Energy efficiency in North America: Evolution and perspectives

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1. INTRODUCTION

Energy efficiency

The biggest untapped source of energy we have available to us is the energy we waste. Using energy wisely to make sure our energy supplies go further yields huge benefits for all energy end-users. Consumers reap significant dollar savings while business and industry see increased profits and productivity. However, the biggest impact of our investments in energy efficiency is reduced air pollution and greenhouse gas (GHG) emissions that affect our environment and health.

Saving energy and being more energy efficient without compromising our lifestyle is simple. There is a good amount of energy that we are using inefficiently and that we can save at a lower cost than supplying it. Changing some of our behaviors and with the technology already available in the market we could save more than 20% of what we already consume without reducing the services we get from conventional sources of energy. [1,2]

Increasing the efficiency of energy use in North America will provide a broad range of benefits, including:

- Saving consumers and businesses money on their energy bills;
- Reducing dependence on imported fuel sources;
- Reducing vulnerability to energy price spikes;
- Reducing peak demand and improving the utilization of the electricity system;
- Reducing the risk of power shortages; and
- Reducing pollutant emissions by power plants and improving public health.

Energy supply and consumption in North America

North America consumed 120,000 PJoules of energy in 2004, representing almost 27% of the world's total (Fig. 1).[3] Of this share, the U.S. accounts for 84% of North American consumption, followed by Canada (11%) and Mexico (5%).

Of this consumption, oil accounted for 40.5%, natural gas 25%, coal 22%, nuclear energy 7.5% and hydroelectricity 5%.

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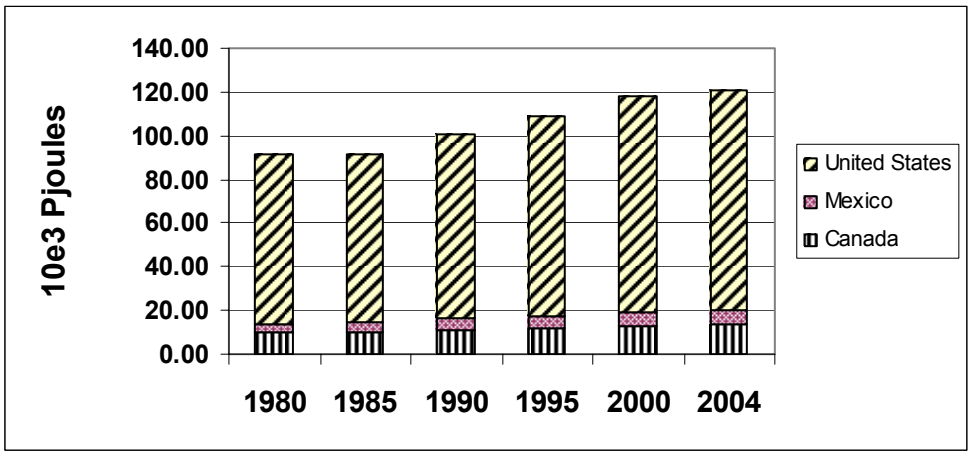
[1]Canadian Options for Greenhouse Gas Emission Reduction (COGGER) Panel, *Final Report* (Ottawa: Royal Society of Canada, September 1993).

[2] Interlaboratory Working Group. 2000. Scenarios for a Clean Energy Future (Oak Ridge, TN; Oak Ridge National Laboratory and Berkeley, CA; Lawrence Berkeley National Laboratory), ORNL/CON-476 and LBNL-44029, November.

[3]BP Statistical Review of World Energy, June, 2006

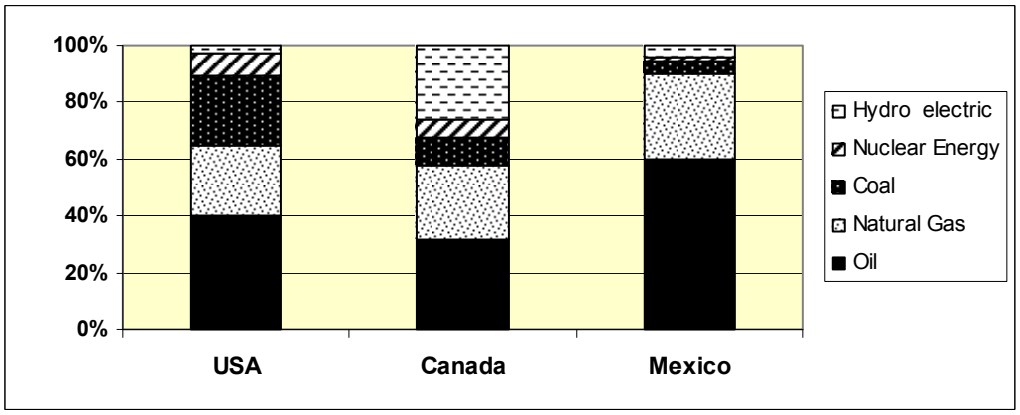
Figure 1. Total energy consumption in North America (1980-2004)



Source: US Energy Information Agency

The energy mix is quite different by countries, with the US depending mostly on oil, coal and natural gas; Canada on oil, natural gas and hydroelectricity; and México on oil and natural gas (Fig. 2).

Figure 2. Energy consumption by fuel in North America (2004)



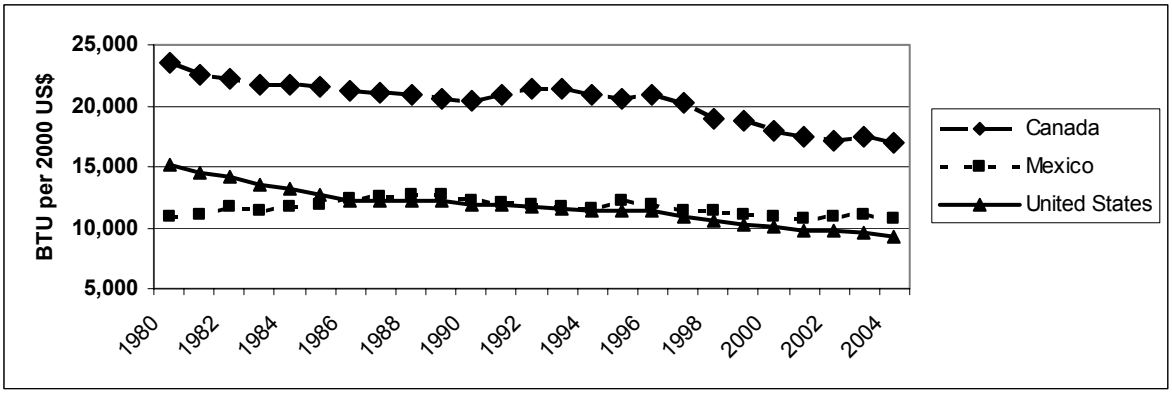
Source: US Energy Information Agency

Industry is the biggest consumer of energy in North America, representing 38% of the total. Transport is next with 34%, followed by the commercial and residential sectors. In the industrial sector, a small group of industries account for the majority of the use. These include pulp and paper, chemicals, petroleum refining, and primary metal production, which together account for 77% of industrial sector consumption and 29% of total North American energy consumption.

Potential for Energy Efficiency in North America

The energy intensity of the region has been decreasing steadily since the Oil Crisis of the 1970s (Fig. 3). This has been a result of several factors, mainly technological development driven by public policies and changes in the economic structure of the individual countries.

Figure 3. Total primary energy consumption per USD of GDP in North America (1980-2004)[4]



Source: US Energy Information Agency

The energy efficiency potential of a country involves a number of economic elements, as well as the way energy is consumed by the different productive sectors, thus affecting energy intensity.

Canadian studies have identified a technical potential to reduce energy consumption by 40 to 50% and a cost-effective potential of roughly 25%.[5] This means that the country could reduce its energy consumption by one quarter and save money at the same time.

In the United States, a scenario analysis of a number of energy efficiency measures shows a reduction of 20% in energy consumption by 2020 over a "business as usual" scenario. These savings of 23,000 quadrillion PJoules are equal to almost one-quarter of the nation's current energy use.[6]

The energy efficiency potential of Mexico has yet to be identified comprehensively. Considering that energy efficiency investments have a longer history in Canada and the U.S. than in Mexico, this potential should be at least the same as the greater of the two referred above, that is, there is likely a cost effective potential to save more than one quarter of current energy consumption in Mexico.

In general, there are a number of variables that determine the technical and economic potential for energy efficiency for a household, firm and/or social level. We identify six as the most significant.

- Energy prices.
- Time patterns of energy use.
- The energy demand characteristics of the present equipment and building stock.
- The energy demand characteristics and price of materials, equipment and systems that can be used to replace the present stock.

[4] Using market exchange rates.
[5]Canadian Options for Greenhouse Gas Emission Reduction (COGGER) Panel, *Final Report* (Ottawa: Royal Society of Canada, September 1993).
[6] Interlaboratory Working Group. 2000. Scenarios for a Clean Energy Future (Oak Ridge, TN; Oak Ridge National Laboratory and Berkeley, CA; Lawrence Berkeley National Laboratory), ORNL/CON-476 and LBNL-44029, November.

- The cost of replacement, including transaction costs.
- The discount rate from an individual, firm and/or social perspective.

These are variables that change in time and modify what can be saved economically. The price of fuels (p.e.: oil and natural gas) can change from one day to the other and the price of electricity changes more slowly. What is installed is practically fixed and the energy demand characteristics and the cost of the replacement change slowly as technology comes into the market and its prices reflects its demand. Patterns of use may shift as response to prices but depend mostly on specific needs and individual and organizational behavior.

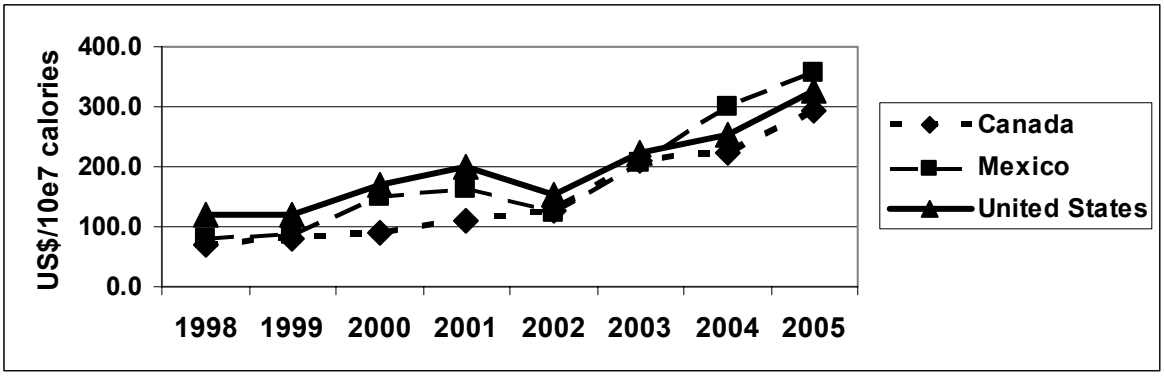
Energy prices in North America

High energy prices are the main driver for energy efficiency and energy prices have been growing significantly in North America in the last years, particularly driven by the international price of oil. The evolution of energy prices to end-users in North America has had patterns that have been different by energy type and by country, reflecting the differences in supply and demand structure, level of dependency on certain fuels and national economic policy.

Natural gas

Natural gas prices in North America have experienced a significant increase since the beginning of the 21st century, an increase that has been the same for the whole region (Fig.4).

Figure 4. Evolution of natural gas prices for industrial end-use in North America (1998-2006)



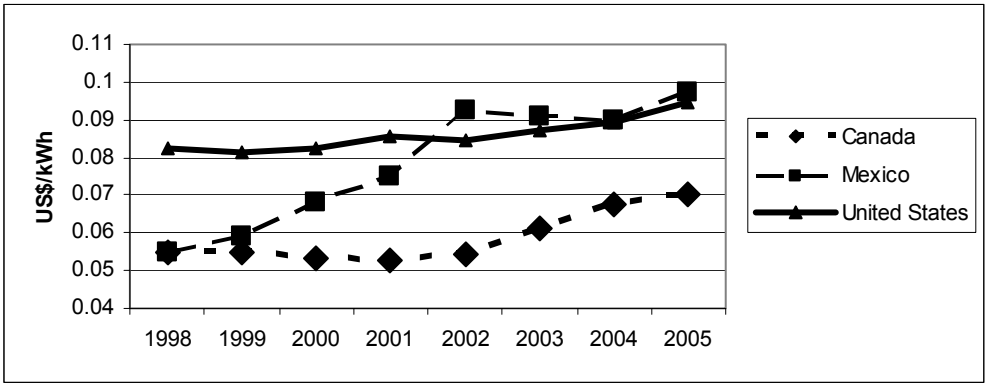
Source: U.S. Energy Information Administration

Electricity

Electricity prices have risen notoriously in North America over the last decade. According to data from the US Energy Information Administration (EIA), the average price of electricity for residential sector has had significant changes, particularly in Mexico and Canada (Fig. 5). By 2005, Canada had the lowest average prices of electricity for residential end-users. Mexico showed the higher increase –nearly 100%- in the 1998-2005 period, from 5 cents to almost 10 cents per kilowatt-hour by the end

of 2005. In the same period, average electricity prices for residential users in Canada and the U.S. increased by 27% and 14%, respectively.[7]

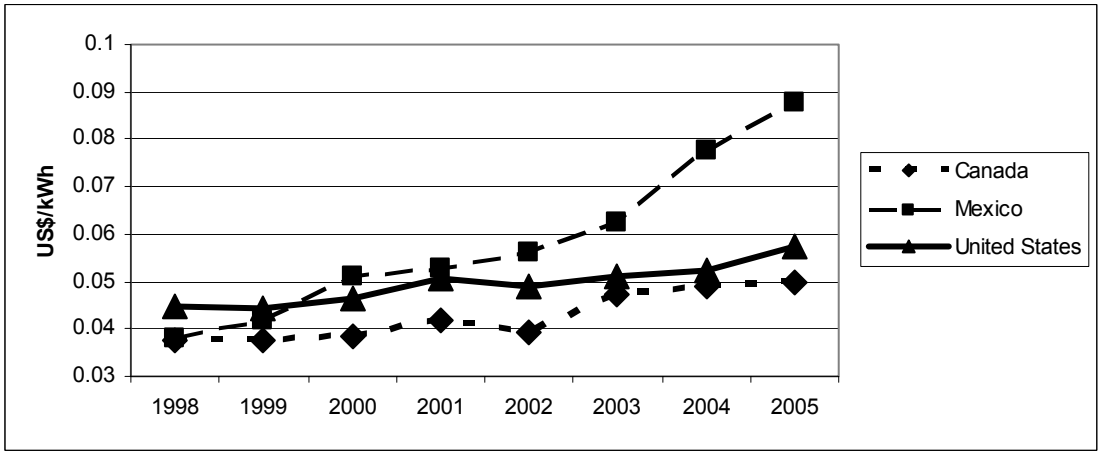
Figure 5. Average price of electricity 1998-2006 for residential end-use



Source: U.S. Energy Information Administration

In the industrial sector, the most significant change in the 1998-2005 period has been the rise of close to 100% in the average price of electricity for the industry in México, driven mostly fro its growing dependency on natural gas (Fig. 6). Electricity prices of industrial end-users in Canada and the U.S. have increased in the period 1998-2005 in 31% and 26% respectively.

