, an increase of 42 percent over 1996. In 1998, 17,249 million kWhrs of electric energy were used in San Diego, an increase of 3.2 percent over the preceding year. The power-consuming sectors in San Diego are the commercial (39 percent), residential (36 percent) and industrial sectors (18 percent). Note the comparison with Tijuana, where the electric usage in the industrial sector accounts for a much larger portion of total consumption than in San Diego.

The major power-related infrastructure elements in San Diego consist of two large thermal power plants located in Carlsbad (Encina) and Chula Vista (South Bay) plus the San Onofre Nuclear Generating Station (SONGS) located just south of San Clemente, 20 percent of which is owned by SDG&E. All thermal power plants operating in the county use natural gas, and there are only two high-voltage (500 kV) transmission lines, one to the north and the other to the east, responsible for carrying all the imported power into the region.

As allowed under California's restructured electric market (see below), it is now possible, and required in some cases, for the state's investor-owned utilities, such as SDG&E, to sell its power generating facilities. Last year Sempra Energy sold its two main power plants in San Diego, the Carlsbad and Chula Vista facilities. The Carlsbad plant, the largest thermal power plant in the county, was sold for $356 million to a partnership composed of the Houston-based Dyenergy Inc. and NRG Energy Inc. The price was considered well above book value for the plant.[35] The new owners can continue to operate the plant and sell its power to the power exchange, or they may decide to construct a new generating facility at the site, using more modern and efficient technology than what is currently in place. Should they take the latter course, most of the needed permits will be in place since the site is already being used for a power plant. This would save them considerable time and expense, and may account for the high price they paid for the plant.

Sempra Energy also sold its Chula Vista plant last year to the Port Commission for $100 million. With these two sales, Sempra Energy's only remaining major generating holding is its 20 percent share of the San Onofre Nuclear Generating Station (SONGS).

Electric Industry Restructuring in California

The most important energy-related development in the last few years has been the restructuring of California's electric utility industry. This reorganization of the electric sector will have an important impact on San Diego and could result in increased trade in energy services between San Diego and Baja California. A detailed summary of the restructuring of California's electric utility industry is provided in Appendix I.

Through reforms passed by the California legislature, a significant new element of competition has been introduced into the electric utility sector in the state. The intent of the legislation is to create competition among potential generators of electricity, thereby letting an electricity market

set the price for the electricity-generating component of a customer's electricity bill. These reforms have effectively separated, or "unbundled," the generation of electricity from its transmission and distribution. State-created entities serve to create a market for electric power, through an auction-like function that matches requests to buy a quantity of electricity at a given price with an assured supply. This function solicits bids from electricity generators and chooses the lowest bidders until there is enough supply to meet the requests to buy power.

The Impact of Electric Restructuring in the Binational Region

It is too early to tell exactly what effect the restructured electricity market will have in the San Diego/Tijuana region, but the impact is likely to be significant. By opening power generation to competition and ensuring equal access to the transmission system, the way is open for greater integration of Baja California's power sector into California's energy markets.

The combination of electric restructuring in California and gradual opening of the energy markets in Mexico allow for a degree of energy trading across the border that would have been difficult or impossible a few years ago. The following are some possibilities opened by these reform efforts:

- It is now possible for private companies to generate electricity for their own use or for sale to CFE. Private concerns can also build power plants and sell power to CFE. These are known as independent power producers (IPPs). Companies such as Sempra Energy could bid on new power plant construction in Baja California, if the economics were favorable.

- Generating facilities could be constructed on the U.S. side of the border to supply electric services to customers in Tijuana. Following the FERC ruling discussed earlier, SDG&E would have to allow equal access to all qualifying generators to transmit power over its transmission and distribution system, at least up to the border connections. Beyond that point, power would flow in CFE controlled lines. For example, US Generating, a subsidiary of Pacific Gas and Electric, has developed preliminary plans for a sizable power plant (about 500 MW) in Otay Mesa, presumably to supply customers in both San Diego and Tijuana.

- It may also be possible for generating facilities to be built in Baja California to supply customers on both sides of the border. When CFE had excess capacity in the 1980s and early 1990s, San Diego routinely purchased power from Mexico. Now, the situation is reversed. As the Mexican energy sector continues to open to private investment, the possibility exists for IPPs, Mexican or foreign, to build plants in Mexico and export their power to San Diego and other parts of the western United States.

