ENERGY EFFICIENCY IN THE BORDER REGION: A Market Approach

BORDERENERGY

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Energy Efficiency in the Border Region:
A Market Approach

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Executive Summary

The U.S. – Mexico Border Region (border region) is experiencing rapid economic and population growth. Corresponding to this growth is a projected annual increase in energy demand. This study assesses the potential for energy savings through the implementation of industrial and commercial energy efficiency projects in the border region. Because extensive energy efficiency studies focusing on the U.S. side of the border have been conducted, and in order to allow a comprehensive view of the market opportunities in the border region as a whole, this market assessment focuses on opportunities on the Mexican side of the border. The information in this report was collected through a survey of existing published data and documents. The study's ultimate goal is to promote energy conservation and to focus future project implementation efforts, resulting in air quality improvements in the region.

The current installed electricity generating capacity in Mexico is 38,500 MW and electricity consumption 157,200 GWh annually. The Mexican border states provide approximately 16% or 6,000 MW of the nation's generating capacity while consuming 34% or approximately 53,300 GWh of the nation's total energy. The growth in energy demand in the Mexican border region is forecasted to grow 5.7% to 6.5% annually. This represents a doubling in the region's annual energy consumption in 12 years.

The generating capacity in U.S. states bordering Mexico is 150,300 MW. U.S. border states generated 77% to 173% of their annual consumption in recent years. The growth of energy use in U.S. border states is projected to increase by 0.1% to 3.9% depending on the customer sector and state.

New electricity generating capacity in Mexico is expected to meet the increased industrial demand and population growth only through the next three years. Moreover, domestic fuel supplies for electricity generating facilities, which are becoming increasingly dependent on natural gas and LNG, are not keeping pace with demand. The price of natural gas may rise as much as 48% for power generators if U.S. reserves remain low and other sources of natural gas are not found.

Although utility reform in both the electricity and natural gas sectors is expected to be initiated in the border region, lag time for construction of new power plants and development of new natural gas sources and LNG facilities can be expected. These factors bring into question the continued availability and future cost of electricity in the border region. Therefore, energy conservation, distributed generation, and renewable energy must become an integral component of future energy policies and must play a key role in meeting the region's energy needs.

Key Sectors

This report focuses on three customer sectors: industrial, commercial, and institutional. Within these sectors, the following subsectors are highlighted: manufacturing (industrial); hospitality, commerce and trade (commercial); and health care/hospitals, government, and education (institutional).

Industrial and residential customers dominate electricity use in Mexico and obtain the lowest average electricity rates. The industrial sector alone is responsible for 59% of Mexico's electricity consumption nationwide. This report focuses on the manufacturing subsector. Among the fastest growing energy-users in the manufacturing subsector nationwide are machinery manufacturing facilities, which produce machinery, domestic appliances, office machines, computers, electricity generators, electric lamps and lighting equipment, electronic components, televisions, radios, and recording devices. These facilities' energy use grew by an average of 15% annually between 1994 and 1999. Manufacturing of motor vehicles, including car bodies, parts, and accessories, also experienced a high growth rate in energy use between 1994 and 1999. These facilities' energy use grew by an average of 9% annually over this period.

Manufacturing employs over 28% of the Mexican workforce, and the border region contains 11.6% of this manufacturing workforce. With the exception of Sonora, border states have a higher concentration of workers in the manufacturing sector than the national average. Manufacturing activity in the border region is located primarily in Tijuana and Mexicali, Baja California; Ciudad Juárez, Chihuahua; Matamoros and Reynosa, Tamaulipas; and Nogales, Sonora. About 71% of Mexico's maquiladoras, which are a critical element of the Mexican economy, are located in the region. Manufacturing maquiladoras alone represent one-third of the region's electricity consumption.

Commercial and public-sector customers pay the highest average rates in the country. Electricity consumption by the class that includes hotels and restaurants, wholesale and retail trade, health and social work, public administration, and education, grew an average of 2% from 1994 to 1999 and totaled 16,433 GWh in 1999. By 2001, commercial and public-sector customers were responsible for about 18,200 GWh or 12% of the nation's electricity use.

Targeted Cities

Three of the largest population centers in the border region – Tijuana, Ciudad Juárez, and Matamoros – are highly industrialized. Electricity consumption is expected to rise 6% to 8% annually in states where these cities are located. This represents a doubling in annual energy consumption from 22,600 GWh to 45,200 GWh within 12 years.

This study estimated savings for the key customer sectors in the targeted cities. Due to unavailability of specific energy use data by sector at the local level, the total energy usage and potential energy savings in the highlighted sectors and subsectors were calculated based on the following:

- Average potential energy savings for industrial, commercial, and institutional facilities in the border region that underwent preliminary energy audits sponsored by the Western Governors' Association between September 2001 and October 2002
- Distribution of audited facilities in each sector, by rate tariff
- Statewide averages in 2001 for energy consumption per customer, by rate tariff
- Statewide averages in 2001 for blended electricity rates, by rate tariff
- Number of establishments in each highlighted subsector for which data was readily available.

Among the key sectors highlighted in this report, manufacturing facilities show the highest potential for energy savings in the region. Cost-effective lighting, HVAC, and process improvements were identified for all audited facilities in this sector: average energy savings are estimated at 26% for facilities in this sector, and project payback periods range from 1.3 to 6.0 years.

Manufacturing, which includes the majority of maquiladora operations, comprises 33% of the employment in Tijuana, 46% in Ciudad Juárez, and 40% in Matamoros. Production and assembly of electronic, electrical, and automotive products is predominant in all three highlighted cities. Future energy efficiency programs should target these manufacturing subsectors in these cities. Educational facilities and the hospitality subsector (hotels and motels) also represent a relatively high potential for energy savings.

Based on existing data and the assumptions listed above, this report estimates a market potential for cost-effective energy efficiency projects with annual energy savings of approximately 434,600 MWh and cost savings of about $22.8 million in the industrial (manufacturing) sector, 101,200 MWh and cost savings of $5.4 million in the commercial (hospitality) sector, and 283,000 MWh and cost savings of about $15.4 million in the institutional (healthcare/hospitals, government, and education) sector in the target regions.

Challenges

Challenges to implementing potential energy efficiency projects include a lack of program funding for implementing agencies, a lack of financing options for interested customers, a lack of awareness and technical knowledge among potential customers, insufficient technical assistance for project identification and evaluation, an undeveloped energy services industry, insufficient market data to target services to appropriate sectors, difficulty in establishing project proponents within customer organizations, and a regulatory environment that hampers private energy projects.

Recommendations

Some precedent has been set in Mexico for state-sponsored energy efficiency programs for the public- and private-sector. Bi-lateral energy efficiency programs between the U.S. and Mexico have also been established. However, increasing efforts in this area requires increased program financing options, a more favorable regulatory environment that facilitates participation in project development and investment from the private-sector, and further collaboration between potential program sponsors to promote the use of efficient energy practices and innovations.

Program partners are advised to do the following:

- Assist local agencies and customers to obtain alternative financing
- Create a revolving loan fund for small projects
- Initiate educational activities in collaboration with local groups
- Provide third-party technical expertise to interested customers
- Develop business models to deliver energy efficiency services to the private sector, and support the development of energy service industry associations
- Collaborate with national and local agencies to develop energy consumption data at the local level that is classified by sector and subsector
- Develop a coaching system to assist facility managers and aid in completing projects successfully
- Participate in the utility reform process to support private energy projects.

Section 1

Overview of Border Energy – A Context for Improving Air Quality Through Energy Efficiency

The U.S. – Mexico Border Region (border region) is experiencing rapid economic and population growth. Corresponding to this growth is a projected annual increase in energy demand. This study assesses the potential for energy savings through the implementation of industrial and commercial energy efficiency projects in the region. It provides market information to facilitate the development of projects and prioritizes market sectors and regions for project implementation. Because extensive energy efficiency studies focusing on the U.S. side of the border have been conducted[1], and in order to allow a comprehensive view of the market opportunities in the border region as a whole, this market assessment focuses on opportunities on the Mexican side of the border. The information in this report was collected through a survey of existing published data and documents. The study's ultimate goal is to promote energy conservation and to focus future project implementation efforts, resulting in air quality improvements in the region.

This study is sponsored by the Western Governors' Association (WGA), which has conducted several energy audits in the border region and has developed a website (www.BorderEnergy.org) focusing on energy efficiency improvements and alternative fuels technologies in the border region.

1.0 Demographics

The border region runs 2,000 miles (3,100 kilometers) from the Gulf of Mexico to the Pacific Ocean and about 63 miles (100 kilometers) on both sides of the border. It extends across the northern borders of six Mexican states (Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas) and the southern borders of four U.S. states (California, Arizona, New Mexico, and Texas).

The current population in the border region is 11.8 million people: 6.3 million on the U.S. side and 5.5 million on the Mexico side[2]. By the year 2020, total population in the region is expected to grow to between 20 – 24 million people: 9.0 –10.7 million on the U.S. side and 10.9 – 13.4 million on the Mexican side[3]. This represents an annual population growth rate ranging from 1.8% to 2.7% on the U.S. side and 3.5% to 4.6% on the Mexican side. In comparison, the United States and Mexico as a whole had populations of 285.0 and 98.9 million, respectively, in the year 2000 and the United Nations projects an average annual population growth rate of only 1.0% and 1.2% respectively through the year 2020.[4]

The majority of the border population lives in one of the 14 major sister cities. The remainder lives in small or rural towns. The sister cities and their populations are listed in Table 1.

Section 1

Figure 1 shows the distribution of these population centers along the border (reference numbers are listed in Table 1). San Diego County is the most populous location on the U.S. side of the border region, whereas Ciudad Juárez and Tijuana are the most populous cities on the Mexican side of the border region.

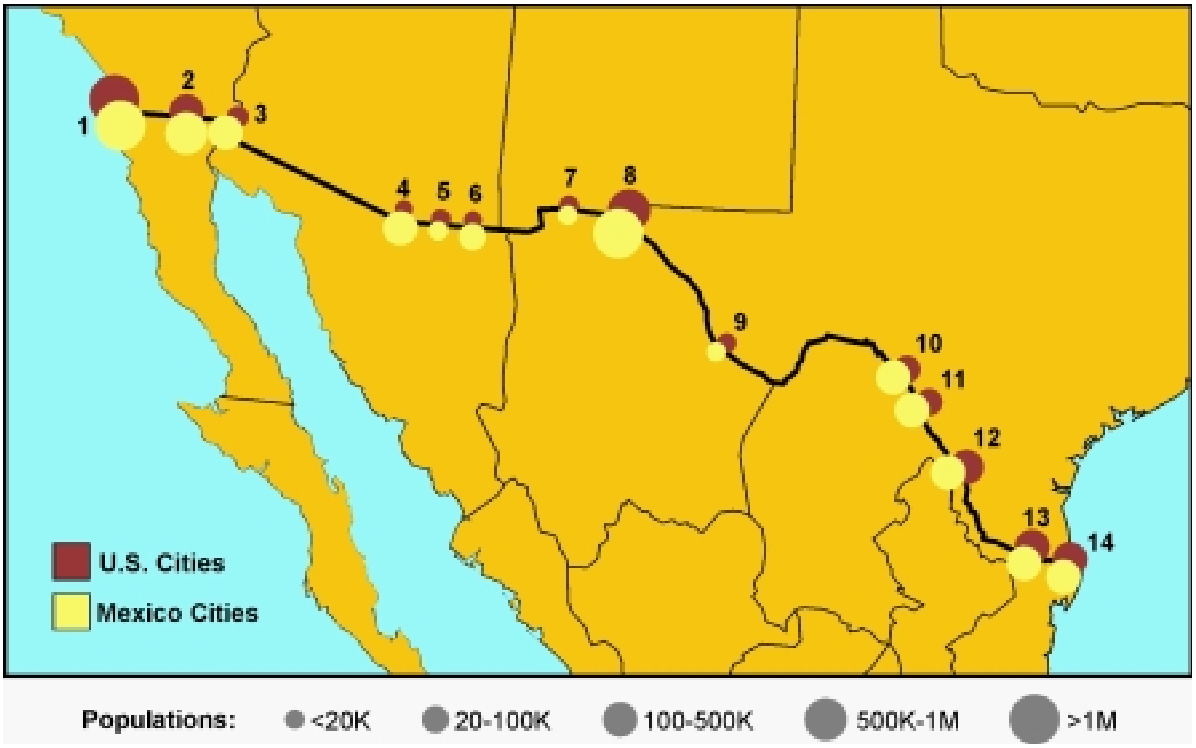
Table 1. Population of Sister Cities in the Border Region

Reference Number	U.S. City	Population[1]	Mexican City	Population[2]	Total Population
1	San Diego, California	1,223,400	Tijuana, Baja California	1,210,820	2,434,220
2	Calexico, California	27,109	Mexicali, Baja California	764,602	791,711
3	Yuma, Arizona	77,515	San Luis Río Colorado, Sonora	145,006	222,521
4	Nogales, Arizona	20,878	Nogales, Sonora	159,787	180,665
5	Naco, Arizona	833	Naco, Sonora	5,370	6,203
6	Douglas, Arizona	14,312	Agua Prieta, Sonora	61,944	76,256
7	Columbus, New Mexico	1,765	Puerto Palomas, Chihuahua	N/A	N/A
8	El Paso, Texas	563,662	Ciudad Juárez, Chihuahua	1,218,817	1,782,479
9	Presidio, Texas	4,167	Ojinaga, Chihuahua	24,307	28,474
10	Del Rio, Texas	33,867	Ciudad Acuña, Coahuila	110,487	144,354
11	Eagle Pass, Texas	22,413	Piedras Negras, Coahuila	128,130	150,543
12	Laredo, Texas	176,576	Nuevo Laredo, Tamaulipas	310,915	487,491
13	McAllen, Texas	106,414	Reynosa, Tamaulipas	420,463	526,877
14	Brownsville, Texas	139,722	Matamoros, Tamaulipas	418,141	557,863

[1]U.S. Census Bureau, Census 2000.

[2]Instituto Nacional de Estadística Geografía e Informática (INEGI), XII Censo General de Población y Vivienda 2000 (Census 2000).

Figure 1. Population Centers in the Border Region



The border region's economy is particularly dynamic. In the 1990's, the annual growth rate in employment on the Mexican side of the border was 5.9% to 6.8%, versus 4.5% to 4.7% in the nation as a whole. The region is characterized by a strong service sector and industrial/manufacturing sector, which employ 66% and 28% of the economically active population, respectively, on the Mexican side of the border region. The percentage of the population employed in the manufacturing sector is significantly higher in the border region than in Mexico as a whole. In the late 1990's, the percentage of the border region population working in that sector exceeded the national average by 10.5%.[5]

Thus, the border region is characterized by its projected high population growth on both sides of the border and a high concentration of employment in the industrial and service sectors. Tijuana, Ciudad Juárez, and Matamoros are among the most populated cities on the Mexican side of the border and also contain among the highest concentration of industrial and commercial activities of all the border cities. This report discusses energy efficiency opportunities in these cities in more detail in Section 3.

1.1 Energy Supply and Demand

This section discusses Mexico's current and projected electricity generating capacity and natural gas resources, including a summary of average electricity rates for major customer categories. The current and projected demand for electricity on both the U.S. and Mexico sides of the border region is also described.

1.1.1 Electricity

Mexico's National Conditions

Current Conditions. In 2001, Mexico had about 38,500 megawatts (MW) of installed capacity from hydrocarbons including fuel oil, diesel, and natural gas (63%), hydroelectric (25%), coal (7%), nuclear (4%), and geothermal sources (2%).[6] Over the past decade, the generating capacity from Mexico's two electricity companies has not kept pace with the increase in electricity consumption. Thus, the reserve margin (the spare generating capacity available for emergencies) – which ought to be at least 6% of the existing demand – is now often near zero.[7]

The Comisión Federal de Electricidad (Federal Commission of Electricity) or CFE is a state-owned company that generates, distributes, and markets electricity for 19 million clients nationwide (ultimately serving 98 million Mexican end-users) with the exception of Mexico City. The CFE spent about 14.5 billion pesos (US $1.3 billion[8]) for capital expenditures on energy projects in 2001. CFE's operating expenses reached over 78.8 billion pesos (US $7.1 billion) in the same year.

Luz y Fuerza del Centro (Central Light and Power) or LFC is the electricity company that serves Mexico City. LFC spent about 3.3 billion pesos (US $300 million) on capital expenditures and 12.0 billion pesos (US $1.1 billion) on operating expenses for energy projects in 2001. In total, the two state-owned electricity companies spent over 108.6 billion pesos (US $9.77 billion) on energy projects in 2001.

Both public and private entities generate electricity. Private generation projects include cogeneration plants and self-supply projects, which require a permit from the Comisión Reguladora de Energia (Energy Regulatory Commission) or CRE. Private generation projects also include independent production for sale to CFE through their bidding process.

The total electricity consumption in Mexico in 2001 was approximately 157,200 gigawatt-hours (GWh).[9] About 95% of the country's population has access to the electrical system[10], and there are approximately 24.9 million electricity customers in Mexico. Industrial and residential customers dominate electricity use in Mexico. Agricultural, industrial, and residential customers obtain the lowest average electricity rates, and commercial and public-sector customers pay the highest average rates in the country.

- **Industrial customers.** Although the number of industrial customers was less than 1% of the total number of electricity customers in Mexico, they represented over 59% (93,300 GWh) of the electricity usage in the country in 2001. The average electricity price for industrial customers was 53.97 centavos/kilowatt-hour (c/kWh) (US $0.049/kWh) for CFE customers and 59.78 c/kWh (US $0.054/kWh) for LFC customers in 2001.

- **Residential customers.** 88% of the electricity customers in Mexico belong to this sector, which consumed over 24% of the country's electricity (38,300 GWh) in 2001. Their average rates were 60.78 c/kWh (US $0.055/kWh) for CFE customers and 60.50 c/kWh (US $0.054/kWh) for LFC customers.

- **Commercial customers.** The commercial sector accounted for over 10% of the electricity customers and 8% (12,200 GWh) of the total electricity sales in 2001. Average commercial rates were 131.83 c/kWh (US $0.12/kWh) for CFE customers and 126.99 c/kWh (US $0.11/kWh) for LFC customers.

- **Agricultural customers.** This sector comprised less than 1% of the customers and 5% (7,500 GWh) of the total electricity sales in 2001. Average agricultural rates were 31.33 c/kWh (US $0.028/kWh) for CFE customers and 31.38 c/kWh (US $0.028/kWh) for LFC customers.