Figure 6. Average price of electricity 1998-2006 for industrial end-use



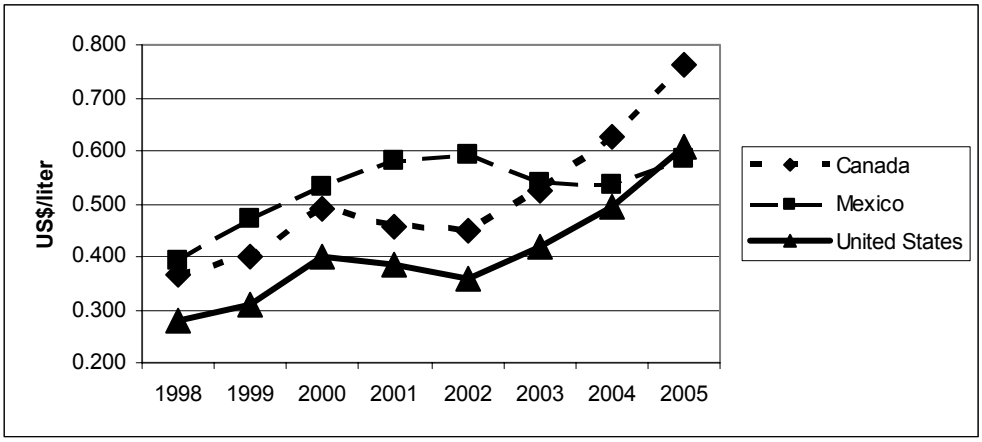
Source: U.S. Energy Information Administration

Gasoline

Average gasoline prices in Canada and the U.S. have increased by more than 100% from 1998 to 2005, whilst in Mexico the increase rate has been of nearly 50% (Fig. 7). This evolution reflects the evolution of international oil prices (in the case of the US and Canada) and internal policies (in the case of México).[8]

[7] It should be noted that there are very significant differences in prices within the individual countries and that the price shown is the national average price.
[8] Gasoline prices in México are determined by the treasury ministry (Secretaría de Hacienda y Crédito Público).

Figure 7. Average price of gasoline 1998-2005

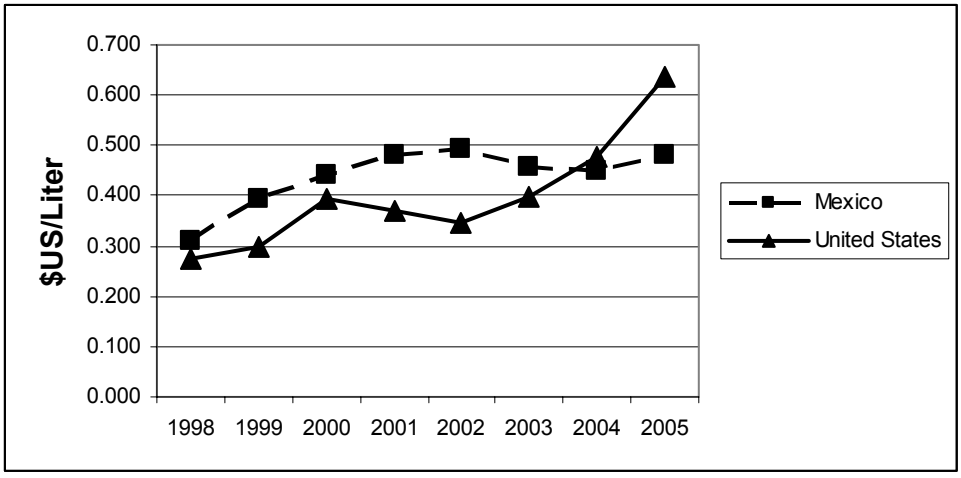


Source: U.S. Energy Information Administration

Diesel

Diesel prices in the U.S. have doubled from 1988 to 2005, whilst in Mexico they have remained at the same level since 2001 (Fig. 8).[9]

Figure 8. Average price of diesel 1998-2005



Source: U.S. Energy Information Administration

From the numbers above, there are three conclusions

- Prices of natural gas are practically the same for the whole region and have increased significantly in the last few years, but they affect the region in different manners depending on aspects related to its final use.
- Average national electricity prices have great differences in the region, have been growing in the five years and Mexico has had the greatest growth rate (mainly driven by its high dependency on oil and natural gas for power generation).

[9] No diesel prices were available for Canada for a time series from 1998 to 2005.

- Transportation fuel prices are different for each country and have grown significantly in the US and Canada since 2002, a pattern not followed by Mexico because transportation fuel prices are controlled by the government.

Time patterns of energy use

Patters of energy use—in terms of intensity and time of use—in existing households, and industrial and commercial installations are determined by the particular needs of the end-user, which may change by periods of a fraction of a second to periods of several months (summer and winter) and have a close relationship (in a market economy) with energy prices. Thus, much of the potential for energy efficiency depends on very particular conditions that relate energy use to its market price.

Present equipment and building stock

In the industrial sector, motors are a major end-use and represent a significant potential for energy efficiency. They consume 65 to 70 percent of industrial electricity in the U.S. and Canada and roughly 60% in Mexico. They also consume more than half the electricity generated in the U.S. [10]

In the commercial sector, lighting and cooling are the main end-uses and represent the main sources of energy efficiency potential. A typical U.S. commercial building uses two-fifths of its electricity for lighting directly, and more than half if the cooling load that is attributable to heat given off by lights is included.

Lighting is also a major source of energy efficiency potential in the residential sector. Most homes use incandescent lights that can be replaced by compact fluorescent lamps that use an average of only one-quarter as much electricity.

In transportation, energy efficiency can be increased chiefly through improved fuel efficiency standards and mode shifts.[11] Shifting long-distance freight from trucks to trains and urban auto-based commuting to public transit offer further energy saving potentials.

New technologies

New technologies are continuously developing that are more and more efficient in their use of energy. These technologies provide the same energy services, but use far less energy.

Some examples are:

- For energy savings of 60%–75%, many incandescent lamps can be replaced by compact fluorescent lamps (CFLs).[12]
- On average, weatherization reduces heating bills by 31% and overall energy bills by $358 per year at current prices.[13]

[10] http://www.gepllc.com/pdfs/ELECTR5237-The_Electricity_Journal.pdf
[11] "Bringing fuel-efficiency standards up to 40 miles-per-gallon (mpg) would save consumers an estimated $9.8 billion a year on fuel costs". http://www.pacinst.org/publications/essays_and_opinion/CAFE_op-ed.htm
[12] http://www.eere.energy.gov/consumer/your_home/lighting_daylighting/index.cfm/mytopic=12250
[13] http://www.eere.energy.gov/weatherization/

- Today's best air conditioners use 30%–50% less energy to produce the same amount of cooling as air conditioners made in the mid 1970s.[14]
- In a house that uses electricity for heating, a heat pump can trim the amount of electricity needed for heating by as much as 30%–40%.[15] [16]
- Energy-efficient motors, adjustable-speed drives and various changes in the choice, sizing and maintenance of motors can all significantly reduce their energy consumption. For example, reducing the speed (flow) by 20% can reduce input power requirements by approximately 50%.[17]
- As of early 2004, the average fuel economy of cars under Corporate Average Fuel Economy (CAFE) must exceed 27.5 mpg. Today there are hybrid cars in the market that reach 60.0 mpg.[18]
- Working in partnership with industry, the U.S. Department of Energy's (DOE's) Industrial Technologies Program (ITP) has supported approximately 600 separate research, development and demonstration (RD&D) projects that have produced more than 170 technologies. In 2004, ITP programs were instrumental in achieving energy cost savings to industry of 366 trillion Btu.[19]

Trends in energy use

In the US, the growth in the economy, as well as the nation's rising population is leading to more, larger, and better equipped homes (p.e.: larger refrigerators) and commercial buildings, resulting in greater energy consumption in these sectors. Also, recent trends suggest little or no improvement in overall fuel economy levels because of the increased market share of light trucks and sport utility vehicles.

These trends are replicated, in different degrees, in Canada and Mexico.

Barriers to energy efficiency

Policies and programs are designed to help organizations and individuals who face a variety of complex barriers to choosing the most cost-effective efficiency option, which vary by user, technology, and end-use.

*Information & transaction costs***.** Wise purchases are based on reliable and easily accessible information. Cost-effective energy efficiency measures are often not taken as a result of lack of information on the part of the customer on how much a specific piece of equipment consumes, lack of confidence in the information and/or high transaction costs for obtaining the information. Public agencies and utilities play an important role in providing this information.

*Financial barriers**.*** Many consumers and industries face capital constraints in pursuing those energy efficiency improvements that require additional incremental investment. These constraints surface as short payback time requirements for investments (2-3 years), or an inability to even consider investing due to lack of money. Creating

[14] http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12440
[15] http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12610
[16] However, the efficiency of most air-source heat pumps as a heat source drops dramatically at low temperatures, generally making them unsuitable for cold climates, although there are systems that can overcome that problem.
[17] http://www1.eere.energy.gov/industry/bestpractices/pdfs/38947.pdf
[18] http://autos.yahoo.com/green_center/
[19] http://www1.eere.energy.gov/industry/about/pdfs/impacts2006.pdf

attractive financing options that improve the consumer's monthly cash flow is one strategy that has proven successful.

*Split incentives***.** Whenever the purchaser or operator of an appliance is not the same person who pays for the electricity, the incentive for considering efficiency can be diluted or eliminated. Builders who sell their buildings after construction do not have the incentive to make them energy-efficient. Split incentives are particularly difficult to ameliorate, but minimum efficiency standards have been effective in counteracting them.

*Underpriced energy***.** A strong case can be made that energy fuels are underpriced, because market prices do not fully account a variety of social and environmental costs associated with fuel use, and especially oil use. Those externalities related to fuel use include greenhouse gases as well as its contributions to air, water, and land pollution.

*Risks to manufacturers***.** Redesigning motor vehicles for substantial fuel economy improvements requires massive capital investments. In an intensively competitive car market a negative reaction by consumers, even to subtle aspects of a new technology, could result in massive financial losses to manufacturers. Manufacturers will therefore be understandably reluctant to commit to rapid, sweeping design changes to improve fuel economy, a matter of relatively small concern to motorists.

2. INSTITUTIONAL AND LEGAL FRAMEWORK RELATED TO ENERGY EFFICIENCY IN NORTH AMERICA

There are a number of elements to understanding current and ongoing energy efficiency improvements, policies and regulations. Technology development, response to rising energy prices and the need to increase the competiveness of economies have resulted in a number of policies implemented by governments in order to reduce energy use, influence or mandate end-users purchase of energy efficient goods and modernize the energy supply industry.

Also, energy efficiency policies have a relevant contribution in terms of reducing greenhouse gas emissions which cause climate change and have proven to be a cost-effective measure to increase a nation's response to the increasingly unstable oil market. Therefore, the energy efficiency potential of a country involves a number of economic variables, as well as the way energy is consumed by the different sectors.

Canada

Canada is a federation of ten provinces and three territories. The division of powers, as set out in the Canadian Constitution, confers federal, provincial/territorial and municipal governments with discrete jurisdiction and responsibilities over many policy areas relevant to energy efficiency and climate change.

The *Energy Efficiency Act*, which came into force in 1993, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labeling of energy-using products and the collection of data on energy use. Energy efficiency is also a key component of *Canada's National Action Program on Climate Change (NAPCC)* approved in February 1995 by federal and provincial ministers of energy and environment.

Following extensive consultations with provincial governments, affected industries, utilities, environmental groups and others, the first Energy Efficiency Regulations came into effect in February 1995. The Regulations refer to national consensus performance standards developed by the Canadian Standards Association, which include testing procedures that must be used to determine a product's energy performance.