- Renewable energy resources, such as solar and wind, are a source of future energy production in the binational region. Wind farms and solar facilities could be located in Baja California, where land and labor costs are less than in San Diego, and power sold to end users on both sides of the border.

Challenges and Opportunities

A secure supply of reasonably priced energy with a minimum of environmental impact will be needed for the San Diego/Tijuana region if it is to remain competitive in the global economy. Given the high population growth expected in both San Diego and Tijuana over the next 10 to 20 years, meeting increased demand for energy in services will prove to be one of the most important challenges facing the region.

Meeting this challenge will require effective cooperation and coordination between the privatized energy market players and the local and state agencies still responsible for regulating the energy sector in California. Complicating the development of new methods of planning for future energy-related infrastructure is the lack of formal cross-border energy planning, coordination and cooperation. The impediments to creating a healthy energy supply system in the binational region are not mainly technical or financial, but grow out of the absence of planning, forecasting and coordination at the *binational and regional* level. Listed below are some suggestions to meet the challenge of meeting the energy needs of the San Diego/Tijuana region.

- **Create a *binational* collaborative effort to examine the future energy needs of San Diego, Tijuana and surrounding areas.** This group should have representatives from all the major stakeholders in the region: energy services companies, major energy consumers, relevant local and state agencies, environmental groups, appropriate non-governmental organizations (NGOs), ratepayer advocates and the general public. It is critical that broad representation from *both* sides of the border be present. This entity could be under the auspices of SANDAG, provided it was jointly developed with relevant agencies in Tijuana. An example of this approach is SANDAG's Committee on Binational and Regional Opportunities (COBRO). Alternatively, it could be separate from any existing organization and develop its own identity, in a manner similar to the San Diego-Tijuana-Rosarito Air Alliance. In addition, this group could work with global entities such as the World Bank to encourage efforts toward maximizing efficient use of energy.

- **Encourage greater usage of natural gas in Tijuana.** A secure supply of natural gas for industry and power generation in Tijuana will go a long way toward meeting the energy needs of the Tijuana region in a manner less harmful to the environment than fuels currently in use. One possible way to assist the transition to natural gas is to consider an exchange between Mexico and the United States. Mexican natural gas could be imported to the United States via Texas and U.S. gas exported to Baja California by extending San Diego pipelines into Tijuana. This could reduce the burden on Mexico of having to utilize its foreign currency reserves to purchase U.S. natural gas. Other issues that need to be addressed are tariffs on gas imported to Mexico and the security of supply.

- **Prepare and maintain a comprehensive energy database for the cross-border region.** The last energy study of San Diego took place in 1994, before restructuring and the changes in the Mexican energy sector. The region has no central database related to energy, and no entity is collecting and distributing such information. SANDAG maintains up-to-date

information about topics such as housing, population, economic indicators and land use, but not energy. Either SANDAG or the Regional Energy Office would be appropriate entities to gather, maintain and distribute this information. Once again, this would have to be a binational effort involving appropriate organizations in Tijuana and Baja California.

- **Invest in renewable sources of energy.** Although the cross-border region will likely remain dependent on non-renewable energy sources imported from outside the region for some time, more could be done to encourage and utilize existing renewable energy resources found on both sides of the border. The region has yet to fully exploit a combination of energy resources such as solar, wind, geothermal and biomass. The State of California has a wide range of programs to encourage greater use of renewable energy resources, and San Diego needs to take better advantage of these programs. Greater utilization of renewable sources of energy not only will reduce air pollution, but could form the basis of a new high-tech research, development and manufacturing sector in the field of advanced energy technology.

The underlying logic of electric restructuring in California, the opening of the energy sector in Mexico to private investment, and the growing economic interdependence of California and Baja California will inevitable lead to greater cross-border trade in energy services between San Diego and Tijuana. This trade is likely to take place in the buying and selling of electricity by California-based entities and by private and government power plants based in Mexico. We also expect natural gas from the United States to be available in Tijuana in the future. In the open market for energy services that is emerging on both sides of the border, the final price to consumers will be the most important element in deciding where to purchase energy; the location of the energy source will become less relevant than it is today. Over time, the international border will become less of a barrier to energy flows, a consequence of the continued integration of the cross-border region.

