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Energy Efficiency in the Northern Border States: Cooling Device Replacement

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Abstract

Northern Mexico is a predominantly hot and dry region, making cool air a basic necessity. Cool air is generally provided by devices that require electricity. In northern Mexico the acquisition and use of oversized, second-hand appliances imported from the United States at very low prices is widespread. This results in the northern border's residential sector consuming the highest levels of electricity in Mexico. High electricity use has a significant impact on the economy and the population's income. In addition, because power is generated primarily by fossil fuel plants, electricity use in northern Mexico has a great impact on air quality and water consumption in the region. An appliance replacement program, in particular for air conditioners and refrigerators, in the northern states would yield important environmental and economic benefits for the region. This chapter analyzes the problem of low energy efficiency in residential air conditioning in Mexico's northern states, identifies the opportunities for existing regulations and institutions to help solve the problem, and outlines a recommended mechanism for the development of a large-scale program to replace inefficient refrigerators and air conditioners currently used in the region.

Eficiencia Energética en los Estados del Norte del México: Reemplazo de Refrigeradores y Aires Acondicionados

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Resumen

El norte de México es una región predominantemente árida y calurosa, causando que el uso de aire frío se convierte en una necesidad básica. El enfriamiento de aire se obtiene principalmente de equipos que consumen energía eléctrica. En el norte de México es común la práctica de adquirir y utilizar equipos baratos, de segunda mano, ineficientes y de capacidad mayor a la requerida, provenientes de los Estados Unidos. Esto provoca que en la zona se presenten los más altos índices de consumo eléctrico en el sector residencial de todo México. Esta mayor intensidad de consumo eléctrico tiene fuertes impactos económicos y en el ingreso de la población. Además, como la electricidad es principalmente generada por plantas que consumen combustibles fósiles, el consumo de energía eléctrica en el norte de México tiene importantes impactos en la calidad del aire y en el consumo de agua en la región. Por lo anterior, un programa para reemplazar los equipos ineficientes en el norte del país, en particular refrigeradores y aires acondicionados, representaría importantes beneficios económicos y ambientales. Este trabajo analiza el problema de los bajos niveles de eficiencia en el uso residencial de aires acondicionados en los estados del norte de México e identifica las oportunidades que las instituciones y regulación existentes ofrecen para resolver el problema, y describe un programa a gran escala para reemplazar refrigeradores y equipos de aire acondicionado actualmente usados en la región.

Introduction

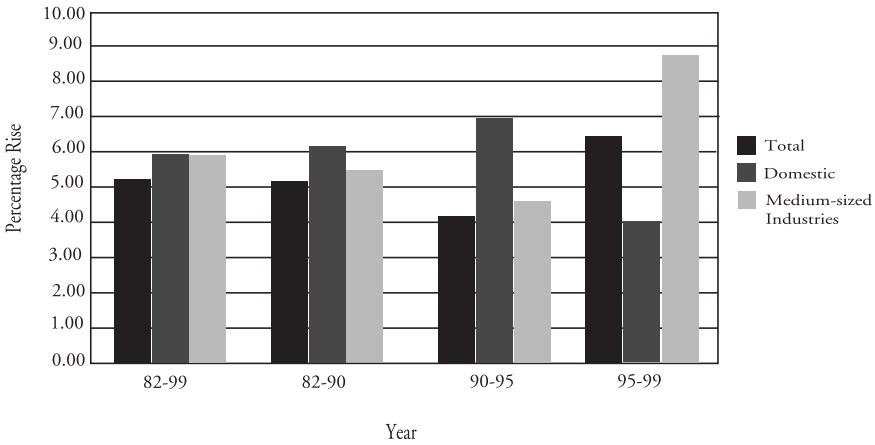
There are significant opportunities to increase energy efficiency in Mexico's Northern Border States (NBS). Higher energy efficiency improves levels of comfort, reduces electricity bills, increases disposable income, and reduces negative environmental impacts that result from the generation of electricity. The chapter discusses why, in spite of the successful application of programs that reduced electricity consumption in the country from 1995 to 1999, consumption in the NBS is still increasing quickly. This chapter also discusses the circumstances and patterns of use of cooling devices in the NBS and their estimated environmental costs. Finally, it describes a program that may further improve the quality of life of citizens at the U.S.-Mexican border.