Natural Resources Canada (NRCan)

The Federal Department of Natural Resources (NRCan) has primary responsibility for formulating and implementing energy policy in areas of federal jurisdiction. Its energy efficiency activities are delivered by two groups: the Office of Energy Efficiency (OEE), formerly the Energy Efficiency Branch, and the CANMET Energy Technology Branch. The OEE has a mandate to renew, strengthen and expand Canada's commitment to energy efficiency in order to help address the challenges of climate change with specific emphasis on the Kyoto Protocol.

OEE was established in April 1998 as part of NRCan with a mandate to communicate the importance and value of energy efficiency and alternative transportation fuels and

to advise the public on actions they can take to contribute to individual and societal benefits. The OEE manages energy efficiency and alternative transportation fuels measures aimed at the residential, commercial/institutional, industrial and transportation sectors and to overcome the market barriers of inadequate information and knowledge, institutional deterrents in energy end-use markets and financial and economic constraints on energy users.[20]

OEE maintains strong links with NRCan's research and development programs for advanced energy efficient technologies. It works closely with NRCan's CANMET Energy Technology Centre to ensure that Canadians are kept abreast of technology developments that can either reduce the consumption of fossil fuels or enable the transition to less greenhouse gas-intensive energy sources, including renewable energy. The CANMET Energy Technology Branch (CETB) works in partnership with industry and all major stakeholders in the Canadian energy and R&D sectors. Its mandate is to develop and deploy energy-efficient, alternative energy and advanced hydrocarbon technologies.

Provincial agencies

In Canada, provincial governments have their own entities in charge of promoting energy related matters, and in most cases they manage specific energy efficiency programs. Following Canada's commitment towards reducing greenhouse gas emissions, most provincial and local regulations, strategies and programs have the objective of establishing specific and measurable mitigation goals, developing demand-side actions, as well as reducing energy demand in the different end-use sectors.

In Alberta, the Ministry of Energy has responsibility for a diverse resource development and commodity portfolio that includes natural gas, conventional oil, oil sands, coal, minerals, petrochemicals and electricity. In this sense, the ministry and other provincial authorities work on a number of issues concerning energy efficiency, such as regulation, promotion policies and information for energy users.

The British Columbia's Energy, Mines and Petroleum Resources Ministry has developed an Energy Plan, which establishes targets for zero net greenhouse gas emissions.[21]

In Quebec, the Ministry of Natural Resources and Fauna established an Energy Strategy in 2004, whith priority actions that include the adoption of more ambitious energy savings targets for all forms of energy, including petroleum products; drawing up a comprehensive plan for all forms of energy, and taking steps to implement it; reducing the consumption of petroleum products by taking specific action; making better use of electricity; extending the scope of energy efficiency measures for natural gas; and strengthening leadership in the public sector.

This strategy also establishes that the reduction in greenhouse gas emissions depends on the promotion of energy efficiency within Quebec, Canada and the northeast sector of North America, in compliance with the Kyoto Protocol. It also establishes specific targets for energy savings in the petroleum products sector.

[20] The State of Energy Efficiency in Canada, Office of Energy Efficiency, Natural Resources Canada, Report 2006.
[21] Ministry of Energy, Mines and Petroleum Resources, British Columbia. 2005/06 – 2007/08 Service Plan Update, September 2005.

In Quebec, the *Association québécoise pour la maîtrise de l'énergie* (AQME) also works as a non-governmental organization to promote relevant energy efficiency programs and information exchange between all related stakeholders. AQME develops dissemination strategies and relevant research studies on efficient use of energy as well as innovation technologies which lead to reduced energy consumption.[22]

Ontario's Ministry of Energy is focused on promoting energy efficiency and innovation in the energy sector. In particular, Ontario's government established an *Energy Conservation Responsibility Act* in 2006, which requires preparation of energy conservation plans on a regular basis, and reporting on energy consumption, proposed conservation measures, and progress. This regulation also establishes energy efficiency standards for a wide range of energy-using products, with the objective of eliminating the least energy efficient products from the Ontario marketplace. It covers a wide spectrum of products, including household appliances, furnaces and boilers, water heaters, lighting products, air conditioners, heat pumps, chillers and nine commercial products (such as motors, transformers, vending machines, etc.).

In general terms, provincial agencies in Canada are committed towards promoting energy efficiency at different levels and considering a number of policies and regulations. The same is true of many of Canada's urban municipalities. These policies and actions are considered as a complement of national energy efficiency policies, considering local conditions and priorities.

México

The energy sector is led by the Secretaria de Energia (SENER), which defines and conducts energy policy and oversees the operation of the national energy oil company (Pemex) and the power utilities (Comisión Federal de Electricidad and Luz y Fuerza).

There is no specific law mandating energy efficiency programs and regulations in Mexico. However, it is the Federal Law on Metrology and Standards that establishes the mandate to implement mandatory technical standards (Mexican Official Standards or NOM) which define "the characteristics and/or specifications that products or processes must meet in case they may constitute a risk for the human safety or could endanger human, animal or vegetable health, overall or working environment, or for natural resources preservation". Through this law, SENER has the mandate for energy efficiency NOMs, which is transferred to the National Commission for Energy Conservation (Conae).

Secretaria de Energia (SENER)

As Mexico's energy ministry, SENER conducts national energy policy and exercises the right of the nation with regards to oil and all solid, liquid and gas hydrocarbons as well as the use of natural resources required to generate, conduct, transform, distribute and supply electricity for public service.[23]

[22] AQME, Mission et objectifs. http://www.aqme.org/a_propos/a_propos01_fr.php
[23] Ley Orgánica de la Administración Pública Federal, Título Segundo, Capítulo II, Diario Oficial de la Federación, 21 de mayo de 2003.

Secretaria del Medio Ambiente y Recursos Naturales (SEMARNAT)

As Mexico's ministry of the environment and natural resources, SEMARNAT is mandated to manage, regulate and promote the sustainable use of the nation's natural resources, with the exception of oil and all liquid, solid and gas hydrocarbons, as well as radioactive minerals; and to conduct relevant national policies concerning Climate Change issues and the protection of the ozone layer.[24]

Comisión Nacional para el Ahorro de Energia (Conae)

Conae is a decentralized administrative agency that is part of SENER, with technical and operational autonomy and with the objective to serve as a technical advisory body for the agencies and entities of Mexico's public and private sectors on issues related to energy savings, energy efficiency and renewable energy use. The most relevant programs developed by Conae, in terms of scope and impact, are the mandatory energy efficiency standards (NOM), the federal buildings program, the technical support to PEMEX internal program, and the programs undertaken in the private industrial and service sectors. [25]

Fideicomiso para el Ahorro de Energía Eléctrica (FIDE)

FIDE is a private, non-profit organization created in 1990 by the national power utility (CFE) and is supported by a small internal tax on CFE's suppliers and by loans from international development banks. FIDE´s objective is to promote actions that encourage and foster electricity conservation and its rational use. FIDE has provided financing for hundreds of energy audits and the purchase of several million units of energy efficient lamps, motors, AC units and refrigerators, thus achieving important energy savings in industrial and commercial installations of the private sector, as well as municipal lighting and pumping systems. As a main result, it has contributed significantly to the development of the energy efficient equipment and systems market, and a solid and highly skilled consultant pool.[26]

Comisión Federal de Electricidad (CFE)

Comisión Federal de Electricidad (CFE), Mexico's national power utility, has developed several energy efficiency programs directed both to end-use as well as demand-side management. These programs are the Electricity Sector Energy-Savings Program (PAESE) and the Trust Fund for the Thermal Insulation Program of Households in the Mexicali Valley (FIPATERM).

The Electricity Sector Energy-Savings Program (PAESE)

PAESE was created in 1989 as part of CFE and as an evolution of a previous program operating since 1982 (the National Program for Rational Electricity Use – PRONUREE). PAESE basically operates with a network of specialized professionals which provides

[24] Ley Orgánica de la Administración Pública Federal, Título Segundo, Capítulo II, Diario Oficial de la Federación, 21 de mayo de 2003.
[25] Decreto por el que se crea la Comisión Nacional para el Ahorro de Energía, como órgano desconcentrado de la Secretaría de Energía, Diario Oficial de la Federación, 20 de septiembre de 1999.
[26] Misión y objetivos del Fideicomiso para el Ahorro de Energía Eléctrica. http://www.fide.org.mx/

support to end-users on issues related to electricity-efficiency improvement. More recently, its work has concentrated in CFE´s own installations (mainly buildings).

The Trust Fund for the Thermal Insulation Program of Households in the Mexicali Valley (FIPATERM)

The first systematic effort undertaken to achieve energy savings in Mexico was designed and implemented by PRONUREE to reduce energy consumption from AC use among residential end-users in the city of Mexicali, Baja California.[27] In 1989, based on the PRONUREE´s program design, CFE created a trust fund (FIPATERM), which has the objective of providing financing for thermal insulation of high energy-consumption residential users.

United States

In the U.S., responsibilities for energy efficiency policies are divided among the federal government, the state and municipal governments.

The Department of Energy (DOE)

The Department of Energy's (DOE) overarching mission is to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex. At a federal level, DOE develops, implements and co-ordinates the R&D to improve the energy efficiency of building components and integrated systems. Its R&D addresses both the building envelope (walls, windows, roofs) and equipment (heating and cooling equipment, lighting, etc.) and their integration into optimal "whole building" designs. [28]

As part of DOE, the mission of the Office of Energy Efficiency and Renewable Energy (EERE) is to strengthen America's energy security, environmental quality, and economic vitality in public-private partnerships that enhances energy efficiency and productivity; and bring clean, reliable and affordable energy technologies to the marketplace. EERE leads the federal government’s research, development, and deployment efforts in energy efficiency. EERE's role is to invest in high-risk, high-value research and development that is critical to the nation’s energy future and would not be sufficiently conducted by the private sector acting on its own. Program activities are conducted in partnership with the private sector, state and local government, DOE national laboratories, and universities. EERE also works with stakeholders to develop programs and policies to facilitate the deployment of advanced clean energy technologies and practices.

Environmental Protection Agency (EPA)

The U.S. Environmental Protection Agency (EPA) was created in 1970 as an independent regulatory agency responsible for the implementation of federal laws designed to protect the environment. EPA's mission includes “the establishment and enforcement of environmental protection standards consistent with national environmental goals, and the conduct of research on the adverse effects of pollution

[27] Mexicali is located in the State of Baja California on the Mexico-US border.
[28] U.S. Department of Energy Strategic Plan, 2006

and on methods and equipment for controlling it". EPA operates, jointly with the DOE, the Energy Star program.[29]

State energy commissions and agencies

Energy efficiency programs and actions are also implemented at the state level and considering local conditions. The programs developed by state agencies in the U.S. are conducted both in line with overall national policies but also as part of local priorities. There is a federal mandate to establish an energy efficiency office in each state of the Union, but each state agency's structure is defined on the basis of state and local conditions.

Also, and considering state local development, a number of agencies and state commissions receive direct federal resources from the Department of Energy, and the programs implemented are a complement of federal strategies and regulations.

The California Energy Commission (CEC) has implemented a number of energy efficient and related policies in order to reduce energy consumption. The CEC works on several initiatives which are directed towards promoting and developing energy efficiency standards for appliances and buildings, as well as other related regulations. The CEC also works on several programs to promote efficient energy use in agriculture, manufacturing, water systems, transportation and local industry. The CEC carries out an extensive technical assistance program to support other state and local agencies programs. It develops a number of programs to reduce energy consumption, install energy efficient office equipment and comply with related energy efficiency measures by state and local public entities.[30]

In Connecticut, a state consultation council sets a number of long-term recommendations on energy demand and supply energy options, with particular emphasis on conservation and energy resource management within the state.

In states such as Arizona and New York, local energy authorities also develop a number of activities to promote production and use of energy efficient systems and appliances. In Maryland, energy efficiency promotion activities are focused on the procurement of energy efficient products.

In the state of Iowa, the Energy Bank helps energy users manage their energy efficiency improvements through energy audits and financing of the proposed measures. In the states of Indiana and Kansas, public entities make use of ESCO financing schemes to apply energy efficiency measures. There are specific laws which promote and regulate this kind of financing instrument.

In general, state and local agencies in the U.S. develop and implement a number of policies, programs and regulations to achieve energy efficiency. These activities depend on local conditions and state economic development and consider a range of demand-side strategies, enforcement of federal and local related regulation, R&D of energy efficiency alternatives, and end-user driven promotion and information activities.

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[29] The Guardian: Origins of the EPA, http://www.epa.gov/history/publications/origins.htm

[30] Energy Action Plan II, Implementation Roadmap for energy policies, State of California, September, 2005 http://www.energy.ca.gov/ energy_action_plan/index.html

3. MAIN ENERGY EFFICIENCY PROGRAMS IN NORTH AMERICA

Canada

NRCan has more than 15 market-related energy efficiency initiatives that target all types of consumers and emphasise partnerships and economic investments. Their objective is to overcome the market barriers of inadequate information and knowledge, institutional deterrents in the energy market, and financial and economic constraints on energy users. NRCan's initiatives use the following policy instruments: leadership, information, voluntary actions, fiscal incentives and regulations.

Energy Efficiency Regulations

Following extensive consultations with provincial governments, affected industries, utilities, environmental groups and others, the first Energy Efficiency Regulations came into effect in February 1995. The Regulations set minimum energy-performance levels for a number of energy-using products such as appliances, lighting, and heating and cooling products and refer to national consensus performance standards developed by the Canadian Standards Association, which include testing procedures that must be used to determine a product's energy performance.