APPENDIX I: THE RESTRUCTURING OF CALIFORNIA'S ENERGY SECTOR

On Sept. 23, 1996, Gov. Pete Wilson signed legislation that dramatically changed the regulatory system governing electric utilities in California. In outline, the new law, commonly known as AB (Assembly Bill) 1890, accomplishes the following:

- Recognizes that new technology and new federal laws allow change from today's highly regulated market structure to one that relies on competition to set the price of the generation component of electricity bills
- Creates two new market entities, one to oversee the high voltage transmission system (Independent System Operator—ISO) and one to create an auction market for the buying and selling of electricity (Independent Power Exchange—PX)
- Authorizes retail competition, allowing customers to choose their electricity supplier, which began on March 31, 1998
- Permits new business opportunities to develop in buying, selling or brokering electricity for individual customers or customer groups
- Permits utilities to recover their transition costs from ratepayers
- Mandates a 10 percent rate reduction for small residential and commercial customers; this went into effect Jan. 1, 1998, with a goal of an additional 10 percent reduction by 2002
- Provides funds for continuation of utility energy conservation; research, development and demonstration (RD&D); public assistance; and renewable energy-based electricity generation activities
- Allows customers to continue to rely on service from local utility companies as they have in the past, if they choose not to participate in the competitive market.

AB 1890 effectively separates, or "unbundles," the generation of electricity from its transmission and distribution. Power plant owners now have the opportunity to sell electricity to customers with whom they have negotiated sales contracts, to sell electricity into a general "pool" (the Power Exchange, described below) from which large customers and distribution utilities may draw to meet their needs, or to "aggregators," which are companies that have signed contracts with many small customers to provide their electricity needs. The transmission and distribution of electricity still is a regulated monopoly under control of the local utility—in this case, SDG&E. However, SDG&E cannot refuse to transmit and distribute power from qualified generators, and it must charge the same tariff to all generators. The intent of the legislation is to create competition among potential generators of electricity, thereby letting an electricity market set the price for the electricity-generating component of a customer's electricity bill. The role of regulators is to ensure that competition is allowed to flourish and that no companies can dominate the market and set prices.

It should be kept in mind that the generation portion of the final retail price for electricity is only about 30 percent in the San Diego region. Thus, reduction of a few percentage points in generation costs will result in only a small decrease in the price customers pay for electricity, unless the transmission and distribution (T&D) sectors are also opened to competition.

AB 1890 created three new entities: the Independent System Operator (ISO), the Power Exchange (PX) and the Oversight Board. The Independent System Operator oversees the operation of the high-voltage electricity transmission system in California. Western North America is interconnected by many high-voltage electric lines. These lines allow electricity to be generated in one area and used in another, in a geographic region that extends from Colorado to the Pacific and from Canada to northern Mexico. The major responsibility of the ISO is to ensure fair and impartial access to the transmission system for all generators, while maintaining reliable operation. Since the high-voltage lines are the electrical "highways of commerce," the ISO will ensure that no particular buyer or seller of electricity can block access by others.

The Power Exchange (PX) accepts requests to buy a quantity of electricity at a given price. The PX functions like an auction, matching total demand for power with generation of power; in fact, in late October Mexico's CFE began purchasing power from the PX. The PX creates a "pool" or "spot market" where price information is publicly available. The PX solicits bids from electricity generators and chooses the lowest bidders until it has enough supply to meet the requests to buy power. PX prices will change on an hourly basis. Many customers pay for electrical power based on this price, either directly through their distribution utility or through a private power supply contract with terms that are pegged to the PX price. Thus, consumers who choose to enter into private contracts for power, where the terms, conditions and price are not public knowledge, may use the public information from the PX to gauge the attractiveness of supply or service offers they receive.

An Oversight Board of five members oversees the restructured electricity market. The governor makes three appointments to the Oversight Board and the Legislature makes two appointments. The legislative appointees are non-voting members of the board. The Oversight Board has established a governing board for the Independent System Operator and another for the Power Exchange. Both the Independent System Operator and Power Exchange are private, not-for-profit California corporations. They are not government agencies.

The governing board for the Independent System Operator is composed of individuals involved in the generation, transmission, distribution, purchase, sale and use of electricity. Appointments are drawn from public interest groups and individuals not directly involved in the electricity market. The Power Exchange governing board also consists of representatives drawn from all aspects of the business of the Power Exchange and from sources not directly involved in the electricity business. The objectives in having such a wide representation of all market interests on the ISO and PX governing boards are to ensure that no one interest can dominate the market and that robust competition will prevail.