- **Public-sector.** Public-sector customers comprised less than 1% of the customers and accounted for 4% (6,000 GWh) of the total electricity sales in 2001. Average public-sector rates were 113.55 c/kWh (US $0.10/kWh) for CFE customers and 111.97 c/kWh (US $0.10/kWh) for LFC customers.

Mexico has about 23,500 miles (37,800 km) of transmission lines and 393,000 miles (633,000 km) of sub-transmission and distribution lines. [11] These components of the electrical system are state-owned, although private-sector entities may participate as contractors to the state.

The reliability of electricity supply has improved significantly over the past decade. In 1993, the average end-user experienced 7.5 hours of power interruptions annually. By 2001, this had decreased to 2.5 hours per year. [12]

Projections. SENER (Mexico's Ministry of Energy) forecasts national electricity demand to grow at an average rate of 6.3% annually over the coming decade, with about 28,900 MW of additional capacity (an additional 75% of existing capacity) required by 2011.[13] CFE estimates for the period between 1996 and 2005 are slightly lower, at 4.7%.[14]

Cost estimates for supplying the projected electricity demand range from US $49 billion over the next twenty years[15] to US $50 - US $60 billion over the next decade.[16] The increased demand for electricity is credited primarily to growth in the industrial sector and secondarily to population growth. As discussed above, industrial activities are responsible for over half of the electricity demand in the country.

Twenty-seven new generation plants were either under construction, development, or expected to be bid out by the CFE between 2001 and 2005. These projects will add about 10,900 MW of generating capacity to the national system from a mix of natural gas-fueled, geothermal, and hydroelectric sources. Electricity generation from privately owned sources is also expected to grow, at an average rate of 14.2% annually over the next 10 years.[17] With the addition of the planned new power plants, CFE and LFC should be able to continue to meet the nation's electricity needs through the next three years.[18]

Border Region Conditions

Current Conditions on the Mexican Border. Medium-sized, export-oriented manufacturing industries constitute one-third of the region's electricity consumption.[19] Based on CFE's sales figures, the energy consumption in border states in 2001 totaled about 52,800 GWh.

Baja California. Based on CFE's total sales in the year 2001, annual electricity consumption in Baja California is about 7,800 GWh.

Energy resources local to this region are few. Except for the geothermal resources in Mexicali Valley, almost all of the energy used in this region is imported in the form of gasoline, diesel, jet fuel, liquefied petroleum, fuel oil, natural gas, uranium, and imported electricity. Mexicali is connected to the U.S. natural gas distribution network and similar connections are under consideration in Tijuana and Rosarito. However, Baja California as a whole lacks a natural gas pipeline system.[20]

Total generating capacity in Baja California is 1.4 GW, as compared to 2.5 GW in San Diego. San Diego consumes 3.5 times more power than Baja California and does not meet its demand with local generation capacity. The U.S. city imports nearly 60% of its electricity from outside the region. Until recently, Baja California met its own electricity needs, and exported its surplus to California.[21] Baja California has two electrical interconnections to California's power grid, but is not connected to Mexico's main power grid.

Electrical generation is fueled by oil (44%), geothermal resources (44%), and diesel (12%). Generation facilities consist of a large plant near Rosarito that uses fuel oil; a large plant near Mexicali that uses geothermal resources; and several smaller plants in Tijuana, Mexicali, and Ensenada that are fueled by diesel.

Sonora. Based on CFE's total sales in the year 2001, annual electricity consumption in Sonora is about 8,000 GWh.

Chihuahua. Based on CFE's total sales in the year 2001, annual electricity consumption in Chihuahua is about 7,600 GWh.

Coahuila. Based on CFE's total sales in the year 2001, annual electricity consumption in Coahuila is about 8,200 GWh.

Nuevo Leon. Based on CFE's total sales in the year 2001, annual electricity consumption in Nuevo Leon is about 14,000 GWh.[22]

Tamaulipas. Based on CFE's total sales in the year 2001, annual electricity consumption in Tamaulipas is about 7,200 GWh.[23]

The Mexican states bordering Texas (Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas) contain eight power plants with a capacity of 4.6 GW. These represent about 15% of the nation's generating capacity. Electrical generation in these states is fueled by coal (41%) and fuel oil or natural gas (50%).[24] There are eight electrical interconnections across the Texas-Mexico border.

Current Conditions on the U.S. Border. The current energy consumption in border states on the U.S. side totals about 646,600 GWh annually.

California. By early 2003, electricity consumption in California was 265,000 GWh annually[25]. In 2002, the commercial sector in California was responsible for over a third (36%) of the energy consumption, followed by the residential sector (30%), industrial sector (21%), agricultural and water pumping (7%), and other (6%).[26]

In 2002, California supplied about 77% of the state's electricity needs and imported the remainder from sources in the northwestern and southwestern United States. In-state natural gas-fired facilities supplied one-third (33%) of California's consumption, followed by nuclear power (13%), coal plants (10%), large hydroelectric power (10%), and renewable sources (11%)[27]. In 1999, the state's total generating capacity was about 53,200 MW. Over one-third of the state's generating capacity consisted of gas-fired plants (36%), followed by hydroelectric power (27%), combined petroleum and gas-fired plants (16%), nuclear power (8%), and other (13%)[28].

Arizona. Electricity consumption in Arizona in the year 2000 was 61,000 GWh[29]. In 1999, the residential sector represented the bulk of consumption from utility supplies (39%), followed by the commercial sector (34%), industrial sector (22%), and other (5%)[30].

Electricity generation in the state in 1999 (84,000 GWh) exceeded the following year's electricity consumption by almost 38%. Almost half of the electricity generated in 1999 was from coal-fired power plants (46%), followed by nuclear power (36%), hydroelectric power (12%), and natural gas-fired facilities (6%). Total generating capacity in the state in 1999 was about 15,300 MW. In-state generating capacity consisted of coal-fired plants (35%), followed by nuclear power (25%), gas-fired plants (20%), hydroelectric power (19%), and other (2%)[31].

New Mexico. Electricity consumption in New Mexico in the year 2000 was 18,800 GWh[32]. The industrial and commercial sectors each commanded a third of the total consumption from utility supplies in 1999, followed by the residential sector (26%) and other (9%)[33].

Electricity generation in the state in 1999 (32,600 GWh) exceeded the following year's electricity consumption by about 73%. The majority of the electricity generated in 1999 was from coal-fired plants (86%), followed by natural gas-fired facilities (13%) and hydroelectric power (1%). In-state generating capacity in 1999 was about 5,500 MW and consisted of coal-fired plants (71%), followed by gas-fired plants (25%), hydroelectric power (2%), and other (2%) [34].

Texas[35]. Total electricity consumption in Texas in 1999 was about 301,800 GWh. The residential sector was responsible for over a third of the total consumption from utility supplies (36%), followed by the industrial sector (33%), commercial sector (26%), and other (5%).

Electricity generation in the state exceeded consumption by about 20% in 1999 (359,400 GWh). Gas-fired facilities produced about half of the power (49%), followed by coal-fired plants (40%), nuclear power (10%), and other sources (1%). Texas had a generating capacity of about 76,300 MW of electricity in 1999. Almost two-thirds of the generation capacity in Texas that year consisted of natural gas-fired facilities (64%), followed by coal-fired plants (27%), nuclear power (6%), and other sources (4%).

Projections for the Mexican Border. As mentioned above, industrial activities are the main driver for the growth in electricity demand. In industrialized areas such as the border region, the demand for electricity is forecasted to grow at a faster rate than the national average. Although specific projections vary, they are in agreement that energy demand in the border is expected to grow at a faster rate than the country as a whole.

Baja California. CFE estimates that electricity demand will grow at a rate of 6% - 7% in Baja California.[36] SENER projections are slightly higher at 7.2% through 2020.[37]

Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas. Electricity consumption in the Mexican states that border Texas is projected to increase 6% - 8% annually over the next few years.[38]

Border Region. SENER projects growth rates in electricity demand of 6.5%[39] annually in the border region over the coming decade. CFE projections for growth in electricity demand in the northern Mexican states are slightly lower, at 5.7% between 1996 and 2005.[40]

Over 60% of the additional capacity required nationwide is expected to serve states in the border region.[41] As shown in Table 2, fourteen of the twenty-seven new generation projects that were constructed or are planned for construction between 2001 – 2005 are located in border region states.

Table 2. New Power Projects Planned or Under Construction

Project	Location	Type	Bidding date	Bidding type	Construction Year and MW				
					2001	2002	2003	2004	2005
Chihuahua II	Chihuahua	CC	1996	BLT	449				
Rosarito III (8 y 9)	Baja California	CC	1996	BLT	559				
Río Bravo II	Tamaulipas	CC	1998	IPP	511				
Hermosillo	Sonora	CC	1998	IPP	258				
Saltillo	Coahuila	CC	1998	IPP	256				
Monterrey III	Nuevo León	CC	1998	IPP		505			
Altamira II	Tamaulipas	CC	1998	IPP		525			
Mexicali (Rosarito 10 y 11)	Baja California	CC	1998	IPP			506		
Agua Prieta (Naco Nogales)	Sonora	CC	2000	IPP			267		
Altamira III y IV	Tamaulipas	CC	2000	IPP			1,066		
Río Bravo III	Tamaulipas	CC	2000	IPP				512	
Samalayuca III (Chih. III)	Chihuahua	CC	2000	IPP			268		
Altamira V	Tamaulipas	CC	2001	IPP					528
Chihuahua III	Chihuahua	TG	2001	OR		134			
Year Total					**2,033**	**1,164**	**2,107**	**512**	**528**

CC: Combine Cycle TG: Turbo Gas
BLT: Building, Leasing and Transfer IPP: Independent Power Producer OR: Own Resources

Source: Secretaria de Energia (Mexico's Ministry of Energy) or SENER.

Projections for the U.S. Border. Electricity consumption on the U.S. side of the border is projected to increase by 0.1% to 3.9% depending on the customer sector and state.

California[42]. Electricity consumption in California is growing at 2% annually.

Arizona[43]. From 2003 to 2020, assuming no increased adoption of energy efficient technologies in homes and businesses, electricity consumption is expected to increase annually by 3.9% in the commercial sector, 2.6% in the residential sector, and 1.9% in the industrial sector.

New Mexico[44]. From 2003 to 2020, assuming no increased adoption of energy efficient technologies in homes and businesses, electricity consumption is expected to increase annually by 2.0% in the commercial sector, 2.3% in the residential sector, and 0.1% in the industrial sector.

Texas[45]. During the 1980's and early 1990's, electricity demand in Texas grew an average of 2% annually. In the late 1990's, this growth in demand accelerated to 4.4% annually. The Public Utility Commission of Texas projects that total demand will continue to grow at 3.7% annually statewide.

Summary of Electricity Conditions

Based on the data collected and as summarized in Table 3, Mexico's installed electricity generating capacity is 38,500 MW. Approximately 6,000 MW or 16% of this generating capacity is located in five of the six Mexican states bordering the U.S. (Baja California, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas). The generating capacity nationwide is dominated by hydrocarbon-fueled power including fuel oil, diesel, and natural gas (63%), whereas the generating capacity in Baja California is dominated by geothermal power (44%) and the generating capacity in the remaining border states relies predominantly on fuel oil or natural gas (50%) and coal (41%). The generating capacity in U.S. states bordering Mexico is 150,300 MW and is dominated by natural gas-fueled power plants (48%).

The Mexican border states consume a significantly larger proportion of electricity than they generate. Moreover, the border states' consumption is expected to grow at a faster rate than the nation's consumption as a whole. The current electricity consumption in Mexico is 157,200 GWh annually. Approximately 53,300 GWh or 34% of this consumption is attributed to the Mexican states in the border region. Nationally, electricity demand is expected to grow at an annual rate of 4.7% to 6.3%, whereas the border region's demand is expected to increase by 5.7% to 6.5% annually. As shown in Table 4, almost 60% of total electricity use nationwide is attributed to industrial customers.

The growth of energy use in U.S. border states is less dramatic than Mexican border states, and industrial customers do not dominate total energy use as in Mexico. The electricity consumption in U.S. states bordering Mexico totals 646,600 GWh annually and is projected to increase by 0.1% to 3.9% depending on the customer sector and state. Also depending on the state, residential, commercial, and industrial customers consume between 21% and 39% of the total electricity used.

Table 3. Installed Capacity and Annual Consumption

	Mexico	Border Region												
		Mexico Side								U.S. Side				
		Baja California	Sonora	Chihuahua	Coahuila	Nuevo Leon	Tamaulipas	**Total**	**Percent of National**	California	Arizona	New Mexico	Texas	**Total**
Installed Capacity (MW)	38,500	1,400	N/A	4,600				**6,000**	**16%**	53,200	15,300	5,500	76,300	**150,300**
Annual Consumption (GWh)	157,200	7,800	8,000	7,600	8,200	14,000	7,200	**52,800**	**34%**	265,000	61,000	18,800	301,800	**646,600**
Consumption Annual Growth Rate	4.7% - 6.3%	6% - 7.2%		6% - 8%				**5.7% - 6.5%**		2%	1.9% - 3.9%	0.1% - 2.3%	3.7%	**0.1% - 3.9%**

Table 4. Electricity Consumption by Customer Sectors

Portion of Total Electricity Consumed	Mexico	U.S. Side of Border				
		California	Arizona	New Mexico	Texas	**Total**
Industrial	59%	21%	22%	33%	33%	21% - 33%
Residential	24%	30%	39%	26%	>33%	26% - 39%
Commercial	8%	36%	34%	33%	26%	26% - 36%
Agricultural	5%	7%				7%
Public Sector	4%					
Other		6%	5%	9%	5%	5% - 9%

1.1.2 Natural Gas

Mexico's National Conditions

Current Conditions. In the year 2002, natural gas production in Mexico was estimated at about 4,100 million cubic feet per day (MMCFD). The national demand for natural gas in 2002 was about 4,900 MMCFD. Imports comprised about 15% of the natural gas supply. Primary applications of natural gas include the oil industry (41%), electricity production by CFE, LFC, and independent producers (31%), industrial uses (20%), PEMEX petrochemicals (6%), and residential, commercial, and transportation end-uses (2%).[46]

Natural gas exploration, production, and wholesales are reserved for state enterprises. Gas storage, transportation, and distribution, including development of infrastructure, are open for private participation under the regulation of the CRE.

Projections. Between 1993 and 2002, the demand for natural gas in Mexico grew by 39%. Through 1999, domestic production supplied almost 100% of national demand. However, from 2000 to 2002, the portion of demand supplied domestically fell from 95% to 85%.

Over the coming decade, the Secretaria de Energia (Ministry of Energy) or SENER projects that the demand for natural gas will grow by about 8% annually, reaching about 9,500 MMCFD by 2010.[47] The increased demand for natural gas is driven by the electricity sector, which is increasingly turning to natural gas as a fuel for generation facilities. Over the majority of the last decade, the electricity sector's demand for natural gas has grown by an average of 11.7% annually.[48] By 2010, electricity production is expected to dominate natural gas use in Mexico (41%), followed by the oil industry (31%), industrial uses including petrochemicals (23%), residential and commercial end-uses (4%), and vehicle fuel (1%).[49]

At this time, Mexico is striving to increase investments in natural gas infrastructure to increase domestic gas production. However, foreign investment is required to explore and process natural gas. Thus, although plans are underway to help meet forecasted demand, the outcome is still uncertain, because the Mexican constitution does not allow for foreign ownership of those resources.

If gas production is successfully increased, domestic sources are expected to meet the country's needs in the short term, and liquified natural gas (LNG) is being promoted to help meet future natural gas demands. Nonetheless, it is expected that by 2010, Mexico will need to import about 20% of their natural gas demand or 1,900 MMCFD of natural gas. [50] Natural gas prices could rise 48% if U.S. reserves remain low and other sources of natural gas are not put into production.[51]

Petroleum is a possible alternative fuel for power plants. Although petroleum prices are declining, petroleum is a key export. Therefore, it is considered a secondary source of fuel for power plants.

Border Region Conditions

Current Conditions. In 2002, Mexico's northwestern regions imported 100% of their natural gas requirements. Total consumption in this region was about 150 MMCFD. Primary applications of natural gas include the industrial sector (12%), electricity production (86%), and residential uses (1%).[52]

In the northeast, total demand in 2002 was approximately 1,300 MMCFD. The region produced about 1,100 MMCFD, imported about 600 MMCFD, and exported about 400 MMCFD to other regions during this period. Natural gas production in the border region is restricted to the Burgos Basin natural gas field near Matamoros, in Tamaulipas. Primary applications of natural gas in the northeast include the oil industry (15%), industrial sector (30%), electricity production (49%), and residential and commercial uses (6%).[53]

Projections. Between 1993 and 2002, the demand for natural gas in Mexico's northwestern regions grew from 4 MMCFD to about 150 MMCFD, a 38-fold increase. Production in the area remained nonexistent over this period. In the northeast, demand increased about 77% over this period. From the late 1990's forward, regional production supplied 82% to 100% of regional demand. The increased need for electricity generation from maquiladoras in the border region alone is estimated to give rise to a 20% annual increase in the demand for natural gas between 1998 and 2007.[54]

Summary of Natural Gas Conditions

The current demand for natural gas in Mexico exceeds the nation's existing production capacity by about 10%, and this demand is expected to grow by 8% annually. Although the oil industry currently dominates natural gas use, electricity production is driving the growth in demand for natural gas. While the Mexican government is putting an emphasis on exploration and new development of natural gas resources, the outcome and resulting impact on natural gas prices in the country is uncertain.

In the western area of the border region, natural gas demand has grown dramatically over the past decade. The area imports all of its natural gas requirements and uses most of its supply to generate electricity. Although the eastern area of the border region also experienced a large growth in demand during this period, the area supplies most of its own demand with regional production. Electricity generation also dominates natural gas use in the northeastern Mexico.

1.2 Air Quality in the Border Region

The high level of economic activity and population growth in the border region has made it a focus of environmental concern both for Mexico and the U.S. Air quality, water supply, and water quality are particularly important issues in the region due to the impact of transboundary pollution.[55]

A combination of mobile, point, and area sources of air pollution in the region have produced an air quality problem that directly impacts the high concentration of people living and working there. Preliminary data from a series of monitoring stations located on both sides of the border indicates that air quality is poorer in Mexican border cities than in their sister-cities located in the U.S. Particulate matter is of special concern in El Paso – Ciudad Juárez and Brownsville – Matamoros, whereas ozone and ozone-precursors are especially problematic in San Diego – Tijuana.[56]

Mobile sources include the growing number of vehicles in northern Mexico, many of which are not compliant with either U.S. or Mexican auto emission standards. Traffic congestion exacerbates the problem. This is especially true at points of vehicle entry at border crossings, because cars, light trucks, and heavy-duty trucks idle for long periods of time. The heavy-duty trucks are particularly accountable because they utilize diesel fuel, which is a source of airborne particulates. In addition, due to the rapid development in the area, a large number of unpaved roads have come into being. These have become a major source of airborne particulates.