Canada's *Energy Efficiency Act* and Energy Efficiency Regulations support a number of labeling initiatives that aim to help consumers and commercial/industrial procurement officials identify and purchase energy efficient equipment that will save them money and reduce greenhouse gas emissions over the life of the product. They outline a number of responsibilities for dealers who import to Canada (or ship from one Canadian province to another) any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use a range of enforcement measures, when necessary.

The *Energy Efficiency Act*, tabled in Parliament on October 19, 2006, took concrete action to raise the bar on the energy efficiency standards for a range of consumer products and equipment. Broadening and strengthening the Act means that 80% of the energy used in homes and businesses will soon be regulated. Over time, the set of planned new regulations will address about 20 currently unregulated products such as commercial clothes washers and boilers, and will tighten requirements for 10 products such as residential dishwashers and dehumidifiers.[31]

The amendments also improve labeling so consumers have the latest information on the most energy efficient products on the market. This way, Canadians can tap into huge potential savings in terms of energy and money, and they'll benefit from the improved air quality which results when emissions are reduced.

[31] http://www.nrcan.gc.ca/media/newsreleases/2007/200704b_e.htm

Energy Star

In 2001, NRCan became the administrator of International Energy Star in Canada. NRCan and other partner countries recognize and promote the criteria and logo established under the USA Energy Star scheme. The Energy Star label is now recognized by 60% of Canadians who look to this brand to identify products that use less energy and save money.

Model National Energy Code for Buildings *(MNECB)*

The *Model National Energy Code for Buildings* (MNECB) establishes minimum standards of construction for building components and features that affect a building's energy efficiency. It complements the 1995 *National Building Code of Canada*. Produced by the Canadian Commission on Building and Fire Codes, the MNECB is a model upon which energy-conscious building designers, developers and contractors across Canada can base cost-effective, energy efficient building designs. Several provinces/territories are considering adopting the MNECB as part of their building regulations. If adopted by a province, territory or municipality, the provisions of the MNECB will become law in that jurisdiction.

The MNECB is a model code that can be adopted (or adapted) by any province or territory, similar to the *National Building Code* (NBC). Its development was financially supported by every provincial and territorial ministry of energy, the utility members of the Canadian Electricity Association and the federal government. The MNECB is intended to be used in conjunction with the NBC. In contrast to ASHRAE/IES 90.1, the MNECB references Canadian standards and regulations, uses metric (SI) units, and includes only enforceable requirements.

R-2000 Home Program

The voluntary *R-2000 Home Program*, first introduced by the Government of Canada in January 1982, encourages Canadians to build houses that are more energy efficient and environmentally responsible. Certified R-2000 homes meet minimum standards for windows and doors, insulation, HVAC (heating, ventilation and air conditioning), lighting systems, air quality, recycled materials and water conservation. Certified R-2000 new houses are up to 50% more efficient than homes built to current building codes. [32]

EnerGuide for Houses

EnerGuide for Houses, established by the Minister of Natural Resources in 1998, is a labeling and certification program which seeks to persuade and assist homeowners to make energy efficiency investments in their houses, and to consider energy efficiency when purchasing a house.

Energy Innovators Initiative (EII)

This initiative promotes energy efficiency upgrades and building retrofits in the commercial and institutional sector. The initiative recruits Canadian organisations to enroll as Energy Innovators and make a corporate commitment to energy efficiency

[32] IEA, 2002, Energy Efficiency Update, Canada

using an Energy Management Plan. EII offers a pilot retrofit incentive, expanded partnerships and benchmarking.

Commercial Building Incentive Program (CBIP)

The *Commercial Building Incentive Program* (CBIP) was established by NRCan in 1998 to provide financial incentives to builders and developers to incorporate energy efficient technologies and practices into the design and construction of new commercial, institutional and multi-unit residential buildings. In addition to financial incentives, CBIP provides design software and guidelines, case studies and training for architects and engineers.

Industrial Building Incentive Program (IBIP)

This program aims to increase the energy efficiency of newly constructed buildings used for manufacturing and other industrial activities. IBIP will offer an incentive to companies building new industrial facilities to offset additional design costs inherent in the initial attempts at energy efficient design.

Federal Buildings Initiative (FBI)

The *Federal Buildings Initiative* (FBI), co-ordinated by NRCan, is designed to facilitate comprehensive energy efficiency upgrades and building retrofits for departments, agencies and Crown corporations of the Government of Canada, through mechanisms such as public-private partnerships with energy management firms. FBI account managers work with departments from project inception, through contract development and award, celebration and recognition, to monitoring and tracking. The FBI supports partnerships with energy management firms that provide a turnkey service which includes engineering, third-party private-sector financing, comprehensive training packages and performance guarantees. Project data are collected annually from departments and evaluations, and program results are published annually by the Government of Canada.

FleetWise

The Federal Fleet Initiative is a government leadership initiative that targets federal vehicle fleets to reduce energy use and promote the use of alternative transportation fuels. The initiative provides fleet managers with an assessment of fleets at little or no cost and technical advice on using alternative transportation fuels (ATFs) and acquiring alternative fuel vehicles.

Motor Vehicle Fuel Efficiency Program

This program, delivered by NRCan and Transport Canada since 1978, promotes improvements in new vehicle fuel efficiency by encouraging motor vehicle manufacturers to meet voluntary annual company average fuel consumption targets for new automobiles sold in Canada. Average fuel consumption targets are patterned after the US CAFE standards, although compliance is voluntary in Canada. Since 1999, vehicle manufacturers have been attaching a fuel consumption label to their cars, vans and light duty trucks. The label is standardised across the industry and appears on its

own or is combined with the vehicle options and price label on the side window of each new vehicle.

ecoENERGY

Early in 2007, Natural Resources Canada unveiled its Government's plan to invest approximately $300 million[33] over four years to promote smarter energy use and reduce the amount of harmful emissions that affect the health of Canadians under the concept of ecoENERGY Efficiency Initiative. The ecoENERGY components are specifically designed to provide incentives for retrofitting existing houses, small-building and industry stock, to raise the bar for new construction, and to continue collaboration with industry on efficiency improvements. They reinforce extensive *Energy Efficiency Act* amendments already included in the Government's Clean Air Regulatory Agenda that will tighten regulation of a wide range of consumer products and equipment. Program details, including information about how to apply for ecoENERGY grants, will be available when the program starts in April 2007.[34]

ecoENERGY Retrofit program

This program is directed to homeowners, smaller businesses, institutions and industrial organizations. The $220-million[35], four-year ecoENERGY Retrofit Initiative will fill that gap by offering financial support and information to encourage the retrofit of homes, small buildings and industrial processes.

ecoENERGY for Buildings and Houses

The Government of Canada will also encourage the construction, operation and retrofit of more energy efficient buildings and houses using complementary activities such as rating, labeling and training. An investment of more than $60 million[36] in ecoENERGY for Buildings and Houses will generate new design tools and training so designers, builders, owners and operators can learn about and use best practices and new technologies; house and building energy rating and labeling systems; and, dialogue and co-operation with provincial and territorial energy efficient housing programs with a view to encouraging other levels of government to adopt more stringent building energy codes.

ecoENERGY for Industry program

ecoENERGY for Industry program aims to accelerate energy-saving investments and the exchange of best practices information within Canada's industrial sector by helping large industry deal with regulations introduced as part of the *Clean Air Act*, and to stimulate action across all industries. The ecoENERGY for Industry program will devote approximately $20 million[37] to encourage information-sharing on new technologies and best practices in energy use; training for energy managers to identify and put in place energy-saving projects; and cost-shared assistance for energy assessments that identify a wide range of ways to improve energy use.

[33] Canadian dollars
[34] NRCan ecoEnergy Initiative. http://www.ecoaction.gc.ca/ecoenergy-ecoenergie/index-eng.cfm
[35] Canadian dollars
[36] Canadian dollars
[37] Canadian dollars

ecoENERGY for Fleets

The ecoEnergy for Fleets Initiative will emphasize information-sharing, workshops and training to help fleets increase their fuel efficiency.

The other initiatives are the $230-million[38] ecoENERGY Technology Initiative that funds the research, development and demonstration of clean energy technologies, and the ecoENERGY Renewable Initiative, a $1.5-billion investment to boost Canada's renewable energy supplies.

Incandescent lamp phase-out

In April of 2007 Canada's government committed to setting performance standards for all lighting that would phase out the use of inefficient light bulbs in common applications by 2012. Canada's objective is to ensure that efforts are harmonized with those of its trading partners.[39]

México

The efforts undertaken in Mexico to use energy more efficiently are characterized by the continuous institutional development over the past fifteen years, which has already achieved significant results. In this sense, and particularly the work of Conae, FIDE and CFE has resulted in a number of programs which are complemented and that are designed considering the experience and institutional structures in previous programs. Significant energy savings have been obtained in Mexico in this way.

Minimum Energy Performance Standards

One of the main activities that Conae has performed since its origin has been the establishment of Mexican Official Energy Efficiency Standards (NOM) for different equipment and systems. At present, 18 NOM for electricity-consuming equipment and appliances apply to more than 5 million units which are commercialized in Mexico every year.

Building codes

Two energy efficiency standards apply to new commercial buildings, one for its lighting systems and one for the building's envelope. These are standards depend on third parties for its application. In the case of the lighting standard, it is the national power utilities that require certificates of compliance by accredited third parties in the service contracting process, while the one for the building envelope has to be mandated by local codes and then enforced by local authorities.

Green Mortgages Program

In early 2007 Conae announced, in collaboration with the Instituto del Fondo Nacional de la Vivienda para los Trabajadores (INFONAVIT) the Green Mortgages program that will establish financing mechanisms to promote the integration of energy efficiency

[38] Canadian dollars
[39] http://www.rncan.gc.ca/media/newsreleases/2007/200735a_e.htm

measures (thermal insulation and lighting) in housing. The program will start with a pilot project of 10,000 houses supported by INFONAVIT credits and will include the use of renewable energy technologies (domestic solar water heating) for low/medium income housing.

Demand-side management

ILUMEX

ILUMEX was a wide-reaching program designed and implemented in Mexico in 1995 with the support of the World Bank's Global Environmental Facility (GEF). The program was oriented towards the installation of compact fluorescent lamps in the residential sector. It was applied in the states of Jalisco and Nuevo Leon, where more than two and a half million CFLs were installed by the year 1999 when the program concluded. ILUMEX resulted in energy savings of more than 300 million kWh and an important reduction of GHG emissions. This program concluded and served as a base for other related programs implemented by CFE and FIDE. [40]

Thermal insulation of homes in Mexicali

This program, which is operated with FIPATERM financing, has the objective of financing the massive installation of thermal insulation of roofs in households in Mexicali, Baja California. The scheme used by FIPATERM is based in low interest rates, which allows the end-user to pay for the installation cost through the electricity bill. By the year 2000, FIPATERM achieved the insulation of more than 60 thousand roof-tops in Mexicali. The program has evolved to offer door and window insulation, as well as the purchase of efficient equipment, such as air conditioners, refrigerators, and CFLs. It also includes the development of energy audits to identify the feasibility of energy-saving measures. Credits granted by FIPATERM by the first semester of 2004 totalized 93,999 equal to more than 60 million US$.[41]

Daylight Saving Time

Daylight Saving Time was first applied in Mexico in 1996. Benefits achieved over the past ten years since it was first applied are of approximately 12,283 GWh in energy consumption, and an avoided capacity of more than 1,000 MW, equal to more than 11 billion pesos.[42] The analysis of the impacts of this measure as well as the information campaigns related to its implementation are carried out by SENER with the support of Conae, FIDE and CFE.

FIDE's programs

Incentives Program

This program operated through a loan granted by the Inter American Development Bank (IADB), and additional financial resources from CFE, and FIDE's budget. The resources were used to grant economic bonus to end-users who purchase high-

[40] De Buen, O., *Ilumex: Desarrollo y lecciones del primer proyecto mayor de ahorro de energía en México,* January 31st., 2005: www.funtener.org/pdfs/ilumex.pdf
[41] Op.Cit. De Buen, O., Gonzalez, J., January 31st., 2005: www.scerp.org/pubs/m7c6.pdf
[42] Fideicomiso para el Ahorro de Energía Eléctrica, April 16th, 2007: http://www.fide.org.mx/servicios/datos.htm

efficiency technologies. This program includes the use of Sello FIDE for such equipment. The program concluded in 2004, but given its good results, it is expected to undertake a second stage. Through this program, the entire three-phase induction motors markets was transformed, as well as 40% of lighting systems market (T-8 fluorescent lamps and low-loses ballasts), and 80% of the market for compressed-air equipment with capacity higher than 20 HP.[43]

Electricity savings financing

FIDE supports a number of end-users by providing financing for energy audits and energy-savings projects for residential, industrial, commercial and services sectors, as well as for public lighting and water pumping in municipalities ; the purchase of high-efficiency equipment; and the substitution and optimization of chillers, with a grant from the World Bank. FIDE's financial support has resulted, since 1990, in electricity savings per approximately 11,100 GWh.

Financing program (PFAEE)

This program promotes the substitution of air-conditioning systems and refrigerators, as well as to install thermal insulation in household rooftops and walls. Since its implementation in November, 2002 and as of December, 2006, 623,317 refrigerators and 129,887 air-conditioning equipment (including room-type, minisplit and central type of 1 to 5 tons) have been replaced, and 25,346 houses have been insulated.[44]

Residential lighting program

FIDE´s residential lighting program is a continuation of ILUMEX and has promoted the substitution of more than 16.6 million light bulbs with CFLs.