APPENDIX II

Electric Sales for Baja California and Municipalities
1994-1996
(Megawatt hours)

Sector	Baja California			Ensenada			Mexicali			Tecate			Tijuana		
	1994	1995	1996	1994	1995	1996	1994	1995	1996	1994	1995	1996	1994	1995	1996
Residential	1,593,361	1,658,829	1,792,602	132,098	138,098	147,263	955,612	980,308	1,070,708	30,440	31,938	33,931	475,261	508,485	540,700
General up to 25 KW	373,866	377,195	394,019	47,961	47,986	48,532	146,235	149,294	159,842	11,754	12,008	12,781	167,916	167,907	172,864
General	146,163	146,146	148,857	7,106	6,970	6,794	71,431	69,714	70,208	608	3,493	4,146	67,018	65,969	67,709
greater than															
25 KW															
Public	68,094	77,722	75,904	12,796	12,203	12,063	27,486	33,837	32,107	2,249	2,470	2,753	25,563	29,212	28,981
lighting															
Drainage	31,018	30,776	30,769	8,253	7,819	7,658	10,594	10,793	11,808	2,713	3,179	2,425	9,458	8,985	8,968
water															
pumping															
Temporal	155	113	395	55	42	148	11	29	247				89	42	-
General	1,954,390	2,134,304	2,633,359	194,631	212,031	221,895	869,670	917,620	1,171,407	58,490	62,928	74,164	831,599	941,725	1,165,893
high															
tension															
Agricultural	126,540	135,081	169,118	47,868	55,035	64,233	73,207	74,044	98,214	2,174	2,330	2,740	3,291	3,712	3,931
irrigation															
TOTAL	4,293,587	4,560,166	5,245,023	450,768	480,184	508,586	2,154,246	2,235,639	2,614,541	108,428	118,346	132,940	1,580,195	1,726,037	1,989,046

Source: La Economía de Baja California en Cifras 1998
Gobierno del Estado de Baja California, Secretaría de Desarrollo Económico, Mexicali, Baja California.
Margarito Quintero Nunez, UABC

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Dr. Sweedler is the author of more than 40 journal articles, technical reports and book chapters, and is the co-editor of four books. Some of his recent publications include: *Energy and Environment in the California-Baja California Border Region*, (1996); *The Energy Sector of Baja California*, (1997), *Sources of Air Pollution in the U.S.-Mexico Border Region* (1997) and *Modeling Emissions from Heavy Duty Trucks in the California-Baja California Border Area* (1997). His research has been supported by the National Science Foundation, the California Energy Commission, and the U.S. Environmental Protection Agency.