Point sources of air pollution include maquiladoras along the border, as well as Mexican national industries, which emit air pollution due to various industrial processes and combustion of fuels. Commercial activities and businesses that provide services also contribute to the air quality problem. Last, power generation plants along the border are significant sources of air pollution. The flurry of new energy projects driven by the energy needs of the region (see Table 2 on page 9), which include infrastructure as well as electricity generating facilities, may have additional impacts on the region's air quality if they are not mitigated.

1.3 Highlighted Customer Sectors

The Mexican side of the border region is highly populated and industrialized, and energy consumption in the border region outpaces its energy production. This report focuses on energy efficiency opportunities in selected subsectors within the industrial, commercial, and institutional customer sectors. The subsectors were selected based on the number and concentration of facilities, relative prominence, accessibility, and relatively low technical and financial risk of these facilities:

- Industrial Sector: Highlighted industrial subsectors are manufacturing and assembly operations.
- Commercial Sector: Highlighted commercial subsectors are tourism services (including hospitality services). Commerce and trade are also discussed to some extent.
- Institutional Sector: Highlighted institutional subsectors are health care/hospitals, government, and education.

1.3.1 Industrial Sector

Industrial customers represented almost 60% of the electricity use in Mexico in 2001. This report focuses on the manufacturing subsector. Operations that are prominent among maquiladora facilities – electronic, electrical, and automotive manufacturing and assembly – are also among the manufacturing facilities that are experiencing a high rate of growth in energy use. Although this section provides a separate discussion of the manufacturing sector and the maquiladoras in Mexico, for the purpose of the subsequent analysis, manufacturing and assembly operations – whether characterized as maquiladoras or not – are treated similarly.

Manufacturing

Manufacturing employs over 28% of the Mexican workforce, and the border region contains 11.6% of this manufacturing workforce. With the exception of Sonora, border states have a higher concentration of workers in the manufacturing sector than the national average. Therefore, this is a significant market segment in the border region. The manufacturing activity in the border region is located primarily in Ciudad Juárez, Chihuahua; Tijuana and Mexicali, Baja California; Matamoros and Reynosa, Tamaulipas; and Nogales, Sonora.[57]

Nationwide, the manufacturing sector consumed 31,712 thousand tons of oil equivalent[58] (ktoe) or 4,326 barrels of oil equivalent of energy in 1999. The dominant forms of energy used in this sector are natural gas (34%), electricity (24%), and oil (21%). Although nationwide, the energy use in this sector fell by an average of 2% annually between 1994 and 1999, the magnitude of energy use is still significant and certain manufacturing subsectors are experiencing high rates of growth in energy use.[59]

Manufacturing of chemicals, chemical products, and man-made fibers ranks among the highest energy-using manufacturing subsectors nationwide for which data was available. In 1999, this manufacturing subsector consumed 11,388 ktoe of energy nationwide, or 36% of the manufacturing sector's total energy consumption. Dominant energy sources for this subsector were natural gas (49%) and ethane (25%). Electricity represented 6% of the energy consumed.[60]

Also significant in 1999 was iron and steel manufacturing, which accounted for 5,642 ktoe nationwide or 18% of the manufacturing sector's total energy use. Dominant energy sources for this subsector were natural gas (43%), coke, oven coke, and lignite coke (31%), and electricity (14%). Manufacturing of glass, glass products, and other non-metallic mineral products accounted for 3,350 ktoe nationwide or 11% of the manufacturing sector's energy use. Dominant energy sources for this subsector were oil (61%), natural gas (25%), and electricity (13%).[61]

Also worth noting are manufacturing subsectors that showed a high rate of growth in energy use. Among the fastest growing energy-users in the manufacturing sector nationwide is the machinery manufacturing subsector, which includes the manufacture of machinery, domestic appliances, office machines, computers, electricity generators, electric lamps and lighting equipment, electronic components, televisions, radios, and recording devices. This subsector's energy use grew by an average of 15% annually between 1994 and 1999 – among the highest growth rates in this subsector worldwide. Dominant energy sources for this subsector are liquified petroleum gas (84%) and oil (16%).[62]

Manufacturing of motor vehicles, including car bodies, parts, and accessories, also experienced a high growth rate in energy use between 1994 and 1999. This subsector's energy use grew by an average of 9% annually and dominant energy sources were electricity (59%) and natural gas (41%).[63]

Maquiladoras

Maquiladoras are a unique market sector that is a critical element of the Mexican economy. Maquiladoras are Mexican companies that operate under maquila programs approved by the Mexican Secretariat of Commerce and Industrial Development (SECOFI).[64] Begun in 1965, maquila programs allow up to 100% foreign participation in terms of capital investment in and management of the companies, as well as duty free imports of machinery, equipment, raw materials, parts, safety items, and administrative materials (provided the goods do not remain in Mexico permanently).

The border region's economy relies heavily on maquiladora plants, many of which are manufacturing and assembly plants. In 2001, about 2,700 of Mexico's 3,800 maquiladora plants were located in the border states. Maquiladoras in the border region now employ over 1 million people, which is an increase of 150% since 1990.[65] Mexico does not restrict what types of products maquiladoras generate, and typically, their products are exported out of Mexico. These factories exported US $76.8 billion worth of goods in 2001 – nearly half of Mexico's total merchandise. Almost all of these goods were exported to the United States.[66]

Maquiladora operations include industrial operations ranging from simple assembly of imported parts to manufacturing or rebuilding products using imported materials, as well non-industrial operations such as data processing, packaging, and sorting. Thus, although this sector is responsible for a significant portion of the energy demand and use in the border region, this report does not address the sector's energy needs and energy efficiency opportunities as a whole due to the wide variety of operations. Instead, certain types of production are highlighted for discussion.

Although the North American Free-Trade Agreement (NAFTA), which took effect in 1994, provided additional impetus to the growth of the maquiladora sector, the industry has suffered losses in recent years. A total of 350 maquiladora plants have closed down since the start of 2001, leaving 240,000 Mexicans unemployed.[67] This is equivalent to nearly one-fifth of the maquiladora industry's entire possible workforce. Furthermore, in a March 2002 poll by the Japanese Maquiladora Association, 40% of the 71 companies surveyed said they were considering eliminating assembly operations or moving entire factories elsewhere.[68] Although Mexico's proximity to the United States gives maquiladoras that produce heavy goods (such as automobiles and automobile parts) an advantage, there is a fear that this sector in Mexico as a whole is suffering due to the competition from cheaper low-skilled and high-skilled labor in China. Nonetheless, maquiladoras continue to be prominent energy consumers in the border region.

1.3.2 Commercial and Institutional Sectors

Disaggregated data that characterizes energy use in the commercial and institutional subsectors highlighted in this report are not readily available. However, energy usage data for an aggregated customer class that includes hotels and restaurants, wholesale and retail trade, health and social work, public administration, and education, shows that dominant forms of energy used by this customer class are electricity (38%), liquified petroleum gas (38%), and oil (23%).[69]

Electricity consumption by this customer class grew an average of 2% from 1994 to 1999 and totaled 16,433 GWh in 1999. By 2001, commercial and public-sector customers were responsible for about 18,200 GWh or 12% of the nation's electricity use.

Section 2

Energy Efficiency Framework

This section provides an overview of the Mexican public agencies responsible for energy production, sales, and regulation; energy rate setting; existing energy efficiency initiatives in Mexico; perceived energy needs in the border region; and energy utility reform initiatives.

2.0 Major Energy Stakeholders

The hierarchy of federal agencies and federally sponsored research institutes in Mexico is illustrated in Figure 2. The roles and responsibilities of these bodies are as follows:

- The Secretaria de Energia (Ministry of Energy) or SENER is an overarching federal agency that supports Mexico’s national energy security. Two regional councils of SENER are located in northwestern Mexico (serving Sonora, Baja California, and Baja California Sur) and northeastern Mexico (serving Chihuahua, Tamaulipas, Nuevo Leon, and Coahuila).

- The Comisión Reguladora de Energia (Energy Regulatory Commission) or CRE is a federal body charged with regulating the gas and electricity industries in Mexico.

- Comisión Nacional para el Ahorro de Energia (National Commission for Energy Conservation) or CONAE is a section of SENER that specializes in energy efficiency, renewable energy, alternative fuels, and distributed generation. CONAE’s mission is to design and promote energy efficiency guidelines, foster renewable energy use, and promulgate energy efficiency standards. More information about CONAE activities is provided in Section 2.2 and Section 4.

- Petroleos Mexicanos (Mexican Petroleum Company) or PEMEX is a state-owned natural gas and petroleum monopoly. PEMEX sponsors the Instituto Mexicano del Petróleo (Mexican Petroleum Institute) or IMP, which provides research and analysis of natural gas and petroleum technologies to PEMEX.

- Comisión Federal de Electricidad (Federal Electricity Commission) or CFE is a state-owned electricity monopoly that generates, distributes, and markets electricity for 19 million clients, ultimately serving 98 million Mexican end-users. CFE serves the entire nation with the exception of the capital, Mexico City.

- The Luz y Fuerza del Centro (Central Light and Power Company) or LFC is the state-owned electricity company that serves the capital, Mexico City.

- Fideicomiso para el Ahorro de Energia Electrica (Organization for Electricity Conservation) or FIDE is a non-profit, private trust created in July 1990 to support energy efficiency activities. It is funded by the CFE, its contractors, and its own union.

- Fideicomiso para el Aislamiento Térmico (Organization for Heat Insulation) or FIPATERM is a program managed by CFE. Its primary mission is to facilitate the installation of thermal insulating material in households with high electricity consumption in northwestern Mexico.

- The CFE also sponsors the Instituto de Investigaciones Electricas (Electric Research Insitute) or IIE. IIE researches and develops technologies for the power industry, including CFE, LFC, and PEMEX. IIE also provides technical services and partners with research institutions and electricity companies in other countries.

Less pertinent to this discussion are the Comisión Nacional de Seguridad Nuclear y Salvaguardias (National Nuclear Safety Commission) or CNSNS and Instituto Nacional de Investigaciones Nucleares (National Nuclear Research Institute) or ININ. CNSNS is charged with establishing and enforcing rules and regulations regarding nuclear security, operation of nuclear power plants, and the transport of radioactive materials for the public interest, including preservation of public health. ININ researches nuclear energy technologies in collaboration with the academic community and the nuclear industry.

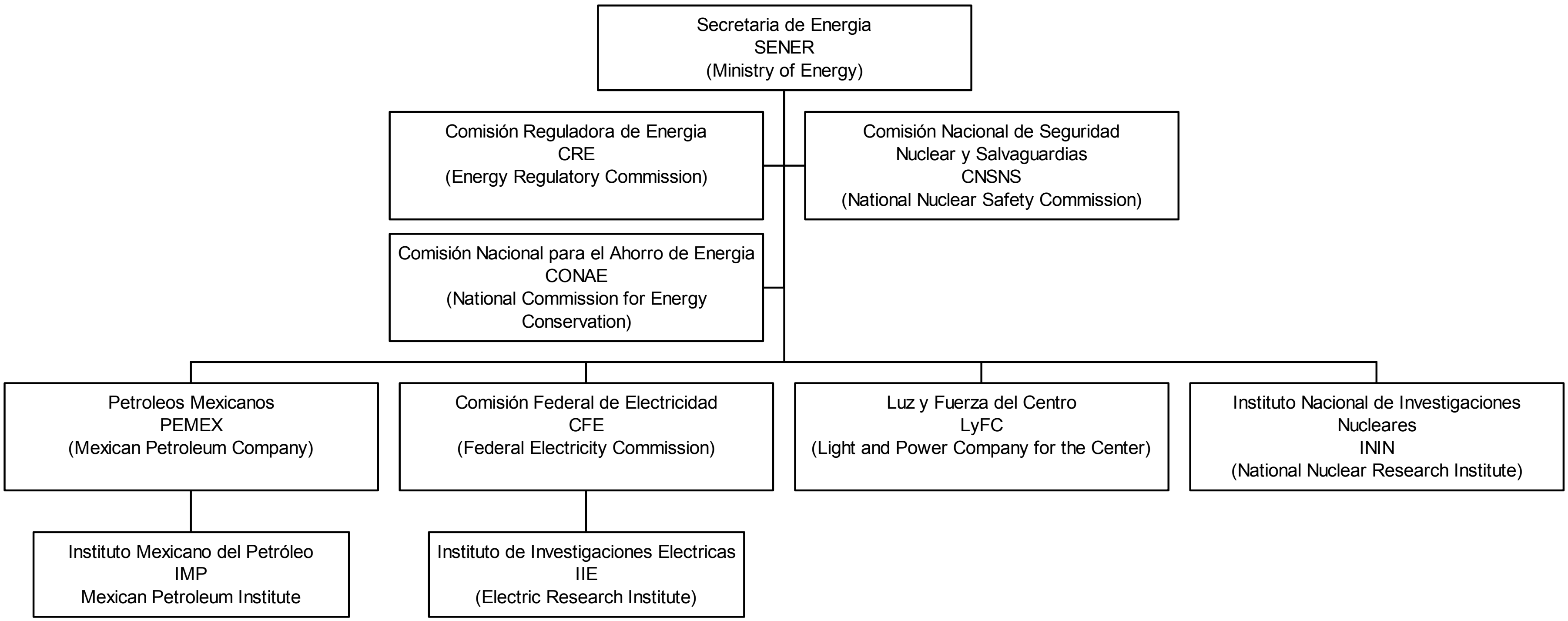
Non-governmental organizations active in the energy arena are as follows:

- The Instituto Nacional de Estadistica Geografia e Informática (National Institute of Statistics) or INEGI coordinates, integrates, and promotes national statistics and geographic information for the national interest. INEGI serves as a data bank for the Mexican government.

- La Asociacion de Tecnicos y Profesionistas en Aplicación Energética (Association of Energy Technicians and Professionals) or ATPAE is an industry association of professionals from the energy and energy service companies.

Although it will be essential to work with all of the agencies and organizations described here, CONAE, CFE, and FIDE appear to be the most active in supporting and implementing energy efficiency activities. Not addressed specifically in this report are state and local economic development agencies such as the Secretaría de Desarrollo Económico del Estado de Baja California (the State of Baja California's Department of Economic Development) and the Tijuana Economic Development Corporation, which also can be key players for promoting awareness of energy efficiency benefits, identifying projects, and facilitating project development within their regions.

Figure 2: Federal Energy Agencies and Federally Sponsored Research Institutes



2.1 Energy Rate Setting

Mexico has three main electricity rate categories: residential, commercial and services, and industrial. Within each of the three categories are up to eight subcategories related to customer-specific factors such as regional temperatures, consumption, and peak usage. The most appropriate rate is applied to each end-user. These rates are based on recommendations from the CFE and the Energy Secretary and are approved by the federal government. They are posted on CFE's website (www.cfe.gob.mx/) under "Información – Conoce tu tarifa".

2.2 Energy Efficiency Programs

This section describes energy efficiency initiatives and programs currently active in Mexico.

2.2.1 CFEfectiva Empresarial

The CFE administers a program called CFEfectiva Empresarial for large customers in the industrial sector, in the Mexican states of Sonora and Sinaloa. Local sources in the Tijuana area state that the program is also active there. The purpose of the program is to maintain a relationship between CFE and its high-consuming customers who are in good standing, by providing the customers with free energy-related consulting services at no-cost. Services include the following:

- Maintaining continuity in electrical service
- Optimizing voltage regulation
- Advanced warning of scheduled suspensions in electrical service
- Explanations regarding the causes of service interruptions
- Replacement of fuses
- Electricity cost projections
- Assistance in developing energy saving strategies
- Rate review
- Maintenance of substations
- Development of load profiles

These and other services are provided through a network of 150 CFE executives throughout the program territory.

2.2.2 Ports of Attention (PACs)

In 1997, CONAE established a network of "Ports of Attention" or PACs, which are internet stations that provide energy efficiency and renewable energy technical assistance for both the public and private-sectors. This program is national in scope. CONAE developed the program as a means for providing low-cost, yet quality energy efficiency outreach assistance, in order to meet growing national demand for these services and to widen the scope of CONAE outreach activities. The primary objectives of the program are as follows:

- To provide energy efficiency technical assistance and information to consumers throughout the country
- To assist energy users in the identification of energy savings potentials
- To assist consumers in establishing economically and financially feasible energy efficiency projects

Primarily students under the direction and supervision of CONAE operate the stations. The PACs, therefore, also serve as a means for developing and encouraging young professionals to enter the field of energy efficiency in Mexico. Since 1997, PACs have expanded throughout the country especially in areas with higher energy consumption rates. In addition, many individual PACs have developed specialized services. Currently, PACs are classified into three types: PACs for municipal and state governments, residents, and businesses and industries. Typically, a PAC is established through an agreement with CONAE and an interested counterpart institution, such as a high school, university, or government office.

To date, the PAC network has experienced steady growth since its inception and has successfully provided energy efficiency technical assistance to a variety of consumers resulting in significant energy savings. CONAE expects that the program will continue to expand, due to its success.

2.2.3 PEMEX Energy Efficiency Program[70]

CONAE began collaborating with Mexico's National Oil Company (PEMEX) in 1995 to enhance energy efficiency and decrease the company's overall energy consumption. As Mexico's largest public-sector company, and one of the ten largest in the world, PEMEX was seen as an opportunity to reap large energy savings benefits. The primary objectives of the collaborative program are as follows:

- For CONAE to provide technical assistance to PEMEX in order to identify energy efficiency opportunities
- For PEMEX to operate more efficiently, to expand the supply of energy, save money, and reduce the company's negative impacts on the environment

The program was initiated in three distinct stages. The first stage occurred between 1995-1997, during which an expert committee consisting of both CONAE and PEMEX representatives conducted several studies to evaluate potential energy savings in PEMEX production units. During 1998-2000, CONAE developed the second stage of the program to provide energy savings technical assistance to PEMEX through internet-based technical assistance. Since 2000, the program has been in its last stage, which has revolved around an effort to optimize the energy efficiency of all PEMEX processes.