Mexico's Northern Border States

The Mexican side of the border with the United States comprises six states: Baja California, Sonora, Coahuila, Chihuahua, Nuevo León, and Tamaulipas. These states have a total population of 16.6 million, equivalent to 17% of the national total (Instituto Nacional de Estadística Geografía e Informática [INEGI] 2000). About 68% of this population lives in urbanized counties with more than 500,000 inhabitants (INEGI 2000).

Electricity consumption growth rates in the NBS have been higher than in the rest of the country (Figure 1). From 1982 to 2001, the share of total electricity consumption in the six northern border states has risen from 27% to 32% of the national total. Consequently, meeting electricity demand has become a challenge for the Mexican electricity sector, one that requires important investments to secure adequate electricity supply as well as consideration of the environment.

Figure 1. National Electricity Sector Annual Growth Rates



Demand growth is due, first and foremost, to the industrial development of the region. This is chiefly reflected in the growth of medium-sized export-oriented manufacturing industries. These industries represent one-third of the region's electricity consumption—44% in the case of Chihuahua—and are responsible for creating a demand growth rate that is double the country's rate.

Electricity consumption in the residential sector also explains the demand growth in the region. The total number of residential electricity users in the region exceeds 3.9 million (Comisión Federal de Electricidad [CFE] 2001), accounting for 89% of the total users in those states. Although in 1999 the NBS accounted for 17% of the national population and held one-fifth of the total residential users in the country, its national share of residential electricity consumption was 32.3% (CFE 2001). Furthermore, there are 3.25 million residential electricity users under hot-weather rates and residential electricity use in the region represents 55.6% and 82.6% of the nation's electricity consumption under the two highest hot-weather electricity rates.[1] The hot and dry climate conditions of the region cause electricity consumption to be significantly higher in the summer.[2] Peak load occurs on summer afternoons from June to September because of air conditioning use (Figures 2 and 3).

Figure 2. CFE Northeast Division Sales

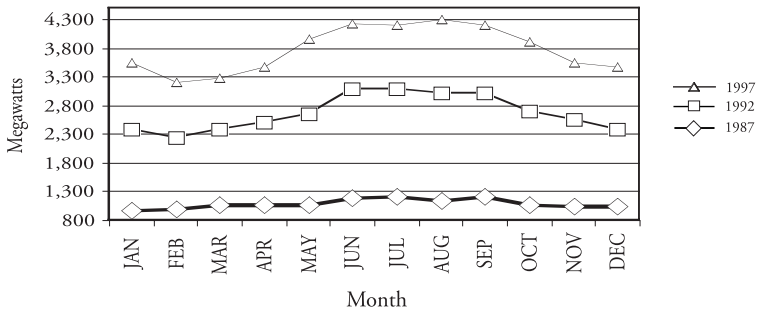
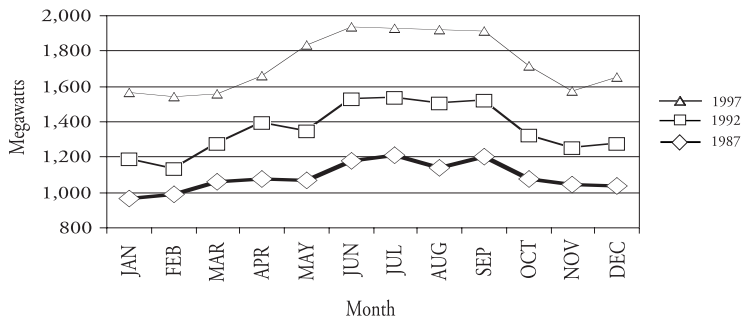