Sello FIDE

In 1995, FIDE introduced the *Sello FIDE*, a voluntary energy efficiency endorsement seal given by FIDE. *Sello FIDE* endorsement requires higher energy performance standards for these products than those established by mandatory NOMs. Appliances labeled under this program are room air conditioners, fluorescent lamps and compact fluorescent lamps (CFLs), refrigerators, refrigerator-freezers, motors, and compressors. To date, 34 companies have been incorporated in the Sello Fide program and 3,075 models of different products have been certified with this label.

Pilot and demonstration projects

From its start, FIDE has supported pilot projects for the use and demonstration of new energy efficiency technologies such as appliances, lighting systems and air-conditioning in new houses.

[43] Fideicomiso para el Ahorro de Energía Eléctrica, January 31st., 2005: www.fide.org.mx/resultados/index.html
[44] Avances y resultados de las actividades del Fidecomiso para el Ahorro de Energía Eléctrica. http://www.fide.org.mx/el_fide/resultados.html

Institutional programs

Energy Savings Program for Federal Administration Buildings

This mandatory program administered by Conae was first introduced in 1999, for the largest buildings of the Federal Administration. The program includes a set of energy intensities and requires the creation of energy management committees within the government's ministries and agencies. These committees are responsible for tracking and reporting electricity consumption. A plan of action is required to reach the mandated intensities for those buildings with energy use intensities greater than those established in the program. The program includes training, a website and a yearly recognition. By the end of 2006, it had incorporated more than 2000 buildings of the federal government. This program has represented energy savings of approximately 211 GWh per year.[45]

PEMEX Energy Conservation Campaign

PEMEX is one of the larger energy users in Mexico. Conae developed for PEMEX a support strategy that has proved very successful through more than eight years of concerted efforts. This strategy was initiated with the integration of a Pemex-Conae working group that identified, based on Pemex´s perspectives, specific needs and opportunities for energy conservation. The strategy evolved from the analysis of individual energy-using systems by actors external to Pemex, to a pilot program that used Internet-based, energy-analysis tools that allowed, with the collaboration of plant operators, for the analysis of a much larger number of systems. This strategy proved its applicability and coincidence with other programs for safety and environmental protection. The Pemex-Conae effort became a permanent energy efficiency campaign in Pemex with significant reductions in energy consumption and their collateral environmental and economic results. According to Conae, energy savings were close to 5 million barrels of oil equivalent in 2006.[46]

United States

Energy Efficiency Standards

In 1975, The Energy Policy Conservation Act (EPCA) directed the U.S. Department of Energy (DOE) to develop voluntary appliance efficiency targets. The National Energy Conservation Policy Act of 1978 (NECPA) directed DOE to set MEPS in replacement of the EPCA voluntary targets, and gave federal MEPS preemption over state standards. The 1987 National Appliance Energy Conservation Act (NAECA) sets efficiency standards and establishes schedules for mandatory review of standards for each product covered. By law the US must set standards at the maximum improvement in energy efficiency that is technically feasible and economically justified. Very detailed engineering-economic analyses keep the requirements cost-effective for consumers. Since 1978, efficiency standards have been established for a wide range of appliances. Residential products covered under NAECA include refrigerators and freezers, room air conditioners, central air conditioners, furnaces, water heaters, washing machines and dryers, and several other appliances. Some of these standards set minimum energy efficiency levels, while others are prescriptive (for example, washing machines were

[45] Comisión Nacional para el Ahorro de Energía
[46] Comisión Nacional para el Ahorro de Energía, *Informe de Labores 2005, CONAE, 2006*

required to have a cold rinse option). The 1992 Energy Policy Act amended NAECA to establish minimum standards for commercial and industrial equipment, including commercial heating and air-conditioning equipment, water heaters, and electric motors, and directed DOE to develop voluntary national testing and information programs for widely-used types of office equipment

The regulations apply to manufacturers of regulated products or dealers who import regulated products into the United States

Energy Star

Energy Star was established in 1992 by EPA. The Energy Star label is being used by EPA and DOE to promote products and services that save energy and money and help the environment It is now operated jointly with DOE. Energy Star first targeted computers and other office equipment. The program quickly expanded to cover heating equipment and consumer electronics. It now covers over thirty different kinds of products, ranging from consumer electronics to commercial buildings.

Under the Energy Star program, the labels show different information depending on the type of equipment. For office equipment and household electronic equipment, the Energy Star label indicates that the model has certain power management capabilities, and that the manufacturer has undertaken to supply the product with those capabilities "enabled." For other types of equipment, the label indicates that the product is among the most efficient of its type, either because it is in the top percentile of the range on the market, or because it exceeds the MEPS level by a specified margin. The amount by which an appliance must exceed the MEPS differs for each product and is dependent on available technology in each product category.

Energy Star for residential markets

Energy Star for the Residential Markets program provides guidance for homeowners on designing efficiency into kitchen, additions, and whole-home improvement projects and works with major retailers and other organisations to help educate the public. It also offers a web-based audit tool and a home energy benchmark tool to help the homeowner implement a project and monitor progress.

Energy Star for commercial market

This program leads building owners through a comprehensive, five-stage strategy to capitalise on building system interactions so as to maximise energy savings from a given amount of efficiency investment. The program works with more than 5,500 organizations across the country, and in 1999 introduced a system that allows the benchmarking of building energy performance against the national stock.

Building codes and "Beyond Code" programs

During the 1970s, almost all states and local governments established energy efficiency standards for new residential buildings. The 1992 Energy Policy Act made it mandatory for states to certify that their energy codes have been updated to meet or exceed minimum levels of efficiency.

Leading states have adopted a recent version of the International Energy Conservation Code (IECC), or a customized energy code that is at least as stringent as this model code. Also, leading states update their energy codes at least once every three years, and leading states train architects, builders and local code officials in how to comply with new codes.

A number of states and utilities implement programs to encourage construction of new homes and commercial buildings that exceed minimum energy code requirements. These programs typically provide training and technical assistance to architects, builders, and contractors as well as promotion and consumer education. In some cases, financial incentives are offered to builders or homeowners who construct/buy buildings that exceed the minimum code requirements. In the residential sector, many of these programs promote construction of Energy Star new homes.

Utility and public benefits energy efficiency programs

These are ratepayer-funded electric energy efficiency programs, and they include demand-side management (DSM) programs and public benefits energy efficiency programs. Funding for these programs is typically provided through utility rates and/or tariff riders. Some states, including California, Montana, and Oregon, have created a funding mechanism via a separate surcharge known as a pubic benefits fund. Most of the programs are saving electricity at a total cost of 2-3 cents per kWh saved.

DSM consists of the planning, implementing, and monitoring activities of electric utilities that are designed to encourage consumers to modify their level and pattern of electricity usage. In the past, the primary objective of most DSM programs was to provide cost-effective energy and capacity resources to help defer the need for new sources of power, including generating facilities, power purchases, and transmission and distribution capacity additions. However, due to changes occurring within the industry, electric utilities are also using DSM to enhance customer service. DSM refers only to energy and load-shape modifying activities undertaken in response to utility-administered programs. It does not refer to energy and load-shape changes arising from the normal operation of the marketplace or from government-mandated energy efficiency standards.

Leading utilities such as California's investor-owned utilities, Austin Energy, Puget Sound Energy, and Seattle City Light are spending at least 2% of their revenues on energy efficiency and load management programs. These programs are cutting electricity use by 0.8-1.0% per year, from efficiency measures installed each year (p.e., the programs would reduce electricity use by 8-10% from cumulative efforts over 10 years). California and Texas have set energy savings targets for their electric utilities. The national average for electric energy efficiency programs as a percentage of total utility revenues is 0.52%. Cumulative energy savings achieved by electric energy efficiency programs were 1.9% of total national energy (kilowatt-hour) sales in 2003.[47]

Recent trends suggest that the energy utility industry is taking a new look at energy efficiency as a viable and cost-effective long-term resource for system planning and operation, and a proven mechanism for helping utilities meet customer demand, and

[47] York D. and Kushler M. 2005. ACEEE´s 3rd National Scorecard on Utility and Public Benefits Energy Efficiency Programs: A National Review and Update of State-Level Activity. American Council for an Energy-Efficient Economy. October 2005.

discussions are underway about how to de-couple utility profits from sales. Today, most electric and gas distribution utilities have to have sufficient sales of electricity or natural gas to earn adequate revenue to realize their allowed, regulated profit. This regulatory approach gives the utilities no incentive to encourage conservation or efficiency. Proposals are being put forward to change the regulatory system to allow a utility to earn its allowed return with lower sales.

The Federal Energy Management Program (FEMP)

In March 1994, a Presidential *Executive Order 12902* called for reduced energy use in federal buildings. Under this Order, each federal agency was mandated to develop and implement a program with the intent of reducing energy consumption by 30% by the year 2005 compared to 1985 levels, based on energy consumption per-gross-square-foot of its buildings in use, to the extent that these measures are cost-effective. As the lead agency for coordinating the implementation of the energy and water goals, DOE's Federal Energy Management Program (FEMP) offers a variety of resources to assist federal agencies in achieving those goals.

On January 24, 2007, a new Executive Order was put in place. "Strengthening Federal Environmental, Energy, and Transportation Management" strengthens key goals for the federal government. This new Executive Order raises the bar in several areas. It requires agencies to reduce greenhouse gases through a reduction in energy intensity of 3% a year or 30% by the end of fiscal year 2015 (compares with 2% per year and 20% overall from EPAct 2005). The new Executive Order also requires that agencies must ensure new construction/major renovation comply with the 2006 Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU), which was signed at the White House Summit on Federal Sustainable Buildings.

Federal Fleets

With the new Executive Order, agencies must ensure fleet petroleum reduction of 2% annually, increased use of alternative fuels of 10% annually, and use of plug-in hybrids. DOE helps agencies meet requirements for federal fleets and provides information on alternative fuels and alternative fuel vehicles that meet these requirements.

Weatherization Assistance Program

The *Weatherization Assistance Program* provides cost-effective services to low-income families who otherwise could not afford the investment in energy efficiency, giving priority to households with elderly members, persons with disabilities, and children. It is the United States´ longest running, and perhaps most successful energy efficiency program. During the last 30 years, it has provided weatherization services to more than 5.5 million low-income families.

Best Practices Program

This program works with industry to identify plant-wide opportunities for energy savings and process efficiency. The program provides informational resources and tools, technical assistance and demonstrated emerging technologies

Industrial Assessment Center Program (IAC)

Through this program teams of engineering faculty and students from over 26 universities around the country conduct free comprehensive energy audits or industrial assessments. They provide recommendations to eligible small and medium-sized manufacturers to help them identify opportunities to improve productivity, reduce waste and save energy. The program provides funding for the university teams; however all recommended plant improvements that are adopted are financed by the participating private sector companies. More than 8,000 audits and assessments have been performed since 1978.

Energy Savers

Energy Savers provides homeowners with tips for saving energy and money at home and on the road. The Energy Savers web site provides the latest information on energy-saving, efficient technologies.

Energy Performance Contracting (EPC)

A turnkey service, EPC reduces energy and other operating costs by implementing facility-wide energy efficiency improvements. It does this while simultaneously addressing two key barriers to these projects: i) the difficulty organizations have providing the up-front financing necessary to initiate the projects; and ii) the real or perceived risk associated with energy management. The firms that provide EPC services, energy service companies (ESCOs), are able to overcome these barriers through proven engineering capability and innovative financing.

Corporate Average Fuel Economy (CAFE)

The Corporate Average Fuel Economy (CAFE) regulations are intended to improve the average fuel economy of cars and light trucks (trucks, vans and sport utility vehicles) sold in the US. Under CAFE, manufacturers' fleetwide fuel economy averages for cars and light trucks are measured against a federal fuel economy standard for each category of vehicles. It is the sales-weighted average fuel economy, expressed in miles per gallon (mpg), of a manufacturer's fleet of current model year passenger cars or light trucks with a gross vehicle weight rating (GVWR) of 8,500 pounds (3,856 kg) or less, manufactured for sale in the United States. CAFE standards are regulated by he National Highway Traffic Safety Administration (NHTSA) and EPA. [48]

Cars and light trucks are considered separately for CAFE and are held to different standards. As of early 2004, the average for cars must exceed 27.5 mpg and the light truck average must exceed 20.7 mpg. Trucks under 8,500 lb must average 22.5 mpg in 2008, 23.1 mpg in 2009, and 23.5 mpg in 2010.[49] After this, new rules set varying targets based on truck size and class. Recent trends suggest little or no improvement in overall fuel economy levels because of the increased market share of light trucks and sport utility vehicles.