The overall results of this collaboration have resulted in:

- Estimated savings of 10.6 billion barrels of oil, and 3.2 million tons of CO_2 in 2001
- Development of an energy efficiency and environmental protection culture among PEMEX employees
- Systemic and permanent energy efficiency efforts throughout PEMEX

Due to the success of this program, CONAE has adopted similar programs for small- and medium-sized businesses.

2.2.4 Residential Programs

FIDE is currently developing a program to finance the acquisition of energy-efficient appliances and equipment for the residential sector. Residential users with a minimum electricity consumption of 1,000 kWh/month are eligible to participate in the program, which offers financial incentives for energy-efficient air conditioning units or the installation of thermal insulation in household roofs. Program funds are administered through FIPATERM. The program operates in the cities of Piedras Negras (Coahuila), Ciudad Juárez (Chihuahua), Nuevo Laredo (Tamaulipas), and other border cities.

Another pilot program in the border region, administered by FIDE and CFE, replaces old refrigerators with new, more efficient units. The cost of the new appliance can be financed through the customers’ electricity bills at a lower cost than the average retail price of the appliance. This program is currently being tested in Ciudad Juárez.

Expanding these programs to other cities depends on the level of success shown in the current cities. It is expected that the number of customers participating in the programs will increase as the implementing agencies continue their marketing campaigns.

CONAE is also currently promoting a number of energy efficiency programs in the border region through its collaboration with state and municipal authorities, as well as industrial and commercial chambers and other organizations, including FIDE and FIPATERM.

2.2.5 International Programs

The Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area, signed in La Paz, Baja California Sur in 1983, empowers the federal environmental authorities in the US and Mexico to undertake cooperative initiatives. The US Environmental Protection Agency (EPA) and Secretaria del Medio Ambiente y Recursos

Naturales (Mexico's Secretariat of Environment and Natural Resources) or SEMARNAT are responsible for coordinating and implementing multi-year, bi-national programs under this agreement.

This is also a vehicle for implementing coordinated energy efficiency programs in the border region. For example, through this cooperation agreement, the United States Agency for International Development (US AID) has funded at least two dozen projects ranging from providing energy efficiency financing support to CONAE, to developing a directory of Mexican energy efficiency companies. Institutions implementing these projects include the Alliance to Save Energy (headquartered in Washington, D.C.), Lawrence Berkeley National Laboratory, and P.A. Government Services, Inc. (headquartered in London), and Mexican partners include CONAE, FIDE, and SEMARNAT.

The EPA and the US Department of Energy have also funded half a dozen projects through this agreement that range from supporting the US/Mexico Border Energy Forum to providing technical assistance for pollution prevention in the border region. Implementing organizations include the Southwest Center for Environmental Research and Policy and WGA. Mexican partners include the maquiladora industry, CFE, and CRE.

2.3 Perceived Energy Efficiency Needs

According to CONAE staff, important issues related to energy in the border region vary depending on the specific location in question. However, they are likely to include electricity consumption in the residential sector, business opportunities in cogeneration projects, renewable energy use, and implementing energy efficiency programs in the industrial and commercial sectors.[71]

From an institutional perspective, CONAE staff believes the following activities would help improve the rate of implementation of energy efficiency projects at the customer level:

- Design financing strategies that facilitate the development of energy efficiency projects at the state and municipal levels
- Develop and apply new energy efficiency laws and regulations jointly with the various customer sectors
- Increase collaborative, cooperative efforts with other government agencies (domestic and international) to promote the use of efficient energy practices and technological innovations
- Provide customer training on energy efficiency
- Allocate additional resources for research and development
- Further promote energy efficiency among all customer sectors

2.4 Energy Utility Reform

CFE and LFC have budget shortfalls amounting to about $5 billion annually[72]. However, the national government, which is burdened with foreign debt amounting to $76 billion, is ill positioned to provide this subsidy to the state-owned electricity companies. Therefore, support is gathering for increased private participation in the electricity generation industry.

In May 2001, President Vicente Fox issued a presidential decree that increased the amount of spare capacity CFE could purchase from cogenerators. Although cogeneration in the private sector was allowed for over a decade previous to the presidential decree, investment in cogeneration projects was small because allowed sales of excess power from these facilities to CFE was limited and the prices that generators were allowed to charge were ambiguous. The new law was expected to spur significant additional private investment in cogeneration projects. A year later, however, the Mexico's Supreme Court repealed the law.

Nonetheless, large-scale utility reform continues to be supported by President Fox. Based on discussions with FIDE staff[73], CFE may be the first electricity utility to be deregulated. One proposal suggests gradually transitioning to nation-wide deregulation by first implementing in northern Mexico and moving south. The government also appears to want to reform energy policy with respect to allowing External Power Producers (EPP's) to meet power needs and provide investment capital to build independent power plants.[74] Although past efforts in this direction were unsuccessful, a new Energy Secretary is expected to push again for reform.

Thus, reforms to Mexico's electricity sector appear inevitable and are likely to provide opportunities for new, independent generation. Due to the border region's economic predominance, meeting energy needs in that region is essential. Thus, changes to the electricity sector are likely to be expedited in the region. However, due to the lengthy construction period for new central power plants, potential increase in natural gas prices for power plants, and slow pace of development of new natural gas sources and LNG facilities (as discussed in Section 1.1.2), energy conservation, distributed generation, and renewable energy must play a key role in meeting the region's energy needs.

Section 3

Regional and Sector Analysis – An Overview of Opportunities

This section describes the characteristics of the highlighted cities and energy using sectors. Information about the highlighted cities, including their dominant business types and energy use characteristics, is provided. For the highlighted energy using sectors, a description of typical operating characteristics and energy efficiency improvements is provided. Case studies illustrating typical opportunities in these facilities are also included.

3.0 Regional Analysis

Tijuana, Ciudad Juárez, and Matamoros are prominent cities in the border region. Along with their sister cities on the U.S. side of the border, they represent three of the largest population centers in the region. They are also highly industrialized and are expected to offer significant opportunities for energy efficiency improvements among the energy using sectors highlighted in Section 3.1. Figure 3 summarizes the available data regarding the number of manufacturing facilities, hospitality establishments, health care/hospitals, government facilities, and educational facilities in the three cities.

Figure 3. Number of Establishments for Highlighted Subsectors

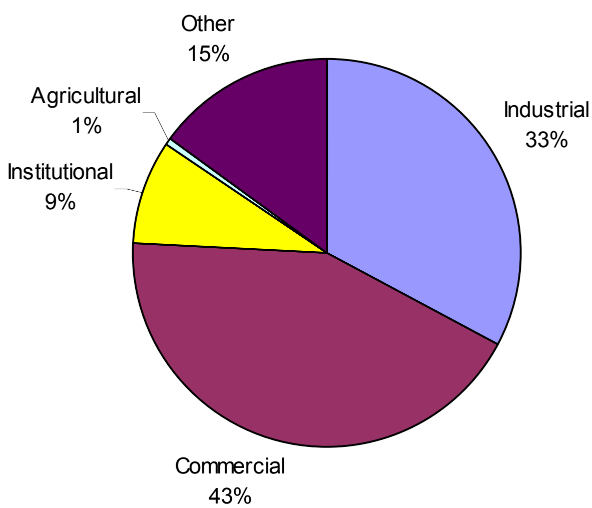
3.0.1 Tijuana, Baja California

Tijuana is located in the Mexican state of Baja California, across the U.S.-Mexico border from San Diego, California. The Municipality of Tijuana covers an area of 1,393 square kilometers (538 sq. miles) and includes the urban center as well as the surrounding region bounded by the U.S. border to the north, the Municipality of Rosarito to the south, the Municipality of Tecate to the east, and the Pacific Ocean to the west. Tijuana had a population of about 1,210,820 in the year 2000, representing about half of Baja California's total population. Tijuana also has a floating population of 50,000 or more, consisting of workers who commute into the municipality for work and undocumented migrants passing through the city. The annual population growth rate in Tijuana was 6.75% from 1990 – 1995.

Employment Sectors

Based on census data from the year 2000, the commercial sector dominates employment in Tijuana and occupies 42% of the economically active workers in the city. The industrial sector employs 33% of the city's workers, and institutional occupations are held by 9% of the workforce. Figure 4 shows the percentage of Tijuana's workers employed in each market sector and Table 5 provides a more detailed breakdown of employment figures in each sector.

Figure 4. 2000 Tijuana Employment



Source: Based on Instituto Nacional de Estadística Geografía e Informática (INEGI), XII Censo General de Población y Vivienda 2000 (Census 2000)

Table 5. 2000 Tijuana Employment by Sector and Subsector

Sector	Number Employed	Percent of Total Employed
Manufacturing	145,128	33%
Mining	139	<1%
Electricity and Water	1,332	<1%
Total Industrial	**146,599**	33%
Commerce	75,056	17%
Culture and Recreation	3,690	1%
Hotel and Restaurants	27,432	6%
Construction	35,164	8%
Transportation and Communication	18,440	4%
Mass Media	4,641	1%
Financial and Business Services	27,727	6%
Total Commercial	**192,150**	43%
Health and Social Services	12,303	3%
Government	11,245	3%
Education	14,556	3%
Total Institutional	**38,104**	9%
Agriculture	**2,718**	1%
Other	**66,768**	15%
TOTAL	**446,339**	

Source: Based on Instituto Nacional de Estadística Geografía e Informática (INEGI), XII Censo General de Población y Vivienda 2000 (Census 2000)

Industrial Sector. Manufacturing is a significant business activity in Tijuana. Manufacturing employs 33% of the permanent workers and comprises 21% of the businesses in the city.[75] Manufacturing of electronics (primarily cathode ray tubes, televisions, and computer monitors) dominates, but production of automotive parts and medical devices are among the most rapidly growing subsectors in the manufacturing industry.[76]

Many of the manufacturing facilities are also maquiladoras, which are more prevalent in Tijuana than in any other city in Mexico. The maquiladora sector generated about $500 million in foreign exchange earnings in 1990[77]. This represented about 15% of the gross regional product. This sector accounted for about 48% of all jobs created in Tijuana from 1980 – 1990. By the year 2000, maquiladoras appeared to be increasing in size and number, establishing these types of operations more securely in Tijuana.

However, jobs and investment in this sector fell sharply in 2001 and 2002. Over a period of 16 months, Baja California lost about 63,000 maquiladora jobs in production operations[78]. By April 2003, maquiladora employment figures were estimated at 138,241 workers for Tijuana[79] and 214,427 workers for the state of Baja California.[80] However, this sector still represents a significant market segment in Tijuana. In April 2003, Tijuana accommodated

641 or 20% of the nation's maquiladoras, and these local businesses employed 13% of the nation's maquiladora workers.[81]

Based on the magnitude of export value added to the final products, the following dominate the maquiladora sector in Tijuana: electronics, including television parts and components; mechanical devices; precision and medical instruments; tools; furniture and lighting equipment.[82] According to a national source, textiles are also significant.[83] Maquiladoras that specialize in television assembly are particularly predominant, with an estimated production of 8 million televisions sets annually[84].

Commercial Sector. The commercial sector employs 43% of the workforce in Tijuana. The highlighted subsectors alone, which include commerce, trade, and tourism activities, occupy 24% of the workers. Commerce and trade in Tijuana is on the rise. Retail trade activity has grown progressively on an average annual basis since 1999.[85] Based on monthly data from 1999 to mid-2003, the month of December tends to have the highest retail activity whereas January and February tend to have the lowest retail activity. No information was readily available regarding the number of commerce and trade establishments in Tijuana.

The tourism subsector also plays a significant role in Tijuana's economy. In 1990, this industry generated revenues of about $700 million annually, representing about 28% of the municipality's gross regional product[86]. Trends in hotel occupancy rates and retail trade illustrate the activity in this sector. Average hotel occupancy rates grew from 43% in 1997 to a high of 58% in 2000 before falling to 50% in 2002.[87] Based on monthly data from 1997 to mid-2003, late summer (July and August) tends to have the highest occupancy rates whereas December tends to have the lowest occupancy rates. According to the Baja State Department of Tourism, there are 221 hotels and motels in Tijuana.

Institutional Sector. The institutional sector, which includes health, government, and education services, employs 9% of the city's workforce. According to the Baja California Department of Education and Social Development, there are 354 preschools, 530 elementary schools, 132 junior high schools, 19 high schools, 28 technical schools, and 25 universities in Tijuana. No information was readily available regarding the number of government buildings in the city.

Electricity Supply and Usage

Tijuana's local electricity supply is a natural gas-fired power plant in the municipality and a thermal electricity plant in the Municipality of Rosarito. These plants have a combined output of 520 MW.[88] Tijuana's electrical system is also connected to Mexicali, which provides geothermal-based electricity. A portion of Tijuana is served by a natural gas distribution system. Bottled propane is also sold to homes and businesses by a government-approved vendor.

The total electricity consumption in Tijuana during the first four months of 2003 was approximately 2,300 GWh, a reduction of about 4% from the same period the previous year.[89] However, SENER and CFE project that electricity demand will grow at an annual rate of 6% to 7.2% in Baja California over the next two decades. It is expected that the power plant in Rosarito will need to double its generating capacity and convert to natural gas fuel in order to meet this increased demand. However, the economic challenges of piping natural gas to the region have delayed the process.

Similar to the country as a whole, industrial, residential, and commercial customers dominate electricity use in Tijuana.[90]

- **Industrial customers.** Industrial customers represented 63% (1,470,000 MWh) of the electricity usage in the city from January to April 2003
- **Residential customers.** Residential customers represented 24% (560,000 MWh) of the electricity usage in the city from January to April 2003
- **Commercial customers.** Commercial customers represented 11% (248,000 MWh) of the electricity usage in the city from January to April 2003.

Local Climate

Tijuana has an annual rainfall of about 250 millimeters (mm) (10 inches) and temperatures range from 10 to 28° C (50 to 82° F).

Air Quality

The thermal electricity plant in Rosarito is the primary stationary source of air pollution in Tijuana, due to the high sulfur content of the fuel oil utilized at the power plant. As mentioned previously, it is anticipated that the plant will be expanded and converted to natural gas. However, these plans have not yet been implemented due to financial barriers.

The primary point sources of air pollution include uncontrolled burning, air borne particulates from unpaved streets, leaded fuel, old vehicles, and poor vehicle maintenance. Idling cars at the border crossing, uncontrolled use of solvents in manufacturing processes (such as furniture production) and transportation of air pollution south from the Los Angeles-San Diego region also degrade air quality in the area.

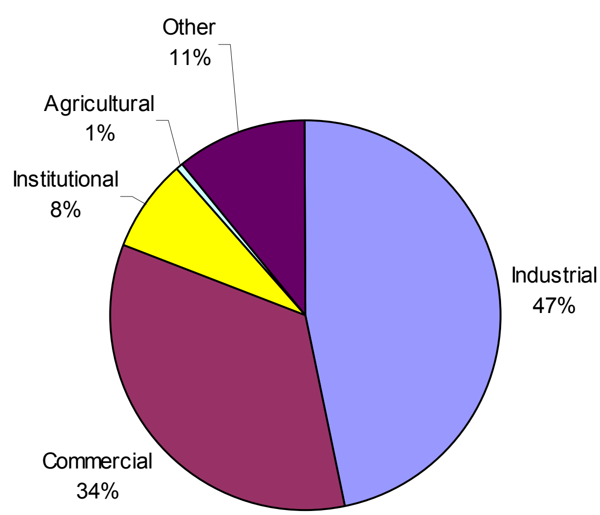
3.0.2 Ciudad Juárez, Chihuahua

Ciudad Juárez is located in the Mexican state of Chihuahua, across the U.S.-Mexico border from El Paso, Texas. In the year 2000, the city had a population of 1.2 million, which represented 40% of Chihuahua's total population.

Employment Sectors

Based on census data from the year 2000, the industrial sector dominates employment in Ciudad Juárez and occupies 47% of the economically active workers in the city. The commercial sector employs 34% of the city's workers, and institutional occupations are held by 8% of the workforce. Figure 5 shows the percentage of Ciudad Juárez' workers employed in each market sector and Table 6 provides a more detailed breakdown of employment figures in each sector.

Figure 5. 2000 Ciudad Juárez Employment



Source: Instituto Nacional de Estadística Geografía e Informática (INEGI), XII Censo General de Población y Vivienda 2000 (Census 2000)

Table 6. 2000 Ciudad Juárez Employment by Sector and Subsector

Sector	Number Employed	Percent of Total Employed
Manufacturing	222,042	46%
Mining	131	<1%
Electricity and Water	1,829	<1%
Total Industrial	**224,002**	47%
Commerce	68,001	14%
Culture and Recreation	2,832	1%
Hotel and Restaurants	22,108	5%
Construction	30,880	6%
Transportation and Communication	14,869	3%
Mass Media	4,419	1%
Financial and Business Services	20,263	4%
Total Commercial	**163,372**	34%
Health and Social Services	12,081	3%
Government	10,866	2%
Education	14,152	3%
Total Institutional	**37,099**	8%
Agriculture	**2,742**	1%
Other	**52,556**	11%
TOTAL	**904,244**	

Source: Based on Instituto Nacional de Estadística Geografía e Informática (INEGI), XII Censo General de Población y Vivienda 2000 (Census 2000)

Industrial Sector. Manufacturing employs 46% of the workers Ciudad Juárez. The city contains the second highest concentration of maquiladora plants in Mexico.[91] The dominant plant types are automotive manufacturing and assembly (25%), manufacturing of electrical lighting supplies and lighting technologies (23%), and manufacturing and assembly of electronics including televisions, VCRs, and computers (21%).[92]

Estimates of the number of maquiladora plants located in Ciudad Juárez increased from 263 plants in the mid-1990's[93] to 316 plants in 2002[94]. Maquiladora employment figures for Ciudad Juárez increased from more than 150,000 people in the mid-1990's[95] to 260,000 in 2001.[96] However, between 2001 and 2002, this figure dropped to 220,000[97]. In the state of Chihuahua as a whole, 261,189 maquiladora workers were employed in 2002.[98]

Commercial Sector. The commercial sector employs 34% of the workforce in Ciudad Juárez. The highlighted subsectors alone, which include commerce and trade and tourism activities, occupy 19% of the workers. According to the non-profit Economic Development of Juarez, the municipality has 82 hotels ranging from economy class to 5-star. No information was readily available regarding the number of commerce and trade establishments in the city.