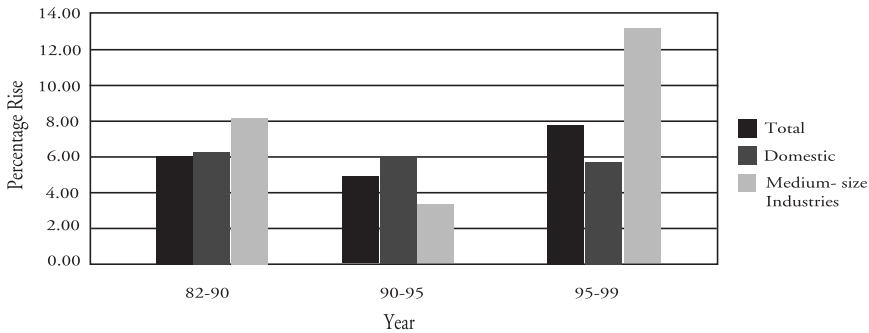
Figure 3. CFE North Division Sales



In addition to the region's climate and the importance of cooling devices, northern Mexico is an important market for low-priced second-hand appliances from the United States. These normally use more energy than new appliances. The acquisition and use of oversized, second-hand air conditioning units is common in the border region. Lack of energy efficiency measures integrated into construction standards further promotes use of inefficient appliances. A clear sign of this problem is the difference in growth rates of electricity consumption in the residential sector in the region compared to the growth rates in the residential sector at a national level. Nationally, as a result of energy efficiency programs, residential consumption was notably lower than that of all other electricity users from 1995 through 1999 (Figure 4). In the NBS however, the rate of growth in the residential sector was not reduced in the same period. As noted

previously, this is explained by the extensive use of second-hand appliances from the United States.

Figure 4. Northern Border States Annual Growth Rates



The City of Mexicali as a Case Study

In Mexico and in the NBS, the city with the highest level of residential energy consumption is Mexicali, located south of California's Imperial Valley. With nearly 800,000 inhabitants, Mexicali is the third largest city along the U.S.-Mexican border. It has a relatively important agricultural and industrial base. Although there has been no research on potential electricity savings in the NBS region, studies for the state of Baja California, and particularly Mexicali, can be used to estimate possible impacts of a large-scale program.

A 1990 study showed electricity used for air conditioning in Mexicali is influenced by the characteristics of the dwelling and the system used to provide cool air. Houses in Mexicali have characteristics that necessitate large cooling loads (De Buen 1992). The same study found an estimated two-thirds of residential customers have evaporative coolers and one-third have compressor-based units. The study also suggested a large fraction of compressor-based air conditioning units installed in Mexicali are "bought used through a well-established market that brings discarded equipment from the U.S. ... and the only test performed on the equipment is to demonstrate its ability to provide cool air." According to observers, truckloads of appliances are bought in Calexico, California, and sold in Mexicali for less than one-third the price of new appliances of the same size (de Buen 1993).

In Mexicali, according to the study, "The cheapest first-cost option for residential air cooling is the most energy-inefficient ... A used compressor-based unit is up to five times cheaper than a new one and also cheaper than an evaporative cooler." Another important conclusion of the study was that "this is also the option with the highest operating cost per unit of heat removed: the cost per year of operating a used air conditioner can be more than twice the price paid for the device." Consequently there exists a large potential for energy conservation and possibly increased comfort by replacing the low-efficiency air conditioning units currently installed.

According to the study, replacing old air conditioners with new units would increase the average EER[3] from 6 to 12[4] and reduce approximately 60% of the electricity consumption, assuming levels of comfort remain constant.[5] This would reduce demand an estimated 1.5 kilowatts (kW), or 82.5 megawatts (MW) (assuming all air conditioning units are on at the same time) per customer, and would avoid annual generation of 210.4 gigawatts (GWh), considering 15.31% of transmission and distribution losses are from gross electricity generation (Secretaría de Energía [SE] 1998). If Mexicali represents 5% of the NBS population, with 50% less consumption per household throughout the region, possible avoided generation for those states could reach 2,000GWh per year. This has a value, in real costs, of about $200 million.

Economic and Environmental Aspects

The principal environmental effects of electricity consumption in the northern states result from a high percentage of fossil-fuel-based generation. There are six important fossil-fuel powered generating plants with 4,738MW in capacity, equivalent to 14.33% of the country's total (SE 1999), located in the border region.