In a proposal published at the beginning of 2006, EPA proposed to revise the methods used to determine the City and Highway estimates that appear on the window stickers

[48] http://en.wikipedia.org/wiki/Corporate_Average_Fuel_Economy#Impact
[49] http://en.wikipedia.org/wiki/Corporate_Average_Fuel_Economy#Impact

of new cars and trucks, in the Fuel Economy Guide and in the Green Vehicle Guide. EPA's proposal aims to bring the MPG estimates closer to the fuel economy consumers actually achieve on the road. The new MPG estimates will take effect with model year 2008 vehicles, which will be available in dealer showrooms in the fall of 2007.[50]

Energy Policy Act of 2005

The Energy Policy Act of 2005 is a statute that was passed by the United States Congress on July 29, 2005 and signed into law by President George W. Bush on August 8, 2005.[51]

- Provides tax breaks of $1.3 billion for conservation and energy efficiency for those making energy conservation improvements to their homes. Specific tax benefits for the home include: $50 for purchasing an advanced main air circulating fan; $150 for installing a highly efficient furnace or boiler; $200 for installing energy efficient windows; $300 for purchasing a highly efficient central air conditioner, heat pump or water heater; 30%, or up to $2000, for the purchase of solar water-heating equipment (excluding equipment used to heat swimming pools or hot tubs). Businesses may be eligible for credits such as: 30% tax credit for the installation of qualifying solar equipment on buildings; business tax credits for companies that build highly energy efficient homes; and credits for companies that manufacture energy efficient appliances such as dishwashers, clothes washers and refrigerators. These tax credits are due to expire after two years, but may be extended in Congress.
- The Act contains provisions for commercial buildings that make improvements to their energy systems. The incentives focus on improvements to lighting, HVAC and building envelope. Often the deductions are combined with participation in demand response programs where buildings agree to curtail usage at peak times for a premium.
- Energy improvements completed in 2006 and 2007 are eligible for tax deductions of as much as $1.80 per square foot. Improvements are compared to a baseline of ASHRAE 2001 standards.
- Extends daylight saving time by approximately four weeks. The bill amends the Uniform Time Act of 1966 by changing the start and end dates of daylight saving time from 2007. Clocks were set ahead one hour on the second Sunday of March instead of the first Sunday of April. Clocks will be set back one hour on the first Sunday in November rather than the last Sunday of October.
- Requires the U.S. Department of Energy to study and report on national benefits of demand response and make a recommendation on achieving specific levels of benefits and encourages time-based pricing and other forms of demand response as a policy decision.

More specifically, the Act establishes a number of measures that add to and/or modify programs already in place:

- *Energy and water saving measures in congressional buildings.* Mandates the Architect of the Capitol to develop, update, and implement a cost effective energy conservation and management plan for all facilities administered by Congress to meet the energy performance requirements for Federal buildings.

[50] U.S. EPA Office of Transportation and Air Quality. *Regulatory Announcement: EPA Proposes New Test Methods for Fuel Economy Window Stickers*. EPA420-F-06-009, January 2006
[51] Energy Policy Act of 2005.http://www.doi.gov/iepa/EnergyPolicyActof2005.pdf, April 30, 2007

- *Energy management requirements for federal buildings.* Mandates the Federal Government to reduce the energy consumption per gross square foot of the Federal buildings in fiscal years 2006 through 2015, as compared with fiscal year 2003. The%age goes from 2% in 2006 to 20% in 2015.
- *Procurement of energy efficient products.* Mandates procurement of Energy Star or FEMP designated energy consuming products.
- *Federal building performance standards.* Federal buildings are to be designed to achieve energy consumption levels that are at least 30% below the levels established in the version of the ASHRAE Standard or the International Energy Conservation Code.
- *State energy programs.* This program mandates DOE to invite, at least once every 3 years, the Governor of each State to review and, if necessary, revise the energy conservation plan of such State. Each State energy conservation plan shall contain a goal, consisting of an improvement of 25% or more in the efficiency of use of energy in the State concerned in calendar year 2012 as compared to calendar year 1990, and may contain interim goals.
- *Energy efficient appliance rebate programs.* Provides money allocations for states that establish (or have established) a State energy efficient appliance rebate program to provide rebates to residential consumers for the purchase of residential Energy Star products to replace used appliances of the same type.
- *Energy strategy for HUD.* Mandates the Secretary of Housing and Urban Development (HUD) to develop and implement an integrated strategy to reduce utility expenses through cost-effective energy conservation and efficiency measures and energy efficient design and construction of public and assisted housing.
- *Low income community energy efficiency pilot program.* This program authorizes DOE to make grants to units of local government, private, non-profit community development organizations to identify and develop alternative, renewable, and distributed energy supplies; and increase energy conservation in low income rural and urban communities.
- *State building energy efficiency codes incentives.* Provides additional funding for implementation of a plan to achieve and document at least a 90% rate of compliance with residential and commercial building energy efficiency codes.
- *Public energy education program.* Mandates DOE to convene an organizational conference for the purpose of establishing an ongoing, self-sustaining national public energy education program.
- *Energy efficiency public information initiative.* Mandates DOE to carry out a comprehensive national program, including advertising and media awareness, to inform consumers about the need and benefits of reduced energy consumption.
- *Energy conservation standards for additional products.* It mandates DOE to produce, within a time frame, a number of new energy conservation standards for products and commercial equipment.
    - Battery charger and external power supply electric energy consumption
    - Ceiling fans and refrigerated beverage vending machines
    - Illuminated exit signs
    - Low voltage dry-type distribution transformers
    - Traffic signal modules and pedestrian modules
    - Unit heaters
    - Medium base compact fluorescent lamps
    - Dehumidifiers
    - Commercial prerinse spray valves
    - Ceiling fans and ceiling fan light kits

    - Very large commercial package air conditioning and heating equipment
    - Commercial refrigerators, freezers, and refrigerator-freezers
    - Automatic commercial ice makers
    - Commercial clothes washers
- *Voluntary agreements.* It allows DOE to enter into voluntary agreements with one or more persons in industrial sectors that consume significant quantities of primary energy for each unit of physical output to reduce the energy intensity of the production activities of the persons that shall have as a goal the reduction of energy intensity by not less than 2.5% each year during the period of calendar years 2007 through 2016. The achievements of participants in these agreements are to be recognized.

4. ENERGY PERFORMANCE STANDARDS

Energy performance standards are mandatory or voluntary requirements for buildings and equipment to meet prescribed levels of energy efficiency. Energy performance standards can play an important role in helping to transform the market towards the use of more efficient products and the construction of more efficient buildings. Among other things, they effectively remove the least efficient products from the market. Both product and building standards have been widely implemented in Canada, the U.S., and Mexico, though building standards still lag behind in Mexico in comparison the other two countries.

An energy performance standard is statistically and/or engineering derived and involves a comprehensive economic and market assessment. Energy performance under specific standards must be determined according to test procedures and, hence, the development or selection of appropriate test standards is an important component of the standards development process. Although government agencies issue the standards, they are usually developed with the active participation of equipment manufacturers, utilities, public entities and other stakeholders.

Generally, there are two types of performance standards. Minimum efficiency standards (also known as Minimum Energy Performance Standards or MEPS) set a "floor" for energy performance and often are established by government legislation. "High efficiency" standards are used to distinguish above average levels of energy performance and, typically, have been used to specify product eligibility in utility demand management programs. Energy performance standards can be either mandatory or voluntary. Mandatory standards require legislation under which product specific regulations are developed.

Energy performance labeling is an important complement to performance standards. By specifying the energy use (in units of energy or currency) of a product either in absolute terms or relative to similar products on the market, the labels help consumers make informed choices about energy end-use products. Labeling can be voluntary or mandatory, but mandatory labeling is much more effective for public education.

Canada

The *Energy Efficiency Act* passed in 1992 and that came into force in 1993 provides for the making and enforcement of regulations concerning mandatory energy performance standards (MEPS) for energy-using products, as well as the labeling of energy-using products and the collection of data. The first regulations under the Act came into effect in 1995, following extensive consultations with the provincial governments, affected industries, utilities, environmental groups, and others (labeling had commenced in 1978 under earlier legislation). The regulations established MEPS for a wide range of energy-using products, with the objective of eliminating the least energy efficient models from the Canadian market.

The regulations apply to dealers (manufacturers or importers) who import regulated products into Canada or ship them from one Canadian province to another. The Federal regulations do not apply to products that are manufactured and sold within one province. However, most provinces have their own energy efficiency regulations, which may differ from the federal regulations or may apply to other classes of equipment.

The federal regulations, which are administered by Natural Resources Canada (NRCan), do not take precedence over provincial regulations for locally-made and sold products.

For the products covered in the federal regulations, the MEPS levels apply equally where the products are incorporated into other products (p.e., where fluorescent lamps and ballasts are sold as part of a complete luminaire). Exports and products which are shipped between provinces only in order to be exported from Canada are exempt from the Federal Regulations.

NRCan also administers the national comparative labeling program, EnerGuide, which has both mandatory and voluntary labeling elements. The EnerGuide label for major household appliances and heating, ventilation, and air conditioning (HVAC) products is administered under the Regulations of Canada's *Energy Efficiency Act*, which specify all details pertaining to the labels, including placement on products. The label applies to both domestic and imported products.

In recent months, a number of changes have been proposed to Energy Efficiency Regulations, which include:[52]

- Ceiling fans and ceiling fan light kits
- Clothes washers – commercial
- Dishwashers
- Dehumidifiers
- Gas furnaces – residential
- Gas unit heaters
- Ice-makers – automatic
- Lamp Packaging Labels for compact fluorescent and incandescent lamps including reflector lamps
- Torchiere lamps
- Traffic and pedestrian signals
- Wine chillers (residential)

Regulatory Process

As part of the regulatory process, OEE consults stakeholders by making public its intentions and providing access to draft proposals. Proposed amendments and important related information are available through its web site in the form of bulletins, and information is also provided as to how to submit comments. [53]

Once approved, the draft proposal is pre-published in the Canada Gazette, Part I, and an official notice is posted on the web site. This allows for public scrutiny during the official 75-day comment period. The proposal is then updated if necessary and proceeds to the final approval and publication in Part II of the Canada Gazette. Another notice is posted on the web site. All public notices relating to pre-publication and publication of the regulations can be found under Regulation Announcements.

[52] Canada´s Energy Efficiency Regulations. http://oee.nrcan.gc.ca/regulations/home_page.cfm
[53] Canada´s Energy Efficiency Regulations. Regulatory processs.
http://oee.nrcan.gc.ca/regulations/process.cfm?text=N&printview=N

Test procedures are generally developed by consensus method at the Canadian Standards Association with participation from regulators (federal/provincial governments), manufacturers, and other interested stakeholders. These documents (generally called "standards") contain the test procedure, recommended minimum levels, and often marking or labeling instructions.

NRCan, through a process of public consultation (bulletins, workshops) and analysis (consumer economics, environmental impact), determines the mandatory MEPS and labeling requirements. The proposed amendments to the regulations are pre-published in the Canada Gazette, upon the approval of a Cabinet committee. A 75-day period for receiving public comments must follow. Depending on the nature of the comments the proposal may be modified, after which it is approved again by Cabinet committee, published in the Canada Gazette for the final time, and implemented.

All regulated energy-using products imported into Canada or shipped between provinces must carry an energy efficiency verification mark from a certification organization accredited by the Standards Council of Canada. The mark, which must be placed on the outside of the product, indicates that the energy performance of the product has been verified.

Before importing products or shipping them between provinces, dealers must ensure that an energy efficiency report for that product has been filed with NRCan. The data in the report are used to verify compliance with MEPS, and also to develop energy labels and directories of labeled products. The Canadian EnerGuide labeling program commenced in 1978. A dealer who imports a covered product or ships it from one province to another must ensure that it is properly labeled, and that the label remains on the product until it is sold at the retail level or leased.

México

Mexico's mandate for energy efficiency standards comes from a generic law, the *Ley Federal Sobre Metrología y Normalización* – Federal Act on Metrology and Standards- of July 16, 1992, which defines two types of standards: voluntary Normas Mexicanas - NMX (Mexican Standards) and mandatory *Normas Oficiales Mexicanas* - NOM (Official Mexican Standards). The NOM are enacted by the Federal Secretariats, according to their areas of competence. In the case of energy efficiency (under the purpose of conserving non-renewable energy resources for future generations), it is SENER, through Conae, which enacts the mandatory standards. These regulations apply to products that are marketed in Mexico.

Under Mexican law and as an element of the standards, Conae also implements a mandatory comparative labeling program for room and central air conditioners, refrigerators and/or refrigerator-freezers, clothes washers, centrifugal residential pumps, gas water heaters, commercial refrigeration, and non-residential building envelopes.

As mentioned previously, Sello FIDE serves as a voluntary energy efficiency provided by FIDE. Appliances labeled under this program are room air conditioners, fluorescent lamps and compact fluorescent lamps (CFLs), refrigerators, refrigerator-freezers, motors, and compressors.

Regulatory Process

The process to establish minimum performance standards is established in the Federal Law on Metrology and Standardization and its rules. Under this law, a Committee has to be established for each standards´ theme. In the case of energy efficiency, it is SENER how has the mandate to do it, but it delegates it to Conae in the so called National Consultative Committee of Standards for the Preservation and Rational Use of Energy Resources (CCNNPURRE) (Comité Consultivo Nacional de Normalización para la Preservación y Uso Racional de los Recursos Energéticos) which is responsible for reviewing all MEPS proposals. Conae presides over and defines membership in CCNNPURRE, which includes representatives from the Secretariats of Economy, Environment, Energy, and Treasury; research institutions such as the Electric Research Institute (Instituto de Investigaciones Eléctricas) and the National University; trade associations such as ANFAD, ANFEAA, and CANAME; and national associations of professionals (p.e., engineers and architects).

Enactment of a new MEPS typically takes about two years and begins with a yearly standardization program that is published yearly by the Secretaría de Economia (SE) in the Diario Oficial de la Federación (DOF). Initially it takes 10 to 12 months to prepare a MEPS proposal and another 210 days to enact the MEPS. A MEPS proposal, together with a cost/benefit analysis from a social perspective is presented to the CCNNPURRE who has 75 days to provide comments. The CCNNPURRE comments are incorporated within the next 30 days and the proposal is then published in the DOF. A period of 60 days for public comment is followed by another 45 days of consultation within CCNNPURRE to incorporate the public comments and approve the final MEPS and/or label and its publication in the DOF.

The NOM includes both the minimum energy performance levels required and the test procedure for determining the equipment performance. Conae is in charge of verifying compliance. Products that require mandatory comparative labels are rated as part of the MEPS process, and the labels show the appliances' efficiency levels in comparison to the MEPS level.