Institutional Sector. The institutional sector, which includes health, government, and education services, employs 8% of the city's workforce. No information was readily available regarding the number of hospitals, government facilities, or education facilities in the city.

Electricity Usage

In the State of Chihuahua, medium-sized, export-oriented manufacturing industries are responsible for 44% of the state's electricity consumption.[99] Total electricity consumption in the Mexican states that border Texas is projected to increase 6% - 8% annually over the next few years.[100] No data was readily available regarding current electricity supply sources or total electricity consumption in Ciudad Juárez.

Local Climate

Summer in the Ciudad Juárez area is hot and dry, and temperatures exceeding 38° C (100° F) are common. Temperatures fall at night to 27 to 29° C (80 to 85° F). Winter temperatures are in the range of 7 to 16° C (45 to 60° F) during the day and -6 to 7° C (21 to 45° F) at night. Annual rainfall is about 220 mm (9 inches).

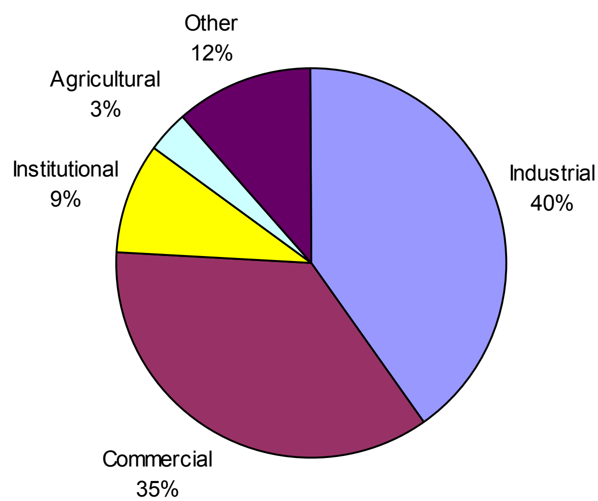
3.0.3 Matamoros, Tamaulipas

Matamoros is located approximately 25 miles inland from the Gulf of Mexico in the Mexican state of Tamaulipas, across the U.S.-Mexico border from Brownsville, Texas. The city has experienced a 38% population growth rate since 1990, the highest growth rate in the last four decades.[101] In the year 2000, Matamoros had 418,000 residents, which comprised about 15% of the total state population of Tamaulipas. Matamoros' increase in population is due largely to the increased industrialization of the region since the passage of the North America Free Trade Agreement (NAFTA).

Employment Sectors

Based on census data from the year 2000, the industrial sector dominates employment in Matamoros and occupies 41% of the economically active workers in the city. The commercial sector employs 35% of the city's workers, and institutional occupations are held by 9% of the workforce. Figure 6 shows the percentage of Matamoros' workers employed in each market sector and Table 7 provides a more detailed breakdown of employment figures in each sector.

Figure 6. 2000 Matamoros Employment



Source: Instituto Nacional de Estadística Geografía e Informática (INEGI), XII Censo General de Población y Vivienda 2000 (Census 2000)

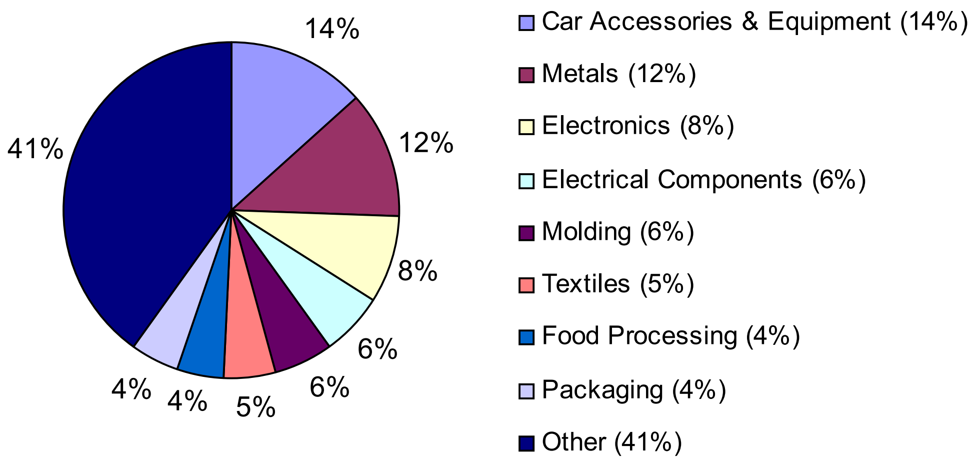
Table 7. 2000 Matamoros Employment by Sector and Subsector

Sector	Number Employed	Percent of Total Employed
Manufacturing	65,141	40%
Mining	88	<1%
Electricity and Water	671	<1%
Total Industrial	**65,900**	40%
Commerce	22,590	14%
Culture and Recreation	854	1%
Hotel and Restaurants	7,880	5%
Construction	13,345	8%
Transportation and Communication	5,852	4%
Mass Media	1,431	1%
Financial and Business Services	5,949	4%
Total Commercial	**57,901**	35%
Health and Social Services	4,135	3%
Government	4,922	3%
Education	5,975	4%
Total Institutional	**15,032**	9%
Agriculture	**5,633**	3%
Other	**18,814**	12%
TOTAL	**302,113**	

Source: Based on Instituto Nacional de Estadística Geografía e Informática (INEGI), XII Censo General de Población y Vivienda 2000 (Census 2000)

Industrial Sector. Manufacturing is the dominant industry in Matamoros. The city, which claims to have one of the highest employment rates in Mexico, employed more than 65,000 workers in the manufacturing sector in 2000. Based on a database of the 157 manufacturers located in Matamoros, the largest single manufacturing subsector in the city is automotive accessory and equipment manufacturing and assembly (14% of total number of establishments); followed by metal manufacturing, assembly, forming, stamping, and finishing (12%); electronics manufacturing, assembly, and repair (8%); electrical equipment and components manufacturing and repair (6%); and injection molding manufacturing (6%).[102] Figure 7 illustrates this distribution.

Figure 7. Dominant Manufacturing Activities in Matamoros



Source: Based on information from the Brownsville Economic Development Council, Database of Local Manufacturers. Total Number of Establishments (100% = 157)

Commercial Sector. The commercial sector employs 35% of the workforce in Matamoros. The highlighted subsectors alone, which include commerce and trade and tourism activities, occupy 19% of the workers. According to the Instituto Municipal de Planeacion (IMPLAN), the municipality has 65 hotels and motels ranging from economy class to 5-star. No data was readily available regarding the number of commerce and trade establishments in the city.

Institutional Sector. The institutional sector, which includes health, government, and education services, employs 9% of the city's workforce. According to a database maintained by the Instituto Municipal de Planeacion (IMPLAN), the municipality contains 18 hospitals and clinics; 21 government establishments including a public works office, migration office, and the U.S. Consulate; and 50 educational facilities including kindergartens, primary and secondary schools, preparatory schools, and universities.

Electricity Usage

The industrial sector dominates economic activity in Matamoros and is also experiencing a high rate of growth in terms of the number of new electricity accounts opened between 1998-2001. As shown in Table 8, whereas the number of total accounts in the city only grew by 14% during that period, industrial accounts increased by 61%. Total electricity consumption in the northeastern region of Mexico is projected to increase by 6.5% annually over the next decade.[103] No data was readily available regarding current electricity supply sources or total electricity consumption in Matamoros.

Table 8. Matamoros Electricity Accounts

Sector	1998	1999	2000	2001	Percent Growth
Residential	99,893	105,618	110,534	115,630	16%
Industrial	1,100	1,326	1,595	1,768	61%
Commercial	9,010	9,299	9,314	9,167	2%
Total	110,003	116,243	121,443	125,565	14%

Source: City of Matamoros

Local Climate

Matamoros has a semi-tropical climate. Annual rainfall averages 675 mm (27 inches). Temperatures range from 11 to 38° C (52 to 100° F).

3.1 Sector Analysis

This section describes potential energy efficiency projects and estimates savings for the target customer sectors in the highlighted regions. Due to unavailability of specific energy use data by sector at the local level, these savings calculations should be considered estimates only. The total energy usage and potential energy savings in the highlighted sectors and subsectors is estimated based on the following data and assumptions:

- Distribution of audited facilities in each sector, by rate tariff. A series of preliminary energy audits were conducted in the border region in the industrial, commercial, and institutional sectors between September 2001 and October 2002. The rate tariffs to which each type of customer subscribed were assumed to reflect the overall sector's customer distribution between rate tariffs. Audited commercial and institutional customers were combined for this purpose.

- Statewide averages in 2001 for energy consumption per customer, by rate tariff. At a state-aggregated level, the total energy consumed and the total number of customer accounts under each rate tariff is available. For lack of more specific data, this statewide data was assumed to approximate customer usage in each highlighted area.

- Statewide averages in 2001 for blended electricity rates, by rate tariff. At a state-aggregated level, the blended electricity rates for each rate tariff is available. For lack of more specific data, this statewide data was assumed to approximate customer rates in each highlighted area.
- Number of establishments in each highlighted subsector for which data was readily available.
- Average potential energy savings for facilities in each sector. The estimated energy savings from audited facilities were assumed to reflect potential savings from other facilities belonging to the same sectors.

Note that because our sample size was relatively small and not random, the first two assumptions represent a significant area of uncertainty in the estimate of the overall electricity usage for each sector. For example, in the manufacturing subsector, we assumed 75% of customers use over 1 million kWh and 25% use 100,000 kWh. A change in those ratios to 60% and 40% would decrease the estimated magnitude of savings by 18%.

3.1.1 Industrial

Estimated energy and cost savings based on available data for the target regions and the manufacturing subsector are provided in Table 9. All monetary amounts are expressed in U.S. dollars. Explanations of the rate schedules are provided below under the heading “Energy Rates”.

Based on this analysis, the area with the most savings potential in this sector is Tijuana (171,500 MWh annually), followed by the balance of the state of Baja California (108,300 MWh), Ciudad Juárez (104,100 MWh), and Matamoros (50,700 MWh). Based on an analysis of audited facilities, the cost associated with implementing energy efficiency projects in manufacturing facilities ranges from one-year of estimated annual cost savings (project payback period of 1.3 years) to six years of estimated annual cost savings (project payback period of 6.0 years).

Table 9. Estimated Electricity and Electricity Cost Savings, Manufacturing Subsector[104,105,106]

Industrial Sector	Tijuana	Balance of Baja California	Ciudad Juarez	Matamoros
Rate Schedule Distribution				
OM	25%	25%	25%	25%
HM	75%	75%	75%	75%
Average Electricity Use Per Customer (kWh/year)				
OM	101,614	101,614	92,401	90,316
HM	1,348,361	1,348,361	1,671,785	1,637,160
Blended Electricity Price Per Customer, 2001 ($USD/kWh)				
OM	$0.0606	$0.0606	$0.0627	$0.0640
HM	$0.0530	$0.0530	$0.0512	$0.0512
Number of Facilities				
Manufacturing and Assembly	641	405	316	157
Electricity Use Per Subsector (MWh/year)				
Manufacturing and Assembly	664,508	419,853	403,513	196,320
Total Electricity Cost ($USD)				
Manufacturing and Assembly	$35,358,481	$22,340,382	$20,746,918	$10,101,777
Average Electricity Savings Per Facility	**26%**	**26%**	**26%**	**26%**
Potential Savings Per Subsector (MWh/year)				
Manufacturing and Assembly	**171,471**	**108,339**	**104,123**	**50,659**
Percent Electricity Savings	26%	26%	26%	26%
Total Potential Electricity Cost Savings				
Manufacturing and Assembly	**$9,123,950**	**$5,764,742**	**$5,353,563**	**$2,606,676**
Percent Electricity Cost Savings	26%	26%	26%	26%

Typical characteristics of energy use and opportunities for energy savings for the manufacturing subsector are identified below. These recommendations are based on a series of preliminary energy audits conducted in the border region, as well as BVA's industry experience. Among the manufacturing facilities audited and included in this report was an electronics manufacturing and assembly plant in the Ciudad Juárez area. Other industrial facilities included a SCUBA equipment manufacturer, cement manufacturer, window manufacturer, and chemical/plastic manufacturer.

Operating Schedule

Manufacturing plants typically operate between 15 to 24 hours per day on weekdays. Depending on the operation, manufacturing facilities may maintain this schedule on weekends as well.

The surveyed electronics manufacturing plant operated two shifts: the first shift was 8 hours per day Monday through Friday, and the second shift was 9 hours per day Monday through Thursday. Thus, the plant operated about 17 hours per day on most weekdays. Administrative offices operated from 7 a.m. to 6 p.m. Monday through Friday. There was occasional overtime work on Saturdays.

Other manufacturing plants operated virtually around the clock throughout the year. For example, the cement manufacturing company operated two plants. One plant operated 24 hours per day, 7 days per week, 35 weeks per year. For the remainder of the year, it operated 15 hours per day, 6 days per week. The other plant operated 24 hours per day, 7 days per week all year.

Energy End-Uses

BVA found that the primary electricity end-use applications in manufacturing plants were the following:

- Lighting
- Air conditioning for clean rooms
- Electric motors
- Compressing air
- Manufacturing processes, including furnaces, welding and soldering, and etching.

The primary natural gas end-use applications in manufacturing plants were the following:

- Space heating
- Steam and hot water generation for space conditioning and process uses
- Manufacturing processes, including furnaces, welding and soldering.

Energy Rates

Based on the data gathered, about 25% of the industrial facilities subscribe to the OM rate tariff, which is a general service for customers with demands over 100 kW, delivered at medium voltage. About 75% of the industrial facilities subscribe to the HM rate tariff, which is a general service, time-of-use tariff for customers with demands over 100 kW, also delivered at medium voltage.

Average electricity rates in audited manufacturing facilities in the Mexican border region ranged from $0.06 per kWh to $0.12 per kWh. The average electricity rate paid by the electronics manufacturer in El Paso, Texas was $0.10 per kWh.

Energy Efficiency Opportunities

Potential energy savings at audited manufacturing facilities ranged from 65,400 kWh to 1,283,000 kWh annually, and associated cost savings ranged from $7,800 to $128,400 annually. Project implementation costs ranged from $47,000 to $174,200, which include installation and labor, and simple payback periods ranged from 1.3 to 6.0 years. On average, the audits found opportunities to reduce electricity consumption by about 26% at manufacturing facilities.

Note that whenever new equipment is put in use, a basic level of staff operations and maintenance training is involved. For example, approximately one-half to one hour of training is necessary to instruct facility staff on proper maintenance procedures for evaporative condensers. However, the measures recommended through the BVA audits and described below are locally available, established technologies that should require minimal training time and costs. Also note that many energy efficiency measures reduce maintenance costs. For example, new lamps that replace aging lamps in existing fixtures tend to be longer living than the original lamps. The impact on future maintenance costs therefore, depends on several factors, including the facility staff's familiarity with energy efficiency technology and the timing of retrofit improvements. The savings and cost estimates above do not include these possible benefits or costs associated with future maintenance impacts.

Although the manufacturing processes of each facility must be studied to identify potential energy savings compatible with specific operations, in general, opportunities exist in most facilities to improve equipment controls, implement energy recovery systems, and optimize operating cycles.

Improve Facility Design. Manufacturing facilities often benefit from redesigning major energy using systems to reduce energy consumption. These opportunities include implementing more efficient lighting designs, optimizing steam and hot water distribution systems, including condensate recovery and heat recovery in steam and hot water systems, optimizing compressed air distribution systems, and implementing more efficient designs for the air distribution systems in clean rooms.

Improve Maintenance and Operation. Energy savings can often be achieved through improved maintenance practices. For example, sealing ducts in the air distribution system will reduce fan, heating, and cooling energy use.

Upgrade Technology. In addition to process-specific efficiency improvements, virtually all manufacturing facilities have opportunities to reduce energy consumption through the following technology upgrades:

- Upgrade fluorescent lighting with T-8 lamps and electronic ballasts. An electronic ballast uses electronic circuitry to regulate voltage with less energy loss than a "core and coil" magnetic ballast. In most cases, there is no need to replace the fixture, only the lamps and ballasts. The T-8 lamp-electronic ballast combination saves at least 20 percent of the energy required to operate the older technology, and provides essentially the same light output. It also produces a much higher quality light, with improved color rendition than cool- and warm-white lamps. Electronic ballasts also virtually eliminate the flicker and hum associated with magnetic ballasts.
- Replace mercury vapor fixtures with metal halide, fluorescent, or high pressure sodium fixtures. A 400-watt mercury vapor lamp can be replaced with a 250-watt metal halide lamp with no reduction in light output and good color rendering properties. In areas where color rendering properties are not important, such as parking or walkway areas, 175-watt mercury vapor lamps can be replaced with a 100-watt high pressure sodium lamps with no reduction in light output. Hi-Bay fluorescent lighting fixtures are also a good alternative to mercury vapor fixtures.

- Convert exit signs to LED. LED exit signs use only a few watts of power and operate for 10 years without requiring lamp replacements, thus reducing both energy and maintenance costs.
- Install occupancy sensors. Occupancy sensors automatically shut off lights when areas are unoccupied.
- Convert air-cooled HVAC units to evaporative cooling. The condenser temperatures of air-cooled air conditioning units can reach extremely high temperatures during the cooling season, which increases the energy consumption of these units substantially. Evaporative pre-coolers direct the intake air to the condenser through a wetted media so that it is cooled by evaporation.
- Install ceiling fans. Research shows that moving air feels cooler than still air to occupants in a space. Installation of ceiling fans will lower the ambient temperature in the space and allow the thermostats to be set higher while maintaining the same level of occupant comfort. Setting the thermostat higher will generate savings by reducing the run time of the air conditioning compressors.
- Install cool roof reflective roof surface. Heat gain through the roof can be reduced substantially by coating the existing roof with a “cool roof” reflective coating. This coating can reduce the heat gain by as much as 90%, lower the temperature of the roof to increase occupant comfort, and also extend the life of the roof.
- Replace standard efficiency electric motors with premium efficiency units. Premium efficiency motors have improved bearings and fans, as well as improved technology core materials and construction designs. All of this results in motors that require less energy to do their work.

Case Study

The results of a preliminary energy audit at the Pollak Electronic Products Division (Pollack) manufacturing plant in El Paso, Texas are summarized below. The company manufactures and assembles printed circuit boards for a wide variety of devices. The 90,000 square foot manufacturing plant has uninsulated concrete walls and an insulated metal roof. The objective of the survey was to identify cost-effective energy efficiency measures (EEMs). The analysis assumed U.S. labor and materials costs. This and other sample audits and case studies are available at www.borderenergy.org/html/opportunity_assessment.htm.