Fossil fuel power plants not only cause air pollution, but they also consume significant water quantities. According to Pace University estimates, each gigawatt generated in a fossil fuel plant releases 800 tons of carbon dioxide (CO_2), 11 tons of sulfur dioxide (SO_2), and 1.7 tons of nitric oxide (NO_x) into the atmosphere. In a system that cools by evaporation, 500 cubic meters of water are required for

every gigawatt produced.

The United States has designed policies to address the pollution problem. California, a state with some of the highest levels of air pollution in the country, enacted the Clean Air Act in 1988 to establish procedures to attain higher air quality. In 1990 the California Energy Commission (CEC) directed that "all costs and emission impacts of compliance with air quality regulations be accounted for in the analysis of the cost effectiveness of power generation." CEC also specified externality values for five categories of emissions, based on the estimates of the marginal cost of the best available control technology (Energy Information Agency 1995).

Pace University estimates of emissions per gigawatt and the costs of the best available control technology as specified by the CEC[6] show that for every gigawatt generated there is an environmental cost of more than $60,000 (U.S. Energy Information Agency 1995).[7]

The monetary environmental value for the 210.4GWh of avoided annual generation for the NBS, mentioned in the previous section, would be $133 million. This environmental value is equivalent to the price of 16,613 new air conditioning units. The same 16,613 air conditioning units are equivalent to 30% of the compressor-based air conditioning stock currently installed in Mexicali.

Substantial investment is needed to install new power plant capacity to meet the demand created by the growing number cooling-device users. The cost of each new megawatt installed can be in the range of $650 to $1,000. The estimate for the avoided demand detailed above is 82.5MW.

Institutional Capacities and Energy Efficiency Program Experience in Mexico

Since 1995 several actions and programs have notably reduced the rate of growth of residential electricity consumption. Three of these, in order of importance, are:

- Comisión Nacional para el Ahorro de Energía (the National Energy Conservation Commission, in Spanish CONAE) has invoked in the last six years a wide array of mandatory ener gy efficiency standards for equipment and systems commercialized in Mexico, such as refrigerators, air conditioners,

clothes washers, and water pumps.
- Daylight Savings Time, first introduced in 1996, reduces electricity demand and consumption in peak hours when electricity is more expensive to generate.
- CFE and the Fideicomiso para el Ahorro de Energía Eléctrica (Electricity Savings Trust, in Spanish FIDE) have developed programs such as CFE's roof-insulation and compact fluorescent lamp programs and FIDE's incentive program.

More specifically, CFE has been working since 1980 to improve the efficiency of its electricity customers. Through its programs, it has become an outstanding marketer of efficient appliances and materials for energy efficiency. CFE has set up several trust funds, such as FIDE and Fideicomiso para el Aislamiento Térmico (FIPATERM), to operate its programs.

FIDE is a private trust created in July 1990 to "support actions that induce and promote electricity savings." Its funds flow from CFE, its contractors, and its own union. In 1996 FIDE began a market transformation program to reduce electricity demand by providing monetary incentives for purchase and installation of high-efficiency equipment by industrial, commercial, and residential electricity users. In 1999 FIDE's incentive programs fostered savings of 554GWh of electricity consumption and 152MW of avoided capacity (CONAE 2001).

FIPATERM is a program managed by CFE. Its main objective is to foster the massive installation of thermal insulating material in households with high electricity consumption in northwestern Mexico. Its thermal insulation program has allowed the insulation of 59,426 households, creating an annual savings of 31.6GWh and 22MW of avoided capacity (CONAE 2001). Last year FIPATERM also began providing financial support for door and window insulation and compact fluorescent lamps (CFLs).

Actions undertaken by FIDE and FIPATERM have resulted in annual savings of more than 140GWh. In particular, FIDE has helped replace 3.2 million light bulbs with CFLs in 134 cities of 22 states (CONAE 2001), all paid through CFE bills. CFE has the institutional and technical infrastructure and the experience to develop and implement large-scale programs for the NBS.