United States

In 1975, The Energy Policy Conservation Act (EPCA) directed DOE to develop voluntary appliance efficiency targets. The National Energy Conservation Policy Act of 1978 (NECPA) directed DOE to set MEPS in replacement of the EPCA voluntary targets, and gave federal MEPS preemption over state standards. The National Appliance Energy Conservation Act of 1987 and amendments of 1988 (NAECA) established MEPS for the twelve categories of appliances covered under EPCA and NECPA and instructed DOE to set MEPS for one additional product if technically feasible and economically justified. It also required DOE to review and update the MEPS to keep pace with technological improvements, and strengthened the preemption of federal MEPS over state standards. The Energy Policy Act of 1992 (EPAct) directed DOE to develop voluntary national testing and information programs for widely-used types of office equipment. It established MEPS for nine categories of energy- and water-using commercial sector products, electric motors, lighting products, plumbing products, and office equipment. It instructed DOE to set MEPS on three additional products if technically feasible and economically justified. Like in Canada, the regulations apply to manufacturers of regulated products or dealers who import regulated products into the United States.

NECPA also required the Federal Trade Commission (FTC) to mandate labels for appliances that indicate their energy consumption. The FTC issued guidelines for the

comparative label in a rule promulgated in November 1979. This required manufacturers of the major home appliance types to place energy labels on their appliances starting in 1980.

Finally, there are two voluntary endorsement labeling programs in the United States. The Energy Policy Act of 1992 directed DOE to support a voluntary office equipment program (Energy Star). Energy Star is a joint effort with DOE and EPA; the lead agency depends on the product. Appliances labeled under this program include office equipment, household appliances and electronics, air conditioners and fans, furnaces and boilers, residential lighting products, and windows and roof products. In addition, a non-profit organization called Green Seal has implemented a voluntary ecolabel since 1992—the Green Seal of Approval—which endorses energy efficient products. Appliances labeled under this program include lamps, clothes washers and dryers, dishwashers, freezers, ranges/ovens, refrigerators, refrigerators-freezers, residential air conditioners, and heat pumps.

Regulatory Process

DOE is required by legislation to set MEPS for a wide range of nominated products. Additionally, those products which are not covered by MEPS but which consume more than a specified amount of energy are to be considered for MEPS. However, MEPS can only be set after a prescribed process of research and consultation, and the MEPS levels must be demonstrated to be technically feasible and cost-effective. MEPS levels are periodically reviewed by DOE, and higher levels are set if the analysis justifies a revision.

A number of analyses are performed in the setting of each MEPS. An engineering analysis identifies and quantifies the cost of energy-saving technologies. Economic analysis looks at historical and projected costs and benefits to consumers, manufacturers, utility companies, and the country. Environmental impacts, including reducing emissions of carbon dioxide and nitrogen oxides, and utilization of chlorofluorocarbons, also are analyzed.

DOE published new process rules in July 1996. The new rules were designed to: 1) provide for early input from stakeholders and support efforts to build consensus on MEPS, 2) increase the predictability of the rulemaking timetable, 3) reduce the time and cost of developing MEPS, 4) ensure increased use of outside expertise, 5) eliminate design options early in the process, 6) ensure thorough analyses of impacts and the use of transparent and robust analytical methods, 7) ensure consideration of non-regulatory approaches, and 8) articulate policies to guide the selection of MEPS. Central to the new process is the consultation with stakeholders at all stages. DOE created an advisory committee to guarantee stakeholders access to the process and the continuing process evaluation and improvement.

The FTC is responsible for the design, implementation and compliance of the US mandatory labeling program. The National Institute of Standards and Technology (NIST) is responsible for the test procedures. The labels use annual energy use (in kWh) as the main comparative indicator. The rating system shows energy (kWh/year), operating cost, and the lowest and highest energy used for similar products. Energy efficiency ratios (p.e., EER or seasonal energy efficiency ratio, SEER) are used for climate-control appliances, for which energy consumption varies by region and seasons. The annual cost appears on the label in the case of room air conditioners, and

on fact sheets and in industry-produced product directories for the other climate-control appliances. To enable manufacturers to produce the correct label, the FTC collects data on the range extremes from time to time, and the DOE publishes the average energy prices to be used in the calculations.

Impacts of MEPS

Canada

According to the Report to Parliament on the *Energy Efficiency Act* for the fiscal year 2004-2005, as a result of Canada's minimum energy performance standards, it is estimated that an aggregate annual energy consumption reduction of more than 178 PJ will be achieved by 2010, with an estimate emissions reduction of 25.6 megatonnes of carbon dioxide. [54]

Of these standards, home appliances and equipment represent almost 65% of the total energy savings, with an estimate of 117 PJ by the year 2010, and 13 megatonnes of CO_2 emission reductions.

México

Energy efficiency standards have represented significant energy savings. According to Conae's information, standards related to electricity end uses have saved an aggregate of 16,065 GWh to end-users by the year 2006 (equivalent to the power consumption of 10 million Mexican households in one year), and resulted in 2,926 MW of avoided power capacity (equal to 6% of Mexico´s installed capacity by the end of 2006).

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[54]Natural Resources Canada, Office of Energy Efficiency, *Improving energy performance in Canada. Report to Parliament under the Energy Efficiency Act for the Fiscal year 2004-2005*, 2006

Energy efficiency standards for water heaters and industrial thermal insulation have resulted in energy savings of 36 Pjoules of LPG by the year 2006 (equal to 10% of a years´ use by residential and commercial end-users).[55]

United States

In the U.S., appliance standards have resulted in significant reductions in energy consumption. In particular, and according to an impact assessment developed by Lawrence Berkeley National Laboratory (LBNL) in 2002, energy efficiency standards for home appliances in force during the period 1988-2007 will reduce primary energy consumption (natural gas and electricity) and GHG emissions in the residential sector by 8% in 2020.[56]

It is expected that these standards will save a total amount of 35,000 PJoules by the year 2020, and 57,000 PJoules by 2030.[57] Benefits for U.S. consumers are estimated in nearly USD 93 billion by the year 2020 and USD 125 billion by the year 2030.

Harmonization

Harmonization refers to the establishment, across national boundaries, of common energy performance test standards, levels of energy performance, and approaches to the energy performance labeling. Internationally, the concept of energy standards harmonization is gaining increased attention as trade is becoming ever more global.

Within NAFTA, Canada the U.S. and Mexico have harmonized three products to the U.S. (and, by extension to the Canadian) standards: three-phase electric motors, refrigerators/freezers, and room air conditioners.

Other products could be subject to harmonization. Table 1 lists products for which one of the following applies:

- Canada, Mexico, and the United States all have MEPS and/or test procedures, but the details of these regulations differ between two or more of the countries; or
- Only two countries have MEPS and/or test procedures, but these are the same or similar.

[55] Comisión Nacional para el Ahorro de Energía, April 16th, 2007: http://www.conae.gob.mx/wb/CONAE/NOM_Conae_ahorros_estimados

[56]Meyers, Stephen; McMahon, James; McNeil, Michael, *Realized and prospective impacts of U.S. energy efficiency standards for residential appliances: 2004 update*. Formal Report, 4th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL 06), June 21-23, 2006

[57] The US consumed about 16,000 Pjoules in the form of gasoline in 2006.

Table 1. Products that could share common MEPS and labels in the Near Term in Canada, Mexico, and the United States

MEPS	Test Procedures
Clothes washers	Clothes washers and dryers
Dishwashers	Dishwashers
Fluorescent lamp ballasts	Fluorescent lamp ballasts
Fluorescent lamps	Fluorescent lamps
Incandescent reflector lamps	Incandescent reflector lamps
Motors	Water heaters
Small motors	Transformers
Single packaged CAC and HPs	

5. EXISTING COOPERATION AGREEMENTS AND OTHER RELATED FORA AND ORGANIZATIONS

The North American Energy Working Group (NAEWG)

The North American Energy Working Group (NAEWG) was established in spring of 2001 by DOE, NRCan and DOE and is led by officials those organizations.

The goals of the NAEWG are to foster communication and cooperation among the governments and energy sectors of the three countries on energy-related matters of common interest and to enhance North American energy trade and interconnections consistent with the goal of sustainable development, for the benefit of all. This cooperative process fully respects the domestic policies, divisions of jurisdictional authority and existing trade obligations of each country.

To achieve these goals, the NAEWG exchanges views and shares information on factors affecting North American energy, including policies and programs, market developments, and anticipated demand and sources of supply. It also identifies issues that need to be addressed, such as regulatory structures, interconnections, technical specifications, and technology research and development.

The scope of the NAEWG's discussions includes the full range of energy development, production, transport and transmission, distribution, and consumption in North America.

It also considers the full range of energy sources, as well as the efficient and clean production and use of energy.

With regards to energy efficiency, NAEWG has served as a driving force to foster the achievement of common goals in terms of energy consumption reduction and efficient use of energy in the three countries.

In this sense, NAEWG created the Energy Efficiency Expert Group, in order to build cooperation on different issues, particularly harmonization of energy efficiency standards.

The Group has focused on establishing significantly similar testing procedures and standards and establishing mutual recognition of each other's analysis and results. The Group's efforts have reduced the costs of compliance with standards and mandatory labeling programs, which have helped reduce the incremental costs of manufacturing and selling energy-using products.

In order to complement the work done by the representatives of the three countries, NAWEG´s Energy Efficiency Experts Group collaborated with the Collaborative Labeling and Appliance Standards Program (CLASP) and the Lawrence Berkeley National Laboratory. As a result of this work, a report on Energy Efficiency Standards and Labels in North America was produced. The report provided an overview and details regarding the MEPS and existing standards in the region, as well as relevant information on regulatory processes, harmonization and products labeled under energy efficiency standards in the three countries.

The Expert Group has met regularly about twice a year and has discussed the following issuies:

- Test procedures
- Voluntary endorsement labels
- Mutual recognition
- Stakeholder involvement
- Long-term harmonization
- Standby power losses
- Transportation

Asia-Pacific Economic Cooperation (APEC)

Asia-Pacific Economic Cooperation (APEC) was established in 1989 to further enhance economic growth and prosperity for the region and to strengthen the Asia-Pacific community.

Since Mexico's incorporation to APEC in 1993, with the support of Canada and the U.S., cooperation activities between the three countries under the scope of APEC fora has been in line with the interests and position their governments have reflected under the NAFTA agreement. Also considering the importance the North American region has for the APEC political and economic balance, a number of initiatives presented by Canada, Mexico or the U.S. with the support of the other two countries, have marked the pace of APEC activities, particularly in the energy sector.

In this sense, NAEWG activities to cooperate on harmonization of energy efficiency standards derived in the creation of a steering committee on energy efficiency standards, under the activities the APEC Energy Working Group have developed since 1997. Other APEC collaboration activities which reflect a unified or common position of the three countries include the development of a number of workshops, demonstration projects and action plan activities.

6. OPPORTUNITIES FOR COOPERATION ON ENERGY EFFICIENCY

Information Exchange

Accurate and timely information is the basis for good-decision making. For those who promote energy efficiency alternatives, information on the way energy is used by the end-users, on the cost of energy, on the technical characteristics and cost of energy efficient products and systems, and on the installation protocols and costs of these products and systems is fundamental to identify the best opportunities. Tri-national cooperation in assembling and disseminating this information would greatly aid the promotion of energy efficient alternatives in the region

The way in which technical information can be made available varies according to the type of information. Under the same categorization established above, the different ways in which tri-national cooperation can promote information exchange on energy efficiency alternatives is discussed below.

- **Energy end-use patterns:** This type of information has very few users, mostly energy producers and research institutions. Under such circumstances, the best way to proceed is to: i) identify sources of this information throughout the region; ii) identify possible users, and iii) inform both the sources and the users about each other. All three of these goals could be addressed by organizing a NAFTA-wide meeting on energy end-use data and the processes involved in gathering them for the most important energy producers and research institutions in the region.
- **Technology:** A technology database, covering energy efficient products from throughout North America, should be made available to all interested parties. In order for the information to be accessible to as wide an audience as possible, the database should be available in hard copy, on diskette or CD-ROM, and via the Internet or other on-line service.
- **Institutional experiences in energy efficiency programs:** For information exchange on institutional experiences, the most effective option may be a set of tri-national workshops and seminars that explore the problems and the solutions that have arisen in the different regional and institutional settings. These meetings may be tied to those on energy end-use patterns.
- **Legislation:** Exchange of information on legislation is to be promoted among energy and environmental policy makers in both the legislative and executive branches of government in the three NAFTA countries. A good means for realizing this opportunity is to convene one or more meetings for these decision makers to exchange ideas and information. This can also serve as an arena for them to formalize future cooperation.

Mutual recognition and harmonization of energy efficiency standards

Standard harmonization collaboration has proven to be successful in the trilateral negotiations and activities between the three NAFTA partners. Harmonization and mutual recognition actions in terms of energy efficiency standards for certain appliances have been carried out under the scope of NAEWG.

Mutual Recognition activities are directed towards defining the adequate mechanisms which facilitate mutual recognition of testing laboratory results for a number of appliances, thus minimizing testing requirements.

Harmonization of energy efficiency standards should then consider a range of test procedures, mutual recognition, and other related energy efficiency promotion activities for the main energy consuming equipment and/or appliances in the three countries.

These efforts should profit from the experience NAEWG has already achieved in this field, as well as should consider ongoing standards processes in the three countries, leading to the update and improvement of MEPS.