During the one-year period from June 2001 through May 2002, based on electric bills provided by Pollak, the plant consumed 4,030 MWh of electricity at a cost of $404,264. The plant’s peak demand was 1,140 kW. BVA’s analysis indicated that 17% of the energy was used for lighting, 40% was used for HVAC in the manufacturing area, 11% was used for HVAC in the office area, and the balance (32%) was used for process and miscellaneous uses.

Three lighting measures were identified for the facility. The lighting recommendations were projected to save approximately 50,300 kWh annually and result in cost savings of $5,122 per year (all values in USD). Implementation costs were estimated at $31,343. The simple payback period is 6.1 years. The analysis assumed that all inefficient lighting equipment would be replaced at the same time. If the facility considered the project cost prohibitive, it was recommended that they upgrade to more efficient ballasts and lamps during routine maintenance when the existing components fail.

Two HVAC measures were identified. Savings were estimated for each HVAC measure implemented alone, due to the potential interaction between two or more implemented measures. The first measure addressed the air-cooled HVAC equipment. In the El Paso climate, air-cooled air conditioners experience very high condenser temperatures, which increase the energy consumption of the units. By using evaporative cooling to cool the condenser air, the energy consumption is lowered significantly. Implementing this measure was estimated to save 715,700 kWh annually, with energy cost savings of $71,600 per year. Implementation costs were estimated at $75,000, resulting in a payback period of 1 year.

The second recommendation was to install high-volume, low -speed ceiling fans which, by moving the air in the plant, could lower the perceived temperature by as much as 4 to 6^{o} C (8 to 10^{o} F) in the summertime without creating undesirable drafts. In the winter, the fans would move heat from the ceiling to the floor area, reducing the need for supplemental heat. Implementing this measure was estimated to save 496,900 kWh annually, with energy cost savings of $49,700 per year. Implementation costs were estimated at $50,000, resulting in a payback period of 1 year.

An opportunity to increase the efficiency of the air compressor system by installing premium efficiency motors was also identified. Implementing this measure was estimated to save 20,000 kWh annually, with energy cost savings of $2,000 per year. Implementation costs were estimated at $5,000, resulting in a payback period of 2.5 years.

Pollak was advised to initiate a more detailed analysis to develop firm savings and cost estimates for some measures, as well as obtain equipment and installation cost quotes from several vendors.

3.1.2 Commercial

Estimated energy and cost savings based on available data for the target regions and the hospitality subsector are provided in Table 10. All monetary amounts are expressed in U.S. dollars. Explanations of the rate schedules are provided below under the heading “Energy Rates”.

Based on this analysis, the area with the most savings potential in this subsector is Tijuana (55,800 MWh annually), followed by Ciudad Juárez (25,500 MWh) and Matamoros (19,900 MWh). Based on an analysis of audited facilities, the cost associated with implementing energy efficiency projects in commercial facilities ranges from one and half years of estimated cost savings (project payback period of 1.5 years) to ten years of estimated annual cost savings (project payback period of 10.1 years).

Table 10. Estimated Electricity and Electricity Cost Savings, Hospitality Subsector[107,108,109]

Commercial Sector	Tijuana	Ciudad Juarez	Matamoros
Rate Schedule Distribution			
3	20%	20%	20%
5A	20%	20%	20%
HM	60%	60%	60%
Average Electricity Use Per Customer (kWh/year)			
3	76,229	73,653	69,821
5A	43,770	29,480	57,852
HM	1,348,361	1,671,785	1,637,160
Blended Electricity Price Per Customer, 2001 ($USD/kWh)			
3	$0.1104	$0.1064	$0.1111
5A	$0.1088	$0.1058	$0.1053
HM	$0.0530	$0.0512	$0.0512
Number of Facilities			
Hospitality (Hotels and Motels)	221	82	65
Electricity Use Per Subsector (MWh/year)			
Hospitality	184,097	83,943	65,509
Total Electricity Cost ($USD)			
Hospitality	$10,062,539	$4,391,553	$3,450,692
Average Electricity Savings Per Facility	**30%**	**30%**	**30%**
Potential Savings Per Subsector (MWh/year)			
Hospitality	**55,832**	**25,458**	**19,867**
Percent Electricity Savings	30%	30%	30%
Total Potential Electricity Cost Savings			
Hospitality	**$3,051,709**	**$1,331,845**	**$1,046,506**
Percent Electricity Cost Savings	30%	30%	30%

Typical characteristics of energy use and opportunities for energy savings for the commercial sector are identified below. These recommendations are based on a series of preliminary energy audits conducted in the border region, as well as BVA's industry experience. Among the commercial facilities audited and included in this report were a hotel, import warehouses (refrigerated and unrefrigerated), and office spaces. Other commercial facilities included a livestock feed production plant.

Operating Schedule

Information on the operating schedules of the hotel and livestock feed production plant were included in the audits performed.

Hotel. Hotels supply diverse services and amenities, including pools, spas, business centers, conference rooms, stores, restaurants, and laundry service throughout the day.

Livestock Feed Plant. The audited livestock feed production plant operated one 8-hour morning shift 4 weekdays per week and on Sundays, as well as one 8.5-hour evening shift on Saturdays. Its administrative offices operated 8 hours per day on weekdays and 5 hours on Saturdays. Maintenance operations worked an 8-hour morning shift every day of the week.

Energy End-Uses

Hotel. Although energy costs are typically not the highest costs in a hotel's annual budget, the hotel industry spends about $500 per room per year for fuel and electricity (energy costs in the Mexican hospitality industry average nearly $2 per square foot). In Mexican hotels, the largest energy consuming systems are cooling at 42% and lighting at 36%, while refrigeration, motors, elevators and laundry each consume between 5 to 7% of energy consumption.[110]

The primary end-use applications in hotels are the following:

- Lighting
- HVAC
- Central plant (boilers). Steam boilers are used to charge a hot water loop for space heating, and heat exchangers use steam to generate warm water.
- Laundry facilities. Note that thermal energy requirements in the form of steam may reach over 300 pounds (lb) per hour when flat irons, clothes washing, and drying tumblers or dry rooms are in use. Typical operating pressures are 100 psig.
- Swimming Pool
- Water Treatment
- Kitchens. Note that cooking equipment such as steam kettles may require steam up to 25 psig. Plate and dish warmers, as well as food preparation and washing use low-level steam.

Import Warehouse. Four facilities used for receiving, inspecting, storing, and shipping imported goods were surveyed. Two were refrigerated warehouses and two were un-refrigerated. The warehouse buildings consisted of cement block or metal walls. Refrigerated warehouses had 4 to 5 inches of foam insulation on their walls and roofs. The unrefrigerated warehouses had uninsulated walls and in some cases, uninsulated roofs as well. Administrative buildings associated with the import facilities resembled the office spaces described below. In all cases, lighting and HVAC represented the largest end-use loads with potential for energy efficiency improvements.

Office Space. Lighting and HVAC are typically the end-use applications with greatest potential for energy efficiency improvements.

Livestock Feed Plant. Motors dominate energy use and are responsible for 95% of energy used at the audited facility. Lighting, HVAC, and boilers constitute the remaining energy load.

Energy Rates

Based on the data gathered, about 20% of the commercial and institutional facilities subscribe to the 3 rate tariff, which is a general service for customers with demands over 25 kW, delivered at low voltage. About 20% of the commercial and institutional facilities subscribe to the 5A rate tariff, which is for public lighting in urban areas, also delivered at low voltage. The remaining 60% subscribe to the HM rate tariff, which is a general service, time-of-use tariff for customers with demands over 100 kW, delivered at medium voltage.

Average electricity rates in audited commercial facilities in the Mexican border region ranged from $0.06 per kWh to $0.16 per kWh. The average electricity rate paid by one import warehouse facility in El Paso, Texas was $0.13 per kWh and its natural gas rate was $0.56 per therm.

Energy Efficiency Opportunities

Potential electricity savings at audited commercial facilities ranged from 122,300 kWh to 351,200 kWh annually, and potential natural gas savings ranged from 26,900 therms to 27,200 therms annually. Associated cost savings ranged from $10,600 to $46,900 annually. Project implementation costs ranged from $16,100 to $236,400, which includes installation and labor, and simple payback periods ranged from 1.5 to 10.1 years. The savings and cost estimates exclude possible positive or negative impacts on future maintenance costs. On average, the audits found opportunities to reduce electricity consumption by about 30% at commercial facilities.

Although the specific commercial facilities must be studied to identify potential energy savings compatible with their operations, in general, opportunities exist in most commercial facilities to improve lighting and HVAC system efficiency. For commercial facilities with central plants, additional energy savings are likely to be identified.

Reduce Loads. Typical opportunities to reduce cooling loads include planting trees or installing awnings on the south side of buildings.

Maintenance and Operation. Typical maintenance and operation improvements for commercial facilities include the following:

- Standardize lighting. A review of the lighting fixtures can be undertaken with the intent of standardizing lighting and reducing the variety of lamps used. This strategy can significantly reduce lighting maintenance costs.

- Weatherstrip doors. This measure is especially beneficial in hotel guestrooms, where a substantial amount of outside air can enter the rooms through each room’s exterior door while the mechanical air conditioning or heating is in operation. Installing weatherstripping on the doors eliminates the infiltration of outside air, reduces heating and cooling loads on the mechanical conditioning system, and increases occupant comfort (particularly when the outdoor temperatures are very high or low).

- Sealing and insulation. Proper sealing and insulation of air conditioning ducts could easily reduce losses by 20%.
- Improve maintenance of steam and hot water generation and distribution systems. Most of the opportunities for efficiency improvements lie in the distribution systems, which typically have leaks and malfunctioning equipment where steam is lost. Opportunities to recover heat can also be found in the use of condensers, trap condensate return, and heat exchangers.
- Provide operations and maintenance training.

Technology Upgrade. Upgrading the equipment is another strategy to reduce energy consumption. Audited facilities were advised to implement the following strategies:

- Upgrade fluorescent lighting with T-8 lamps and electronic ballasts (see previous description of this measure). In hotels, focus these efforts on areas where lights are on 24 hrs per day, such as lobbies, hallways, common bathrooms, kitchen, laundry area, other service areas.
- Convert incandescent fixtures to compact fluorescent. In hotels, this strategy can be implemented in guest rooms. These lamps are available in a wide variety of styles to meet most needs.
- Upgrade special use incandescent lighting. This is a relevant measure for hotels and other commercial facilities that use dimmable spot lights or flood lights in their meeting rooms or other areas. Replacing incandescent lamps with compact fluorescent lamps or halogen infrared reflecting (HIR) lamps can achieve a substantial reduction in energy use. Compact fluorescent lamps are more efficient than HIR lamps, but do not fit into all fixture types. HIR lamps are efficient types of incandescent lamps and are available in “R”, “PAR” and “MR-16” styles. Where dimming is needed, dimmable compact fluorescent lamps or HIR lamps are available.
- Convert exit signs to LED (see previous description of this measure).
- Install occupancy sensors (see previous description of this measure).
- Install skylights to reduce electrical lighting requirements. For warehouses, BVA’s experience indicates that if the roof were fitted with skylights, the lights could be turned off as much as 50% of the time during the day. Any security concerns may be addressed by installing metal bars at the openings.
- Convert air-cooled HVAC units to evaporative cooling (see previous description of this measure).

- Install ceiling fans (see previous description of this measure).
- Install a cool roof reflective roof surface (see previous description of this measure).
- Interlock guestroom sliding doors and windows to HVAC units. In hotels, natural ventilation is often provided via a sliding glass door or window to the outdoors. Although the natural ventilation is desirable and effective, it is not energy efficient if both the natural ventilation and mechanical air conditioning systems are in operation at the same time. Installing an interlock on each room that disables HVAC units if sliding glass doors or windows are opened will prevent natural ventilation and mechanical cooling from operating simultaneously.
- Install a make-up air unit in kitchens. In hotels, kitchens typically have a large exhaust hood system to remove heat and fumes from the area. If there is no source of air to replace the air removed by the exhaust fan, conditioned air is drawn from other areas into the kitchen. Using air from other areas (such as lobbies and guest areas) to ventilate kitchens is inefficient, because air from those areas typically requires more heating and cooling than is necessary in the kitchen area. Installing an air-handling unit to deliver outside air to the kitchen when the exhaust hood is in operation can substantially reduce the energy cost for conditioning the facility. This air should be heated or cooled minimally to maintain an acceptable working environment and should be a slightly smaller volume than is removed by the hood.
- Replace standard efficiency electric motors with premium efficiency units (see previous description of this measure).
- Upgrade air handling system. Improvements in air handling systems, which may include installing efficient fans and controls to permit variations in air volume, can result in large efficiency gains.

Case Study

The results of a preliminary energy audit at Hotel Camino Real in Saltillo, Coahuila are summarized below. The facility is a 164-room hotel that was originally constructed in 1954. It has been expanded and remodeled several times since its original construction and now consists of a central lobby building, offices, two restaurants and bar, reception desk, meeting and event rooms, pool, guest rooms, and central plant that houses steam boilers and the hotel laundry. The main objective of BVA's survey was to identify cost-effective EEMs. The analysis assumed U.S. labor and materials costs.

Figure 8. Interior Lawn, Hotel Camino Real

During the one-year period from August 2001 through July 2002, the hotel consumed 1,960 MWh of electricity at a cost of $123,246. The hotel's peak demand was 544 kW. The hotel also purchased energy in the form of liquid propane from a local supplier. During the one-year period from January 2001 through December 2001, the hotel consumed 617,250 liters (163,100 gallons) of propane with a heating value of 149,379 therms at a cost of $141,120. Energy end-uses at the hotel were lighting, HVAC, central plant to produce steam for the laundry, hot water, space heating, swimming pool, and water treatment tanks to treat water drawn from wells on the property.

Three lighting measures were identified for the facility. The lighting recommendations were projected to save approximately 167,100 kWh annually and result in cost savings of $10,000 per year. Implementation costs were estimated at $36,300. The simple payback period is 3.6 years. The analysis assumed that all inefficient lighting equipment would be replaced at the same time. If the facility considered the project cost prohibitive, it was recommended that they upgrade to more efficient ballasts and lamps during routine maintenance when the existing components fail.

Two HVAC measures were identified. The first measure addressed the natural ventilation system in each guest room, which was supplied through an entry door and a sliding glass door on the opposite side of the room. BVA recommended installing an interlock on each guestroom so that if the exterior sliding glass doors were opened, the room's HVAC unit would be disabled. This prevents natural ventilation and mechanical cooling systems from operating simultaneously. A computer energy model constructed in Visual Doe 3.0 indicated that this measure would save 1,050 therms and 36,750 kWh per year with a total cost savings of $3,200. The estimated cost to implement this measure was $10,600 and the simple payback period was 3.3 years.

The second recommendation addressed the hotel kitchen's exhaust hood system, which removes heat and fumes from that area. Because there is no source of air to replace the air removed by the exhaust fan, conditioned air is drawn from the lobby into the kitchen. Not only is the air from the lobby and guest areas more expensive to condition, but drawing make-up air from the lobby and guest areas creates a negative pressure in these areas relative to the outside. This increases infiltration, which further raises energy costs and creates uncomfortable drafts.

BVA recommended installing an air-handling unit to deliver outside air to the kitchen when the exhaust hood is in operation. This air should be heated or cooled minimally to maintain an acceptable working environment and should be a slightly smaller volume than is removed by the hood. In addition, care must be taken to maintain the kitchen at a lower pressure than the surrounding areas so that smoke and odors from the kitchen are not spread through the building. BVA estimated that this measure would save 5,000 therms and 58,600 kWh per year, with a total energy cost savings of $8,250. Capital costs were estimated at $26,000, and the simple payback period was 3.2 years.

The hotel was also advised to install weatherstripping on the guestroom doors. Based on BVA's computer building model, this retrofit will save the hotel 1,160 therms and 5,850 kWh annually, with a cost savings of $1,450 per year. The cost of implementing this measure was estimated at $8,200 and the payback period is 5.7 years.

The central plant improvements described below were recommended for the facility. Combined, these measures were estimated to save 20,000 therms and 82,000 kWh annually, with a cost savings of $23,960 per year. Total project costs were estimated at $39,000, and the overall payback period is 1.6 years.

- Install boiler stack heat recovery units. Currently, exhaust gases from the boiler fire box pass out of the building through the exhaust stack. These gases carry about 20% of the energy generated by burning the fuel. Installing boiler stack heat recovery units on the boilers would allow about 25% of the lost energy to be recovered and used to preheat boiler feed water.

- Install a heat exchanger. Because the well water at the hotel has a high mineral content, a substantial amount of water must be drained (blowdown) from the system to prevent mineral buildup in the boiler. Blowdown water is removed from the system at 100° C (212° F), and the well water that replaces it must be heated from ground temperature to that temperature. A heat exchanger would transfer heat from the blowdown water to the incoming feed water.

- Install lockout controls. Hot water is circulated continuously from the boiler plant to most of the hotel buildings. Chilled water is circulated from the chillers to about half of the buildings. This circulating is done by constant-volume pumps, which run constantly. BVA advised the hotel to install lockout controls that shut down the heating system circulating pumps when the outdoor air temperature is higher than 21° C (65° F), and disable the chillers and chilled water circulating pumps when the outdoor air temperature is below 24° C (75° F). This will reduce the hours of operation for the chillers and circulating pumps as well as the load on the boiler plant.

- Install premium efficiency motors. The hotel has a substantial number of standard efficiency electric motors over 3.73 kW that operate heating water and chilled water circulating pumps, domestic hot water circulating pumps, and well pumps. BVA recommended replacing these motors with premium efficiency motors as they reach the end of their lives. The newer premium efficiency motors will save 2 to 3% of the energy required for standard efficiency units.

Figure 9. Boiler Room, Hotel Camino Real

Figure 10. Chiller, Hotel Camino Real

3.1.3 Institutional

Estimated energy and cost savings based on available data for Tijuana and Matamoros and the highlighted institutional subsectors are provided in Table 11. All monetary amounts are expressed in U.S. dollars. Explanations of the rate schedules are provided below under the heading "Energy Rates".

Based on this analysis, the area with the most savings potential in this sector is Tijuana (264,400 MWh annually), followed by Matamoros (18,600 MWh). Insufficient data was available regarding the number of institutional establishments in Ciudad Juárez to estimate energy savings. Based on an analysis of audited facilities, the cost associated with implementing energy efficiency projects in institutional facilities ranges from three years of estimated cost savings (project payback period of 3.2 years) to five years of estimated annual cost savings (project payback period of 5.3 years).