NOTES

[1] La Paz Agreement 1983: 1983 United States-Mexico Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area.
[2] The length of the border is 148 miles (237 km) stretching eastward from the San Diego/Tijuana region on the Pacific Ocean to the Colorado River, which forms the border between California, Arizona and the Mexican states of Baja California and Sonora. The estimated population in the border region is approximately 5 million, about half that of the entire U.S./Mexico border region.
[3] San Diego Association of Governments, Current Demographic and Economic Estimates, *San Diego Region*, March 25 1999
[4] See reference 2
[5] The GRP, the value of all goods and services produced in the County, is forecast to reach $91.6 billion in 1999 and further grow to $96.4 billion in 2000. San Diego has not only fully recovered from the recession in the first half of the decade, but has far surpassed former record levels of production set in the 1980s. The current rate of expansion of the GRP peaked in 1997, rising 6.6 percent compared to the previous year, to $82.6 billion. The rate of expansion slowed somewhat in 1998 to 5.5 percent, while climbing to $87.1 billion. The forecast for 1999 shows further moderation to 5.2 percent. The pace is projected to pick up some in 2000, however, rising to 5.5 percent. See Greater San Diego Chamber of Commerce, Economic Research Bureau, **San Diego's General Economy**, http://www.sdchamber.org/, 1999
[6] For an excellent overview of basic information on Tijuana, see, **Tijuana, Basic Information,** Paul Ganster, Institute for Regional Studies of the Californias, San Diego State University, San Diego, CA 92182, 1999
[7] ibid.
[8] United States Energy Information Agency, *Annual Energy Review 1997*, Washington, D.C.
[9] Most of the information in the following sections on the Mexican electric sector is from the United States Energy Information Agency, Country Analysis Brief, *Mexico*, April 1999
[10] CFE owns most of Mexico's 37.6 gigawatts (GW) of installed electric generating capacity. Currently, CFE generates about 90 percent of Mexico's capacity and distributes power to about 16.5 million customers. Another state owned company, Light and Power (LFC), supplies Mexico City and generates 2.3 percent of the total and distributes power to 4.9 million users in Mexico City. Pemex generates 4.4 percent, while the remaining 3.3 percent is generated by the private sector.
[11] Pemex enjoys a monopoly over exploration, development, refining, transportation, storage, and distribution of the country's hydrocarbons, a position guaranteed by Article 27 of Mexico's Constitution. Per Article 27, foreign participation in Mexico's oil sector is limited to service and performance contract arrangements and turnkey drilling contracts. Pemex is divided into four primary areas: exploration and production; refinery; gas and basic petrochemicals; and petrochemicals.
[12] United States Energy Information Agency, *Mexico*, April 1999
[13] Text of relevant Mexican laws and regulations related to the energy sector can be found at the web site of the *Comision Reguladora de Energía* (CRE): http://www.cre.gob.mx/english/regulatory/regulatory.html
[14] Zedillo's plan calls for a gradual transformation of control, under which the government is to rewrite rules and regulations, allowing generators to sell power freely to a government-managed pool which, in turn, is to dispatch electricity to distribution companies. At the same time, CFE and LFC would be divided into smaller operating units. After December 2000, the distribution units would be bid out for long-term concessions to private operators. Generating units eventually would be sold off, while the state would continue to own the national grid.
Big users of electricity—the 300 or so Mexican companies that use 25 percent of national electricity output—would have the right to buy their power directly from generators. Smaller consumers would receive their electricity from the distributors, whose prices would be regulated by the state. According to Energy Minister Luis Tellez, the Mexican government will maintain subsidies on electricity for poorer consumers at least through the end of the current presidential term of 2000. Ownership and control of the transmission network would remain in government hands at least until 2000, although private

concessions will be granted for maintenance and for companies interested in building transmission lines not integrated with the national network. The government also would be in control of a spot electricity market.

[15] The five IPP projects, announced in early 1999, include a 100-MW plant at Azufres, to be completed in 2001, a 900-MW plant at Tuxpan, a 900-MW plant at Altamira, and a 450-MW plant at La Laguna, all to be ready by 2003, as well as a 450-MW plant at Rio Bravo, to begin operating in 2004. Additional projects for the construction of transmission lines and sub-stations will require investments of $722 million. In 1998, the CFE awarded a total of seven tenders to build IPPs at the following sites: Hermosillo (225MW); El Sauz/Queretaro (450 MW); Rosarito (450 MW); Monterrey (450 MW); Nogales (225 MW); Saltillo (225 MW); and Campeche (225 MW). Four independent power projects are currently being built on a 15-year build-lease-transfer basis: Chihuahua (450 MW, gas and diesel), Rosarito III (450 MW, gas), Monterrey (450 MW, gas), and Cerro Prieto IV (100 MW, geothermal). The recently completed Samalayuca power plant, which will burn natural gas imported via a pipeline from the United States, was built by a group of U.S. and Mexican companies (including General Electric Power Systems, General Electric Capital Services, El Paso Energy Corporation, and Grupo Ica of Mexico) under a build-lease-transfer framework. The $647 million project was partly financed by loans from the Inter-American Development Bank and the U.S. Export-Import Bank.

[16] In this case, FERC approved a draft order directing El Paso Electric Co., which owns the only major U.S./Mexico electricity interconnections in the western Texas/New Mexico areas, to offer open access on its cross-border transmission facilities to Mexico. The U.S. Department of Energy has received an increasing number of applications for electricity export licenses in the wake of this FERC ruling.

[17] CFE has been invited to join an electric power pool in Texas (the Electric Reliability Council, or Ercot) in a move that could eventually lead to increased electricity trade between Texas and fast-growing northern Mexico. Currently, Ercot has only limited (800 MW) electricity import or export capacity between Texas and Mexico, but there is interest in expanding this due to forecasts of strong Mexican power demand growth.

[18] Paul, Hastings, Janofsky & Walker 1992, 1993. The energy sections of NAFTA are discussed in Chapter 6 of the treaty.