Building codes and standards

Building energy performance standards have made significant advances in North America (particularly in the U.S. and Canada) in the residential and commercial sectors. As with other policy instruments, a consensus approach is generally used for the development of these standards. Standards developed by the American Society for Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) often serve as the basis for non-residential performance standards. These standards can either require that the building as a whole consumes less than a specified amount of energy (performance-based) or that specific products or systems are installed (prescriptive).

Building energy performance standards in Canada and the U.S. are either mandatory or voluntary. Mandatory standards are less common than voluntary ones. One of the longest existing mandatory standards is "Title 24" in California. Implemented in 1978 and covering both commercial and residential buildings, Title 24 applies to any new construction that requires a building permit, whether it be for an entire building or for adding individual components such as lighting fixtures.[58] The primary enforcement mechanism is through the withholding of the building permit until it complies with the standard.

A variety of voluntary approaches to energy performance standards for buildings have been implemented to date. In general, they fall into five categories: energy rating and labeling (p.e., R-2000 home program in Canada), energy awards programs, professional guidelines, design tool programs, and design assistance programs.[59]

Incandescent lamp phase-out

After Canada's government has committed to phase out the use of inefficient light bulbs in common applications by 2012 and discussions are now in place in the US to do the same, turning it into a regional policy makes a lot of sense.

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[58]Johnson, Jeffrey A., "Changing the Efficiency in New Buildings: California's Perspective", in the American Council for an Energy Efficient Economy, Summer Study on Energy Efficiency in Buildings, 1992. pp.6 and 118.

[59]Vine, E and J. Harris, *Planning for an Energy Efficient Future: The Experience With Implementing Energy Conservation Programs for New Residential and Commercial Buildings* (Lawrence Berkeley Laboratory, September 1988).

Energy Star

The Energy Star endorsement labeling program—active in the United States and Canada and under consideration in Mexico—is an example of a powerful market transformation tool that meets all of these criteria and can be used in conjunction with other programs. The Energy Star label identifies for purchasers energy-using products that meet specified efficiency criteria (p.e., 10% or more above the minimum standard, in the United States). The label also provides a basis for publicity campaigns, supports government and/or private purchasing programs, and gives manufacturers a motive for designing more efficient products and a tool for marketing them. As in the United States, other programs such as government purchasing guidelines and utility rebate programs can be designed to use the Energy Star label as a criterion of compliance, effectively reinforcing to manufacturers and consumers the common efficiency levels endorsed across the programs.

Technology transfer

Appropriate technology already exists in the North American market to improve industrial, commercial and domestic energy efficiency. For example, materials can reduce heat losses and/or solar gains. Energy efficient lighting and air conditioning equipment, better energy management systems, and design tools for better building design also can contribute to energy efficiency. Technology, however, has not expanded to its full potential, and lack of knowledge and/or trust is one of the most important barriers. Promoting technology transfer is a way by which these barriers can be eliminated.

Technology transfer is the process by which technological knowledge developed in some part of the economic chain (from research to the market place) can be used by other parties for the same and other purposes for which the technology was developed.

Best practices

Best practices have to do with information, technology, organization, trained professionals, intelligent financing, adequate policies and good decision making. Best practice depends on context and resources, on information, technology, finance, trained professionals, and institutions available. Best practices involve many dimensions, such as:

- Technology: Best practice can be the use of the best technology but also the best use of simple technology. A sophisticated data collection system may have the same benefit as the use of a simple measuring tool.
- Projects. There are thousands of examples of good practice in installations—houses, buildings, process plants—in many places in the world. Good design, the right materials, good financing and responsible operation have made them a success.
- Programs. Programs are multiple actions that are organized and led institutionally. Programs can be about one or several of the following.
    - **Information**. We need to make people aware of what is being wasted and why. Information—understood as data that helps in making decisions—is a key element for this.

- **Training**. Human resources are always important to design, purchase, install, operate, monitor and evaluate systems that save energy and make installations more efficient.
- **Financing**. Low rates and/or low transaction-cost loans are always useful to change investment priorities.
- **Incentives**. Rebates, tax deductions and low-interest loans have proven very helpful and can be a very good social investment.

Standby power losses

Almost all electronic appliances consume power in their "standby" modes. This wasted energy is commonly referred to as "standby loss" or "leaking electricity. Most commonly, televisions, audio equipment, as well as major appliances such as refrigerators, dishwashers, and ranges have standby losses. According to some estimates, standby losses account for nearly 10% of residential electricity consumption.

Some activities have been carried out under the scope of NAEWG to explore possibilities for harmonizing regulations on standby losses in the three countries and is preparing a white paper on that topic.

Transportation technologies

Transportation accounts for more than 60% of total energy consumption in North America. In Mexico alone, it is expected that energy consumption resulting from the use of fossil fuels in the transportation sector will increase by 50% in 15 years. Increase estimates in Canada and the U.S. are not far from this figure.

Therefore, there is a need to explore cooperative activities which lead to a more efficient use of energy in the transportation sector. A range of collaborative activities would include:

- New energy efficient technologies
- Fuel improvement
- Development of regulations and harmonization of existing standards concerning energy performance and fuel quality.
- Incentive sound and efficient public transportation through a well integrated urban planning strategy throughout the region

Strengthening of regional, state and local energy efficiency related institutions

State energy commissions in the U.S. and provincial energy agencies have proven to be an important instrument to complement national energy efficiency policies, given that local singularities and conditions are different in every state or province. In this sense, policy adequacy and implementation at the state and local level serves as a mean to put in place effective energy efficiency programs, as well as to enforce national regulations such as MEPS.

Cooperation activities can include a number of issues:

- Technical assistance in the development and implementation of state and local agencies.
- Financial tools and instruments to promote energy efficiency in states and municipalities.
    - Performance contracting
    - Pilot programs
- Revision and application of related energy efficiency regulations and programs.
- Identification of state and local priorities towards energy efficiency.
    - Main stakeholders (industrial, commercial, residential and local governments)
    - Information and awareness campaigns for end-users.

Energy Performance Contracting (EPC)

EPC has existed in the U.S. and Canadian markets since the early 1980s and has become an important industry. Nonetheless, there is a significant opportunity to expand EPC applications in North America, particularly in local government facilities, commercial buildings, high rise apartments, and industry. It appears that EPC is particularly well suited to the Mexican market where the ability to finance energy management investments is limited. To be successful in Mexico, however, it will be necessary to foster an indigenous industry.

Opportunities to facilitate the expansion of EPC under NAFTA include: educating the market about the nature and benefit of the service; developing effective methods for institutions to procure these services; and, particularly in Mexico, ensuring that local engineering companies have the ability and opportunity to participate in this business.

GLOSSARY OF TERMS

Alternative transportation fuels. As defined pursuant to the EPACT, methanol, denatured ethanol, and other alcohols, separately or in mixtures of 85 percent by volume or more (or other percentage not less than 70 as determined by DOE rule) with gasoline or other fuels, CNG, LNG, LPG, hydrogen, coal-derived liquid fuels, fuels other than alcohols derived from biological materials, electricity, or any other fuel determined to be substantially not petroleum and yielding substantial energy security benefits and substantial environmental benefits.

Avoided Costs. The incremental costs of energy and/or capacity, except for the purchase from a qualifying facility, a utility would incur itself in the generation of the energy or its purchase from another source.

Building Code. A national and/or regional set of standards for the design and construction of buildings that specifies either the performance required of a building or the particular materials, methods etc. to be used in construction.

Barrier. Condition or circumstance that causes difficulties in the adoption of an energy-efficient technology.

Capacity. The maximum load a generating unit, generating station, or other electrical apparatus is rated to carry by the user or the manufacturer or can actually carry under existing service conditions.

Carbon Dioxide. A colorless, odorless noncombustible gas with the formula CO2 that is present in the atmosphere. It is formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass), by respiration, which is a slow combustion in animals and plants, and by the gradual oxidation of organic matter in the soil.

Climate Change. The increasing mean global surface temperature of the Earth caused by gases in the atmosphere (including carbon dioxide, methane, nitrous oxide, ozone, and chlorofluorocarbons). The greenhouse effect allows solar radiation to penetrate the Earth's atmosphere but absorbs the infrared radiation returning to space.

Cogeneration. The production of electrical energy and another form of useful energy (such as heat or steam) through the sequential use of energy.

Compact fluorescent lamp. A lamp that produces visible light by fluorescence, especially a glass tube whose inner wall is coated with a material that fluoresces when an electrical current causes a vapor within the tube to discharge electrons.

Conservation. A foregoing or reduction of electric usage for the purpose of saving natural energy resources and limiting peak demand in order to ultimately reduce the capacity requirements for plant and equipment.

Consumer Education. Efforts to provide consumers with skills and knowledge to use their resources wisely in the marketplace.

Customer Assistance Programs. Alternative collection program set up between a utility company and a customer that allows customers to pay utility bills on a percentage-of-the-bill they owe or percentage-of-customer-income instead of paying the full amount owed. These programs are for low-income people who can't pay their bills. These customers must agree to make regular monthly payments based on their new payment plans.

Daylight Saving Time. It is a scheme to get people to wake up earlier and go to bed earlier to save electricity. You set clocks ahead a hour (or more) in spring and set them back in the fall.

Demand (electric). The rate at which electric energy is delivered to or by a system, part of a system, or a piece of equipment. Demand is expressed in kW, kVA, or other suitable units at a given instant or over any designated period of time. The primary source of "demand" is the power-consuming equipment of the customers.

Demand-Side Management (DSM). The planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand. It refers to only energy and load-shape modifying activities that are undertaken in response to utility-administered programs. It does not refer to energy and load-shaped changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards. Demand-Side Management covers the complete range of load-shape objectives, including strategic conservation and load management, as well as strategic load growth.

Demonstration project. The application and integration of a new product or service into an existing or new system.

Economic Efficiency. A term that refers to the optimal production and consumption of goods and services. This generally occurs when prices of products and services reflect their marginal costs. Economic efficiency gains can be achieved through cost reduction, but it is better to think of the concept as actions that promote an increase in overall net value (which includes, but is not limited to, cost reductions).

Efficiency. Under the First Law of Thermodynamics, efficiency is the ratio of work or energy output to work or energy input, and cannot exceed 100%. Efficiency under the Second Law of Thermodynamics is determined by the ratio of the theoretical minimum energy that is required to accomplish a task relative to the energy actually consumed to accomplish the task. Generally, the measured efficiency of a device, as defined by the First Law, will be higher than that defined by the Second Law.

Efficiency Service Company. A company that offers to reduce a client's electricity consumption with the cost savings being split with the client. (See also Energy Services Companies).

Electric Utility. A legal entity that owns and/or operates facilities for the generation, transmission, distribution, or sale of electric energy.

Emission. The release or discharge of a substance into the environment; generally refers to the release of gases or particulates into the air.

End-Use. Any specific activity performed by a sector (residential, commercial, industrial, or transportation) that requires energy, e.g., refrigeration, space heating, water heating, manufacturing process, feedstocks, etc.

Energy Consumption. The amount of energy consumed in the form in which it is acquired by the user. The term excludes electrical generation and distribution losses.

Energy Services Companies (ESCOs). ESCOs would be created in a deregulated, openly competitive electric marketplace. The Energy Services industry would be made up of power aggregators, power marketers and brokers, whose job is to match buyers and sellers, tailor both physical and financial instruments to suit the needs of particular customers, and to allow even the smallest residential customers to form buying groups or cooperatives that will give them the same bargaining power as large industrial customers.

Energy efficiency. The inverse of energy intensiveness: the ratio of energy outputs from a process to the energy inputs (for example, miles traveled per gallon of fuel).

Energy intensity. The ratio of energy consumption to a measure of the demand for services (e.g., number of buildings, total floorspace, floorspace-hours, number of employees, or constant dollar value of Gross Domestic Product for services).

Energy Guide Labels. The labels placed on appliances to enable consumers to compare appliance energy efficiency and energy consumption under specified test conditions as required by the Federal Trade Commission.

Greenhouse gases. Those gases, such as water vapor, carbon dioxide, tropospheric ozone, nitrous oxide, and methane, that are transparent to solar radiation but opaque to long wave radiation. Their action is similar to that of increased humidity in a greenhouse.

Greenhouse Effect. The increasing mean global surface temperature of the Earth caused by gases in the atmosphere (including carbon dioxide, methane, nitrous oxide, ozone, and chlorofluorocarbon). The greenhouse effect allows solar radiation to penetrate, but absorbs the infrared radiation returning to space.

Harmonization. In international law, the process by which different states adopt the same laws.

Incentive. A rebate or some form of payment used to encourage people to implement a given demand-side management (DSM) technology. The incentive is calculated as the amount of the technology costs that must be paid by the utility for the participant test to equal one and achieve the desired benefit/cost ratio to drive the market.

Incandescent lamp. An electric light in which a filament is heated to incandescence by an electric current.

Peak demand. The highest electrical demand within a particular period of time. Daily electric peaks on weekdays occur in late afternoon and early evening. Annual peaks occur on hot summer days.

Primary Energy Consumption. Primary energy consumption is the amount of site consumption, plus losses that occur in the generation, transmission, and distribution of energy.

Public Benefits Fund. Program, funded through a generation or transmission interconnection fee on electricity used, to fund various public purpose programs, such as, low-income energy assistance, energy efficiency, consumer energy education, and renewable energy technologies development and demonstration.

Retrofit. Broad term that applies to any change after the original purchase, such as adding equipment not a part of the original purchase.

Tax Incentives. In general, a means of employing the tax code to stimulate investment in or development of a socially desirable economic objective without the direct expenditure from the budget of a given unit of government. Such incentives can take the form of tax exemptions or credits.

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