Table 11. Estimated Electricity and Electricity Cost Savings, Institutional Sector[111,112]

Institutional Sector	Tijuana	Matamoros
Rate Schedule Distribution		
3	20%	20%
5A	20%	20%
HM	60%	60%
Average Electricity Use Per Customer (kWh/year)		
3	76,229	69,821
5A	43,770	57,852
HM	1,348,361	1,637,160
Blended Electricity Price Per Customer, 2001 ($USD/kWh)		
3	$0.1104	$0.1111
5A	$0.1088	$0.1053
HM	$0.0530	$0.0512
Number of Facilities		
Health Care / Hospitals	440	18
Government	N/A	21
Education	1,088	50
Electricity Use Per Subsector (MWh/year)		
Health Care / Hospitals	366,527	18,141
Government	N/A	21,164
Education	906,322	50,392
Total Electricity Cost ($USD)		
Health Care / Hospitals	$20,034,013	$955,576
Government	N/A	$1,114,839
Education	$49,538,651	$2,654,378
Average Electricity Savings Per Facility	**21%**	**21%**
Potential Savings Per Subsector (MWh/year)		
Health Care / Hospitals	**76,139**	**3,768**
Government	**N/A**	**4,396**
Education	**188,270**	**10,468**
Percent Electricity Savings	21%	21%
Total Potential Electricity Cost Savings		
Health Care / Hospitals	**$4,161,669**	**$198,502**
Government	**N/A**	**$231,586**
Education	**$10,290,673**	**$551,394**
Percent Electricity Cost Savings	21%	21%

Typical characteristics of energy use and opportunities for energy savings for the institutional sector are identified below. These recommendations are based on a series of preliminary energy audits conducted in the border region, as well as BVA's industry experience. Among the institutional facilities audited and included in this report were government buildings, a customs and immigration office, and a hospital.

Energy End-Uses

The audit of government buildings in Lemon Grove, California (20 miles east of San Diego) included the city hall/Sheriff's office, recreation center, senior center, fire station, and community center. The primary energy end-uses were street lighting, traffic lights, and building lighting and HVAC. Similar end-uses were found at the Mexican government customs and immigration facility in Colombia, Nuevo Leon (across the border from Laredo, Texas). The facility consisted of ten buildings and energy uses consisted of outdoor lighting, indoor lighting, and plug loads and HVAC.

The audit of an El Paso, Texas hospital focused on lighting and HVAC. A new central plant was also designed and constructed as a related project.

Energy Rates

Based on the data gathered, about 20% of the commercial and institutional facilities subscribe to the 3 rate tariff, which is a general service for customers with demands over 25 kW, delivered at low voltage. About 20% of the commercial and institutional facilities subscribe to the 5A rate tariff, which is for public lighting in urban areas, also delivered at low voltage. The remaining 60% subscribe to the HM rate tariff, which is a general service, time-of-use tariff for customers with demands over 100 kW, delivered at medium voltage.

Electricity rates in Lemon Grove averaged $0.14 per kWh and natural gas rates averaged $1.31 per therm. The Mexican customs and immigration facility paid about $0.15 per kWh for electricity. Information on the electricity rates paid by the hospital was not available.

Energy Efficiency Opportunities

Potential electricity savings from efficiency projects at the audited facilities ranged from 74,000 kWh to 3,800 MWh annually. Associated cost savings ranged from $10,600 to $610,000 annually. Project implementation costs ranged from $55,800 to $2.9 million, which include installation and labor, and simple payback periods ranged from 3.2 to 6.0 years. The savings and cost estimates exclude possible positive or negative impacts on future maintenance costs. On average, the audits found opportunities to reduce electricity consumption by about 21% at institutional facilities.

Although the specific institutional facilities must be studied to identify potential energy savings compatible with their operations, in general, opportunities exist in most institutional facilities to improve lighting and HVAC system efficiency. For institutional facilities with central plants, additional energy savings may be achieved through central plant upgrades and installation of cogeneration systems.

Maintenance and Operation. Developing a scheduled replacement program for HVAC units can reduce maintenance and operation costs. The operating efficiency of air conditioning and heating units typically diminishes over time and aged units develop reliability problems. A replacement program should be developed that suits an institutional facility's budget and starts with the units that are oldest and have the highest maintenance cost. These units should be replaced with high efficiency units that have energy efficiency ratings in the range of 10 to 14. When the units are replaced, the new units should be equipped with outside air economizers and, where practical, should be water-cooled. These projects generate an energy use reduction of 30 to 40% in air conditioning equipment. When planning the replacements, consideration should also be given to consolidating the units wherever it is feasible. Larger units generally operate more efficiently.

Technology Upgrades. Audited facilities were advised to implement the following technology upgrades:

- Upgrade fluorescent lighting with T-8 lamps and electronic ballasts (see previous description of this measure).
- Replace incandescent fixtures with compact fluorescent lamps (see previous description of this measure).
- Replace metal halide fixtures with high pressure sodium fixtures (see previous description of this measure).
- Install occupancy sensors (see previous description of this measure).
- Convert exit signs to LED (see previous description of this measure).
- Install automatic HVAC controls. Typically, air conditioning units and lighting systems in institutional facilities are manually controlled by on-off switches and simple thermostats. As a result, some of the equipment may be operating more hours than necessary. Using setback thermostats and time clocks insures that HVAC equipment operates only when needed.
- Install high-efficiency motors (see previous description of this measure).
- Replace 3-way control valves with 2-way control valves on air handlers.

Case Study

The results of a preliminary energy audit at Aduana Colombia, the customs and immigration facility at Colombia, Nuevo Leon, are summarized below. The 200-acre site consists of 10 buildings for administration, meals, immigration, import customs, import truck inspection, import exit, bridge administration and toll collection, export customs, export truck inspection, and export exit. The buildings were built within the last 5 years and were in good condition. In addition to building energy end-uses, outdoor lighting was used in the parking and inspection areas. The objective of the survey was to identify cost-effective energy efficiency measures (EEMs). The analysis assumed U.S. labor and materials costs.

Figure 11. Aduana Colombia Offices

Figure 12. Truck Inspection Area

During the one-year period from May 2001 through April 2002, the facility consumed 1,340 MWh of electricity at a cost of $197,700. BVA's analysis indicated that 70% of the energy was used for indoor lighting, 11% was used for outdoor lighting, and 19% was used for HVAC and plug loads. Aduana Colombia's electrical use patterns were consistent with other facilities of this type. The electrical consumption showed almost no weather dependence, which indicated that HVAC is a small part of the electrical consumption.

Two lighting measures were identified for the facility. The lighting recommendations were projected to save approximately 382,800 kWh annually and result in cost savings of $57,400 per year. Implementation costs were estimated at $184,500. The simple payback period is 3.2 years.

The facility was advised to initiate a more detailed analysis to develop firm savings and cost estimates for some measures, as well as obtain equipment and installation cost quotes from several vendors. The cost of these measures could also be lower if Mexican contractors or in-house labor were used.

3.1.4 Considerations for Implementing Projects

The primary considerations for facilities when deciding whether to implement energy conservation projects are the capital costs involved and the availability of technical expertise to implement the projects. For industrial facilities, potential constraints due to requirements of their particular manufacturing processes are also a consideration. Table 12 provides a summary of actions taken at selected facilities audited in the border region from September 2001 to October 2002, as of June 2003.

Table 12. Implementation Status of Energy Project, June 2003

Organization	Operation Type	Recommendations Implemented	Projects Implemented		Projects Committed to Implement	
			Projected Savings (kWh/yr)	Projected Savings ($USD/yr)	Projected Savings (kWh/yr)	Projected Savings ($USD/yr)
Industrial Sector						
Pollack Electronic Products Division	Circuit Board Manufacturing & Assembly	Since our audit, the decision was made to tear down about 1/2 of the plant. Energy measures are on hold until after restructure.	N/A	N/A		
Plasticos Rex	Chemical, Plastic, Fiber Manufacturing	Have changed some motors to high efficiency and will continue to do so. Installed ceiling fans in factory area. Have not upgraded lighting yet, but plan to soon. Plan to implement all of our recommendations.	40,000	$2,000	320,000	$31,000
Aqua Lung de Mexico	SCUBA Equipment Manufacturing	Has been implementing measures. Results have been good with documented savings. Plan to implement more measures over the next month or so.	125,000	$9,000	100,000	$7,500
Mex Securit	Window Manufacturing	Has upgraded fluorescent lighting in offices. Needs project development help with upgrade of factory lighting. Installed cool roof and insulation- Very pleased with results factory area much cooler.	1,800	$200		
GCC Cementos	Cement Manufacturing	They like most of the measures, but need help with project development and financing.	N/A	N/A		
Commercial Sector						
Hotel Camino Real Saltillo	Hotel	No implementation. Report was sent to home office in Mexico City. As yet, they are still reviewing.	N/A	N/A	350,000 + 27,000 therms gas	$50,000
International Trade Facilities Center	Industrial Office Park / Office Space	Have implemented HID lighting measures and are pleased with results. Most of the fluorescent light is relatively new, so they are not interesed in retrofitting it. Interested in generating more projects, possibly cogen. Need help with project development and financing.	125,000	$19,000		
DICEX	Refrigerated Warehouse / Imports	Have not implemented the only measure we recommended. Not interested in modifying new refrigeration equipment.	N/A	N/A		
Nutrimentos Mexicanos	Livestock Feed Production	Have changed some motors to high efficiency and plans to change more. Need help with project development and financing on other measures.	38,000	$2,400	75,000	$4,500
Institutional Sector						
Aduana Colombia	Customs & Immigration Office	Have implemented ~30% of the lighting changes. Will make more when new budget year starts. Changes have been approved.	125,000	$15,500	250,000	$31,000
City of Lemon Grove	Public Government Buildings	Have implemented some lighting retrofits. Need help on project development and financing.	40,000	$6,000		

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Section 4

Partnering Organizations

This section provides suggestions for organizations that are good candidates for promoting, co-sponsoring, or facilitating energy efficiency projects in the border region. These include industry associations, local and state agencies, financing entities, and national agencies. This should not be considered a comprehensive list of candidate organizations.

Selected Maquiladora Associations

<u>Tijuana Maquiladora Association</u>
Asociacion de la Industria Maquiladora Zona Costa de Baja California A.C.
Blvd. Agua Caliente # 10440-6 Edif. Barranquitas Col. Revolucion
Tijuana, Baja California
Phone: (664) 686-1487

<u>Ciudad Juarez Maquiladora Association</u>
Asociacion de Maquiladoras de Ciudad Juarez, A.C.
Av. Antonio J. Bermudez # 3545
Ciudad Juarez, Chihuahua
Phone: (656) 629-2001

<u>Matamoros Maquiladora Association</u>
Asociación de Maquiladoras de Matamoros, A.C.
Phone: (812-1819; 812-1895)
President: Ing. Manuel Antonio Cappella
Executive Director: C.P. Roberto Mattus Rivera

La Asociacion de Tecnicos y Profesionistas en Aplicación Energética (ATPAE)

An industry association of professionals from the energy and energy service companies.

Dulce Navarrete
ATPAE
Phone: 52-55-5611-9352
Email: atpae@atpae.org.mx
Website: www.atpae.org.mx (website is under construction)

Energy Efficiency Industry Partnership in Mexico (EEIP)

Affiliated with the Alliance to Save Energy, EEIP in Mexico helps Mexican enterprises and others to reduce their energy costs, increase their productivity, and decrease their pollution. EEIP has four goals:

- Awareness: Raise the level of awareness and understanding about how saving energy both saves money and protects the environment.
- Access to Technology: Provide Mexican enterprises access to energy-saving technologies and services and sources of financing.
- Capacity Building: Develop the Mexican capacity to deliver energy efficiency products and services.
- Market Development: Promote policies and programs that encourage the adoption and use of energy-saving products and services.

The Energy Efficiency Industry Partnership (EEIP) in Mexico is supported by the Export Council for Energy Efficiency, the U.S. Department of Energy, and the U.S. Agency for International Development.

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Mexican Industry Working Group

Created by the Alliance to Save Energy, this industry working group of more than 20 high-level representatives of energy efficiency companies meets three times a year to discuss the energy efficiency industry's role in Mexico's energy future. The working group has the following goals:

- Communicate the benefits of improved energy efficiency to the nation's environment and economy.
- Promote energy-saving equipment and services as a means to reduce production costs and energy expenses and improve reliability.
- Work with government and non-governmental organizations to engage policymakers on energy and regulatory issues of interest to the energy efficiency industry, such as

utility restructuring, national energy planning, alternative financing, equipment standards, and building codes.

For more information, please contact the Alliance to Save Energy. The border region contact is provided below.

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Mexico Hotel Association (AMHM)

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Tijuana Economic Development Corporation

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Southwest Energy Efficiency Project (SWEEP)

The Southwest Energy Efficiency Project (SWEEP) is a public interest initiative promoting greater energy efficiency in a six-state region that includes Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming.

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Cámara de la Industria de Transformación de Nuevo León (CAINTRA)

CAINTRA is the industrial chamber of commerce in Monterrey. Its mission is to represent, develop, and promote local industries.

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ITESM

The Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), a multi-campus private university based in Monterrey, Nuevo Leon. Various research centers at ITESM, including the Center for Energy Studies, often work in partnership with the government and private-sectors to conduct research and develop projects and programs.

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Border Trade Alliance

The Border Trade Alliance (BTA) is a non-profit organization that consists of public and private-sector representatives including business leaders, chambers of commerce and industry, academic institutions, economic development corporations, industrial parks, transport companies, customs brokers, manufacturers, and federal, state, and local government officials and agencies. BTA is a forum for participants to address key issues affecting trade and economic development in Canada, Mexico and the United States, to improve border affairs and trade relations among the three nations.

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US Mexico Chamber of Commerce (Cámara de Comercio México-Estados Unidos)

This nonprofit business association was established in 1973 as a bilateral organization to promote trade, investment, and joint ventures on both sides of the U.S.-Mexico border. The association has two main offices in Washington, D.C. and Mexico City, as well as regional offices throughout both countries that maintain strong local membership and international contacts to assist businesses in navigating the two countries' legal, regulatory, and economic systems, as well as language and cultural challenges.

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North American Development Bank (NADB)

Based in San Antonio, Texas, the NADB is an international financial institution established and capitalized in equal parts by the United States and Mexico for the purpose of financing environmental infrastructure projects located within the border region. Although NADB's mission has traditionally focused on projects in the area of potable water supply, wastewater treatment, or municipal solid waste management, NADB is currently developing financing tools to help support the energy efficiency and renewable energy market in the focus region as well.

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Nacional Financiera Banca de Desarrollo (NAFIN)

NAFIN is a national bank that provides financing and development services to small- and medium-sized companies.

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Comisión Nacional para el Ahorro de Energia (CONAE)

CONAE is the primary federal government agency responsible for promoting energy efficiency and renewable energy in Mexico. Its activities include promoting the development, production, and use of energy efficient and renewable energy products, equipment, and systems.

CONAE works with government agencies (domestic and international), including SENER, PEMEX, CFE, LyFC, IIE, and FIDE, as well as the private-sector. CONAE's main functions are as follows:

- To participate in the development of national mandatory energy efficiency standards and renewable energy standards, jointly with public administration agencies responsible for enactment of the standards
- To issue energy-efficiency related guidelines, based on existing regulations
- To design and propose to the Executive Branch of the federal government, energy efficiency and renewable energy programs (including operation, investment, and financing) required in the short, medium, and long term
- To promote and support technology research and development related to energy efficiency and renewable energy
- To garner financial resources for the implementation of energy efficiency and renewable-energy related activities
- To provide technical assistance and support services on energy efficiency and renewable energy issues
- To compile, analyze, and disseminate information related to energy efficiency and renewable energy
- To promote and disseminate information pursuant to its objectives, through official, federal broadcast spaces in radio and television networks
- To promote energy efficiency in coordination with federal and state government activities, and with the participation of social and private-sectors
- To facilitate, according to the applicable legal framework, the participation of private enterprises and consulting firms specialized in energy efficiency
- To design national programs on energy efficiency and renewable energy for consideration and approval by SENER.

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Investment Promotion Office (UPI)

The Ministry of Energy (SENER) provides assistance to investors interested in participating in Mexico's energy sector through private projects through the Investment Promotion Office (UPI). The UPI is responsible for facilitation, advisory and information services pertaining to investment opportunities, in addition to providing information allowing investors to appraise and develop projects in the energy sector as allowed by the legislation in force. The UPI is located on the 4th floor of the Ministry of Energy's building.

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Section 5

Challenges to Implementation

As illustrated in Section 3, the border region contains ample opportunities to reap energy savings in a range of customer sectors. Manufacturing and commercial establishments are particularly predominant in the region, and cost-effective energy efficiency projects with payback periods typically under 6 years are easily identified for industrial, commercial, and institutional facilities. Total savings potential based on the data provided in this study is approximately 818,800 MWh. Nonetheless, only a fraction of this savings potential is realized due to regulatory, economic, technical, and institutional challenges.

Program Funding. According to CONAE staff, another primary barrier to implementing energy efficiency projects is that public agencies have limited financial resources to promote these programs and projects.[113]

Customer Financing. Based on the WGA's energy audits, the majority of energy efficiency improvements in the border region are likely to result in annual cost savings of less than $50,000 and cost less than $100,000 to implement. As indicated by our survey of implementation results following the energy audits, although energy efficiency projects are often cost-effective investments, financing the projects can be problematic. Projects of this size are not generally of interest as financing opportunities for most commercial banks, particularly if they are difficult to collateralize.

Companies that spend their own funds on energy efficiency projects, do so for only very small projects. Thus, end-users ranging from small and medium-sized businesses to large end-users lose opportunities to make cost-effective investments in energy efficiency due to lack of financing. Companies that are able to obtain outside financing typically use debt financing or work with an energy service company to fund energy efficiency projects. Funding per company may vary from $100,000 to several million dollars.

Institutional customers, such as local governments, are also hampered by lack of financing. Most local Mexican communities have virtually no experience with debt financing and are prevented by Mexican law from incurring debt in foreign currencies or with foreign institutions. The lack of local capacity to design and finance major infrastructure underscores the need for continued decentralization from federal to state governments and enhanced technical assistance and training to local communities.