CONAE

CONAE is the wing of the Ministry of Energy that focuses on the development of energy efficiency programs and the promotion of renewable energies. In addition to its involvement in the development of energy efficiency standards, one of its main functions is to link actors to promote energy efficiency. Recently CONAE held a meeting with the main stakeholders to discuss developing an energy efficiency program in the NBS. Participants included appliance manufacturers, CFE, FIDE, consultants, and development banks.

A Program to Replace Air Cooling Devices in the Border Region

The first step should be to conduct a well-designed survey to provide relevant socio-economic information, including average income per household, average electricity consumption, electricity consumption costs per household, average type and patterns of use of existing cooling devices, and consumer willingness to participate in a program.

The information collected would be used to develop a draft blueprint with objectives, strategies, and actions; a scope and time frame; an evaluation mechanism; and tasks to be performed by stakeholders. The information collected would determine which locality should start a program, the feasibility of a program, and what financial arrangements are required to develop a program. The information would also be useful to estimate the direct and indirect benefits of a program.

Two actions are crucial for a program's success: Finding both national and international mechanisms to preclude introduction and use of discarded air conditioners[8] and procuring participation of relevant experienced institutions and achieving consensus and cooperation of stakeholders and international institutions.

The main actors—CONAE; CFE; FIDE; local governments; federal agencies such as the treasury, energy, environment, and commerce ministries; manufacturers; wholesalers; national and international development banks; international agencies; and consulting

firms—should achieve consensus. Relevant organizations should discuss the draft blueprint and participate in the program's design, operation, and evaluation.

Conclusions

There are great opportunities to increase the quality of life in Mexico's northern border states by promoting energy-efficient cooling devices like air conditioners. The program presented here aims to improve economic conditions, increase levels of comfort, and reduce the negative environmental impacts of electricity generation.

The program proposed here requires the consensus of many actors, including the government, manufacturers, development banks, consultants, the national utility, FIDE, and CONAE. The program should be initiated by conducting a well-designed survey and involving all relevant institutions. It is also important to put into effect both national and international mechanisms to preclude introduction and use of discarded appliances from the United States.

Endnotes

[1] Electricity in Mexico is sold under 20 different rates, six of which apply to residential customers depending on climate. The first is Rate 1, which is applied for temperate climates; the other five are for hot climates (1-A, 1-B, 1-C, 1-D, and 1-E). Rates for hot-climate users apply only from May to September; all residential customers are under Rate 1 for the remainder of the year.

[2] The average residential unit consumption in the region (233 kilowatt hours [kWh] per year) is 66% greater than the national average. Average unit consumption under the 1-D rate is 62.7% higher than the national average for that rate, and 46.1% higher than the national total under the 1-E rate.

[3] The EER is equal to the heat extraction capacity of the compressor-based air conditioning unit in British thermal units per hour (Btu/h) divided by the power of the motor of the compressor (in watts).

[4] The assumption made to calculate savings potential is based on the electricity consumption of a Mexicali's average air conditioning unit (1.5 Ton, EER=6, unit) and it is used by 30% (55,000) of the households.

[5] According to the survey used for the study, a used 2.4 kW, 1-ton EER=5 unit would consume 5,184kWh per year while a new 1kW, one-ton EER=12 consumes 2,160kWh per year. Estimations are made considering 12 hours of use per day and 180 days of use per year.

[6] These numbers were first used in California in its 1993 planning process. For simplicity this chapter will not take into consideration inflationary adjustments or improvements in cost and technology.

[7] California requires utilities to consider quantitative estimates of externalities. The 1992 values of San Diego Gas and Electric, which provides electricity to the San Diego border region, are as follows: \$31,448 per ton of NO_x; \$9 per ton of CO_2 . As California does not specify enternality's monetary values of SO_2, New York's value (\$2,500 per GWh) was used.

[8] Air conditioners in Mexico have an import tariff (ad valorem) of 20% per unit, except for imports coming from the United States, Canada, Bolivia, Costa Rica, and Chile, for which there is no tariff, thanks to free trade agreements. Countries such as Colombia and Venezuela can export air conditioners to Mexico with a preferential tariff of 7.2% to 5.7%. Hotels, restaurants, and other service businesses located in the border region and registered at the Ministry of Economic Affairs can import air conditioners with a preferential tariff.

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