[19] Among these opportunities are the following:

- Private investment. NAFTA permits private companies of all three NAFTA parties to own, invest in or operate electric generation facilities for their own use.
- Cogeneration facilities (facilities that produce both electric power and useful thermal energy) and independent power production facilities that produce electricity for sale. Excess power not used by a privately owned facility must be sold to Mexico's CFE under terms agreed upon by the facility owner and CFE.
- Government procurement. Both CFE and Pemex government procurement contracts are open to competition from U.S. and Canadian companies. These contracts will be principally for equipment and related supplies, but could include provision of services as well.
- All restrictions on Mexican government procurement will be phased out over a period of 10 years:
- After eight years, U.S. and Canadian firms will be able to compete for CFE and Pemex contracts.
- Decentralization of supply contracts. To promote more cross-border trade in natural gas and basic petrochemical trade, NAFTA provides that end users and suppliers will have rights to negotiate supply contracts. Such contracts may be subject to regulatory approval.
- Equal treatment for exports. NAFTA prohibits parties from imposing any tax, duty or charge on the export of energy or basic petrochemical goods unless the same tax, duty or charge is imposed on domestic consumption of such goods

[20] For a comprehensive review, see **The Energy Sector in the California-Baja California Border Region**, Alan Sweedler, Margarito Quintero and Patricia Bennett, in *Boundaries and Energy: Problems and Prospects,* Gerald Blake, ed., Kluwer Law International, The Hague**,** 1998

[21] SANDAG 1995. *Regional Energy Plan*, San Diego Association of Governments (SANDAG), San Diego, California, 1995

[22] For example, fuel oil used at the large (620 MW) Rosarito thermo-electric power plant, located 24 km south of the border, is transported by tanker from Pemex's Salina Cruz refinery 2,400 km to the south and

also from foreign sources. Geothermal energy used to power Baja California's other principal power station is derived from the geothermal fields at Cerro Prieto, located south of Mexicali.

[23] Between Rosarito and Mexicali there is a 10-inch pipeline to transport petroleum and refined products and a similar 8-inch pipeline between Rosarito and Ensenada. Liquid petroleum gas (LPG) is brought into the region by truck or rail and distributed by truck.

[24] The present installed electric capacity at Cerro Prieto is 627 MW. Plans by CFE call for an additional 100 MW to be completed possibly by the end of 1999.

[25] Sempra Energy 1998 Annual Report, Sempra Energy, 101 Ash Street, San Diego, CA 92101-3017, p. 26.

[26] Manuel Felix, Director of Baja California State Energy Commission, private communication with author, October 1998.

[27] Guzmán, S and L. Enrique, "La Industria Eléctrica en Baja California", III Simposium de Ingenieria, UABC, Mexicali, B.C. 1994.

[28] "Venture wins Baja Contract: Swedish-Japanese group to build plant." San Diego Union-Tribune, 15 July 1997.

[29] Distribudora de Gas Natural de Mexicali S. de. R.L. (also knows as ECOGAS)

[30] Lam, Louis., Sergio Holguín and Benjamin Terrazas, "Geothermal Power Plants in Cerro Prieto", in *Energy and Environment in the California-Baja California Border Region*, Alan Sweedler, Paul Ganster and Patricia Bennett, eds., IRSC, San Diego State University, 1995. The state's proven reserves amount to 848 MW of electric power (MWe) and an additional 360 MWe of probable reserves. These represent 79 percent and 22 percent of Mexican proven and probable reserves, respectively.

[31] Grijalva, N. "Investigación de Energía Geotérmica en las Depresion de Wagner en el Golfo de California", CFE reporte 1 y 2, 1986. The location of this resource is Wagner's Trench and the submarine layers are only 80 meters beneath the surface making them highly accessible. Development of this resource is a distinct possibility and will depend on advances in current marine geothermal technologies.

[32] Quintero, M. "Ciclo Binario: Potential de Explotacion de los Recursos de Media y Baja Entalpia par Generar Electricidad", Reunion Nacional de Energy y Confort, Mexicali, B.C., 1986**.**

[33] Quintero, Margarito and M. Rivas, "Microhydroelectric Plants in the Valley of Mexicali", in *Energy and Environment in the California-Baja California Border Region*, Alan Sweedler, Paul Ganster and Patricia Bennett, eds., IRSC, San Diego State University, 1995

[34] SANDAG 1995. *Regional Energy Plan*, San Diego Association of Governments (SANDAG), San Diego, California, 1995

[35] "Power Plant in Carlsbad is sold: $356 million price is higher than expected," Craig D. Rose and Agnes Roletti, San Diego Union-Tribune, 15 December 1998.