Customer Awareness and Knowledge. At the inception of the Border Energy Project in 1999, the Western Governors' Association conducted focus groups in Mexicali and Ciudad Juárez to better understand the needs and obstacles in implementing energy savings projects within their organizations. The participants stated that pertinent information and professional contacts for understanding energy savings opportunities that were relevant to their industries and geographic regions were either difficult to locate or unavailable. Secondly, there were very limited demonstration sites to visit and a scarcity of knowledgeable people who had worked on design and implementation of energy savings projects.

Furthermore, customers have limited access to facility-specific data regarding typical energy consumption and potential energy savings. Although customers have access to their own utility bills, they are not likely to have access to energy use data for other facilities similar to their own, nor other facilities similar to their own that have implemented energy efficiency projects. This makes benchmarking the facility's utility costs difficult and also diminishes the likelihood that the facility will take the initiative to seek out energy cost savings.

In response to the results of the focus groups, WGA created the www.borderenergy.org bilingual website and conducted a series of audits of facilities that are anticipated to become model demonstration sites. Still lacking is end-user knowledge, broad access to benchmarking data, and local initiative and control that promotes information dissemination, project design, project financing, and project implementation.

Technical Assistance. Related to the need for increased customer awareness and knowledge is that customers often lack in-house expertise and/or available staff to conduct audits, identify solutions, analyze the economics, and understand possible technology and financial risks. Many customers also find the prospect of selecting reliable energy service companies to do this work daunting or lack the capacity to adequately structure solicitations. This sentiment was reinforced during the survey of audit implementation results, when a number of customers cited a need for project development assistance. Therefore, opportunities to save energy and reduce operating costs remain unexploited.

Undeveloped Energy Services Industry. Business models and solutions for delivering energy efficiency services are still being developed on the Mexican side of the border region. Few industry associations, such as ATPAE, have been established to standardize industry offerings and service delivery mechanisms. This limits customers' exposure to energy efficiency concepts and lowers their likelihood of implementing projects.

Lack of Market Data. Detailed data about key energy using sectors, the location and type of prospective facilities, their energy use characteristics and potential savings, and facility contacts is not widely available. Although data is available on a state-wide level regarding total energy use and the number of customer accounts under each rate schedule, the information must be disaggregated to the local level to be used effectively. Moreover, information about specific types of facilities that fall under each rate schedule is not widely available. For energy service companies, energy program sponsors, and other likely project proponents, this lack of local market data about energy end-users is a barrier to effectively targeting their energy efficiency services.

Project Champions. Although ample opportunities exist for cost-effective energy efficiency improvements, many of the individual opportunities identified in the audits were expected to result in cost savings of less than $50,000 annually. Implementing these relatively small projects and continuing to pursue energy savings opportunities on an ongoing basis requires a "Project Champion" that is typically missing in an organization. Moreover, based on WGA's energy audits conducted in the border region, it appears that maquiladoras tend to pursue environmental projects less aggressively than their Mexican-owned counterparts. The remote ownership and management in the maquiladoras is likely to contribute to this trend.

Regulatory Environment. According to CONAE staff, among the primary barriers to implementing energy efficiency projects are the cumbersome procedures and requirements established in the energy sector's current regulatory framework.[114] Cogeneration projects in particular must follow a number of procedures and requirements, including complying with electricity wheeling tariffs. According to CONAE staff, these requirements tend to dissuade investors from implementing even profitable projects.

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Section 6

Summary of Findings

Electricity demand is expected to grow at an annual rate of 4.7% to 6.3% in Mexico, and the industrial sector is responsible for 59% of Mexico's electricity consumption. The border states, which represent a significant economic force in Mexico, are responsible for 34% of the nation's total energy use. The growth in energy demand in the Mexican border region is forecasted to grow 5.7% to 6.5% annually. About 71% of Mexico's maquiladoras are located in the border region, and manufacturing maquiladoras alone represent one-third of the region's electricity consumption.

New electricity generating capacity is expected to meet the increased industrial demand and population growth in Mexico only through the next three years. Moreover, domestic fuel supplies for electricity generating facilities, which are becoming increasingly dependent on natural gas and LNG, are not keeping pace with demand. The price of natural gas may rise as much as 48% for power generators if U.S. reserves remain low and other sources of natural gas are not found.

Although utility reform in both the electricity and natural gas sectors is expected to be initiated in the border region, lag time for construction of new power plants and development of new natural gas sources and LNG facilities can be expected. These factors bring into question the continued availability and future cost of electricity in the border region. Therefore, energy conservation, distributed generation, and renewable energy must become an integral component of future energy policies and must play a key role in meeting the region's energy needs.

Based on available data and the savings estimates provided in this report, the manufacturing and assembly subsector has the greatest opportunity for energy savings in the highlighted regions. This is followed by educational facilities, hospitality establishments, health care/hospitals, and government facilities.

Potential annual energy savings for manufacturing facilities in target regions were estimated at 434,600 MWh and annual cost savings were estimated at $22.8 million in this sector. Cost-effective lighting, HVAC, and process improvements were identified for all audited manufacturing facilities: average energy savings are estimated at 26% and project payback periods range from 1.3 to 6.0 years.

Three of the largest population centers in the border region – Tijuana, Ciudad Juárez, and Matamoros – are highly industrialized. Electricity consumption is expected to rise 6% to 8% annually in states where these cities are located. This represents a doubling in annual energy consumption from 22,600 GWh to 45,200 GWh within 12 years.

Manufacturing, which includes the majority of maquiladora operations, comprises 33% of the employment in Tijuana, 46% in Ciudad Juárez, and 40% in Matamoros. Production and assembly of electronic, electrical, and automotive products is predominant in all three cities. Future energy efficiency programs are advised to target these manufacturing subsectors in these cities. Tables 13 and 14 summarize the estimated energy and cost savings.

Table 13. Summary of Energy Savings Estimates

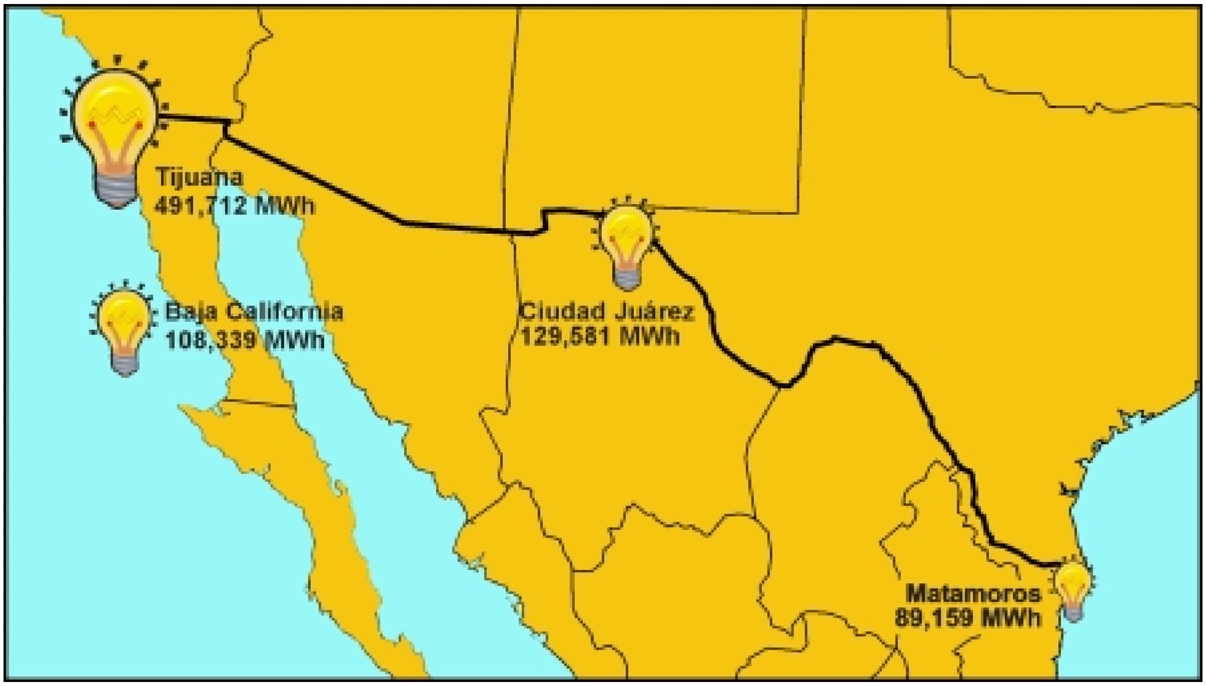
	Potential Savings (Annual Megawatt-Hours)				
	Tijuana	**Ciudad Juarez**	**Balance of Baja California**	**Matamoros**	**Total**
Manufacturing and Assembly	171,471	104,123	108,339	50,659	**434,592**
Education	188,270	N/A	N/A	10,468	**198,738**
Hospitality (Hotels and Motels)	55,832	25,458	N/A	19,867	**101,157**
Health Care / Hospitals	76,139	N/A	N/A	3,768	**79,907**
Government	N/A	N/A	N/A	4,396	**4,396**
Total	491,712	129,581	108,339	89,159	**818,791**

Table 14. Summary of Energy Cost Savings Estimates

	Potential Savings (Annual Dollars)				
	Tijuana	**Ciudad Juarez**	**Balance of Baja California**	**Matamoros**	**Total**
Manufacturing and Assembly	$9,123,950	$5,353,563	$5,764,742	$2,606,676	**$22,848,931**
Education	$10,290,673	N/A	N/A	$551,394	**$10,842,068**
Hospitality (Hotels and Motels)	$3,051,709	$1,331,845	N/A	$1,046,506	**$5,430,060**
Health Care / Hospitals	$4,161,669	N/A	N/A	$198,502	**$4,360,171**
Government	N/A	N/A	N/A	$231,586	**$231,586**
Total	$26,628,002	$6,685,408	$5,764,742	$4,634,664	**$43,712,816**

The regions ranked by their potential energy savings are Tijuana, Ciudad Juarez, the balance of Baja California, and Matamoros. Figure 13 illustrates these results. Energy service companies, energy program sponsors, and other likely project proponents are advised to focus future efforts in these sectors and regions.

Figure 13. Potential Annual Energy Savings, By Target Region



We offer these key additional findings:

- **High Population Growth.** Population growth on the U.S. side of the border is projected at 1.8% to 2.7% over the next two decades, whereas the nation's growth as a whole is projected at 1.0%. Population growth on the Mexican side of the border is projected at 3.5% to 4.6% over the next two decades, whereas the nation's growth as a whole is projected at 1.2%.

- **Growth in U.S. Energy Use.** The growth of energy use in U.S. border states is projected to increase by 0.1% to 3.9% depending on the customer sector and state, and residential, commercial, and industrial customers consume between 21% and 39% of the total electricity used. Therefore, future energy efficiency programs should focus on a range of customer sectors.

- **Significant Manufacturing Employment.** In the 1990's, annual employment growth on the Mexican side of the border was 5.9% to 6.8%, versus 4.5% to 4.7% in the nation as a whole. Manufacturing employs over 28% of the Mexican workforce, and the border region contains 11.6% of this manufacturing workforce. With the exception of Sonora, border states have a higher concentration of workers in the manufacturing sector than the national average.

- **Vital Maquiladoras.** Maquiladoras are a critical element of the Mexican economy. These facilities are under pressure to remain competitive against cheaper labor from China, as evidenced by the reduction in the number of facilities and employment in this sector.

- **Border Air Quality.** Point sources of air pollution in the border region include maquiladoras, Mexican national industries, commercial activities and businesses, and power generation plants. New energy projects driven by the energy needs of the region may have additional impacts on the region's air quality if they are not mitigated.

- **Challenges to Implementation.** Challenges to implementing potential energy efficiency projects include a lack of program funding for implementing agencies, a lack of financing options for interested customers, a lack of awareness and technical knowledge among potential customers, insufficient technical assistance for project identification and evaluation, an undeveloped energy services industry, insufficient market data to target services to appropriate sectors, difficulty in establishing project proponents within customer organizations, and a regulatory environment that hampers private energy projects.

- **Collaboration Necessary.** Some precedent has been set in Mexico for state-sponsored energy efficiency programs for the public and private-sector. Bi-lateral energy efficiency programs between the U.S. and Mexico have also been established. However, increasing efforts in this area requires increased program financing options, a more favorable regulatory environment that facilitates participation in project development and investment from the private-sector, and further collaboration between potential program sponsors to promote the use of efficient energy practices and innovations.

- **Summary of Sector Energy Savings.** Exploiting the available opportunities for cost-effective energy efficiency projects could result in annual energy savings of approximately 434,600 MWh and cost savings of about $22.8 million in the industrial (manufacturing) sector, 101,200 MWh and cost savings of $5.4 million in the commercial (hospitality) sector, and 283,000 MWh and cost savings of about $15.4 million in the institutional (health care/hospitals, government, and education) sector in the target regions.

- **Commercial Sector Opportunities.** In the commercial sector, cost-effective lighting, HVAC, and central plant improvements were identified for all audited facilities: average energy savings are estimated at 30% for facilities in this sector, and project payback periods range from 1.5 to 10.1 years.

- **Institutional Sector Opportunities.** In the institutional sector, cost-effective lighting, HVAC, and central plant improvements were identified for all audited facilities in this sector: average energy savings are estimated at 21% for facilities in this sector, and project payback periods range from 3.2 to 6.0 years.

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Section 7

Recommendations

This report estimates a market potential for cost-effective energy efficiency projects with annual energy savings of approximately 434,600 MWh and cost savings of about $22.8 million in the industrial (manufacturing) sector, 101,200 MWh and cost savings of $5.4 million in the commercial (hospitality) sector, and 283,000 MWh and cost savings of about $15.4 million in the institutional (health care/hospitals, government, and education) sector in the target regions.

As discussed in Section 4, several challenges present barriers to successful identification and implementation of energy efficiency projects. Following are recommendations targeted at energy efficiency advocates for overcoming these challenges.

Program Funding. Assist local agencies in identifying and utilizing financing sources for program support. This may include seeking debt financing through multi-lateral banks such as the North American Development Bank (NADB) or applying for grants from programs and agencies that target specific regions, customers, or project types. See Sections 2.2 and 4.0 for information on possible funding sources.

Customer Financing. Create an intermediary organization that can administer a revolving loan fund with low interest rates to support energy efficiency projects in the border region. This would be instrumental in implementing many smaller projects. Also assist interested customers in identifying and utilizing financing alternatives beyond their own operating and capital budgets. This may include soliciting performance contractors or applying for grants from programs and agencies that target specific regions, customers, or project types. Some customers, particularly maquiladoras that have absentee owners, may also need assistance in developing financially sound analyses to gain initial approval from decision-makers. See Sections 2.2 and 4.0, as well as the customer financing section of the Border Energy website (www.borderenergy.org/html/financing.htm), for information on possible funding sources.

Customer Awareness and Knowledge. Work with the local maquiladora associations and economic development agencies to develop a local marketing plan that promotes and facilitates project development. Energy efficiency improvements may advance the competitiveness of local industries and businesses, as well as help protect them against future energy price volatility and supply problems. These may be motivating factors for the participation of local organizations.

This grassroots, local approach will allow local business communities to design the most appropriate method of communicating information to their constituents and communities – essentially establishing a network that works best for their industries and regions. These local groups may also have more credibility among the target customers and may identify and implement projects more efficiently than outside organizations. These teams should be comprised of a limited number of local businessmen, government leaders, and community organizations interested in improving air quality and/or reducing energy consumption in the border region.

These local organizations would require funding to develop local marketing programs, which may include demonstration facility tours, seminars, and public relations campaigns. These organizations should also have access to technical support to help them design effective programs, understand the costs and responsibilities associated with implementing programs, and measure program results. Initially, funding for these activities may come from government and industry associations.

WGA is currently designing a program to address this need. The Border Energy Regional Advocacy Roundtable Program (BEAR Program) is expected to assemble working groups in key areas of the border region to provide a forum for discussing needs and initiating programs.

At the individual customer level, an interactive tool should be developed that allows a customer to benchmark its facility's energy use against similar facilities in its region. The tool should also provide information about energy efficiency improvements that similar facilities in the region have undertaken and the associated energy savings. A tool similar to this is currently provided online by the EPA for facilities located in the U.S. at http://208.254.22.6/index.cfm?c=business.bus_index. This type of information can encourage customers to seek out energy savings.

Technical Assistance. Sponsor a pool of third-party technical experts to serve as owners' representatives and to provide expertise and technical support to in-house staff. These experts would be restricted from participating as project implementers. Their role would be to identify project opportunities and assist customers in soliciting and contracting with reliable project implementers.

For customers interested in turn-key energy efficiency projects, this technical support may include assisting the customer to explore performance contracting options. In general, this involves contracting with an energy service company that will evaluate energy-saving opportunities at a facility and recommend improvements. The energy service company finances all of the project costs, including up-front engineering, construction, and maintenance services. The annual payments for the project implementation costs are then paid by the project savings, typically over a contract term of seven to ten years. If savings (typically measured in energy savings as opposed to cost savings) are less than expected, the energy service company pays the difference. Measurement and verification, as well as adherence to a maintenance plan, are often required as part of the performance contract.

Undeveloped Energy Services Industry. Develop business models for delivering energy efficiency services to the private sector in Mexico. Support the development of energy service industry associations to standardize business practices and help establish service delivery methods.

Lack of Market Data. Collaborate with national agencies such as CFE, CONAE, and FIDE to extract and make available, useful energy consumption data at the local level that is classified by sector and subsector. This would allow efforts to improve energy efficiency to be targeted at key energy using sectors in specific regions. Work with industry associations and local economic development agencies to develop and make available, customer databases in the key energy using sectors at the local level. The databases should include the number, type, and general location of facility operations (if identifying data is restricted).

Project Champions. Develop a coaching system as part of the local BEAR teams. This system may provide designated resources in each target area to guide interested facility managers through the process of obtaining information, technical expertise, and implementation assistance. These "coaches" would have no self-interest in the projects, and their sole purpose would be to assist facility managers and aid in completing projects successfully. As the success of the BEAR teams grows, local teams can also provide mentoring and local demonstration sites.

Regulatory Environment. Monitor regulatory developments in energy utility reform. As discussed in Section 2, a movement towards increased participation from the private-sector in the area of investment and energy production is evident in the Mexican energy industry. Sponsor lobbying efforts to allow accelerated and expanded participation from the private-sector, which may include end-use customers capable of financing their own cogeneration, energy efficiency, and renewable energy projects.

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