ESMAP

Joint UNDP / World Bank **Energy Sector Management Assistance Programme**

c/o The World Bank • 1818 H Street, N.W. • Washington, D.C. 20433 • U.S.A.

COLOMBIA
ENERGY EFFICIENCY REPORT FOR THE COMMERCIAL AND PUBLIC SECTORS

Activity Completion Report
Report No. 184/96

June 1996

Power Development, Efficiency &
Household Fuels Division
Industry and Energy Department
The World Bank
1818 H Street, N.W.
Washington, D. C. 20433

JOINT UNDP / WORLD BANK
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) is a special global technical assistance program run by the World Bank's Industry and Energy Department. ESMAP provides advice to governments on sustainable energy development. Established with the support of UNDP and 15 bilateral official donors in 1983, it focuses on policy and institutional reforms designed to promote increased private investment in energy and supply and end-use energy efficiency; natural gas development; and renewable, rural, and household energy.

GOVERNANCE AND OPERATIONS

ESMAP is governed by a Consultative Group (ESMAP CG), composed of representatives of the UNDP and World Bank, the governments and other institutions providing financial support, and the recipients of ESMAP's assistance. The ESMAP CG is chaired by the World Bank's Vice President, Finance and Private Sector Development, and advised by a Technical Advisory Group (TAG) of independent energy experts that reviews the Programme's strategic agenda, its work program, and other issues. ESMAP is staffed by a cadre of engineers, energy planners, and economists from the Industry and Energy Department of the World Bank. The Director of this Department is also the Manager of ESMAP, responsible for administering the Programme.

FUNDING

ESMAP is a cooperative effort supported by the World Bank, UNDP and other United Nations agencies, the European Community, Organization of American States (OAS), Latin American Energy Organization (OLADE), and public and private donors from countries including Australia, Belgium, Canada, Denmark, Germany, Finland, France, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States.

FURTHER INFORMATION

An up-to-date listing of completed ESMAP projects is appended to this report. For further information or copies of completed ESMAP reports, contact:

ESMAP
c/o Industry and Energy Department
The World Bank
1818 H Street N.W.
Washington, D.C. 20433
U.S.A.

PREFACE

This report is the principal output of a technical assistance activity in Colombia by the World Bank's Energy Sector Management Assistance Program (ESMAP) with support from the USAID. The activity assisted the National Energy Commission (CNE) to identify and review strategic issues and options for improving energy efficiency in residential, commercial, and public sector buildings in Colombia.

The fieldwork for the activity was conducted primarily by staff of the CNE, working in close coordination with the National Development Planning Department of the Ministry of Mines and Energy (MME).

The World Bank/ESMAP Task Manager for the activity was Mr. Philippe Durand. This report was prepared by Ms. Shaheena Khan (Consultant).

ACRONYMS

CNE	National Energy Commission
DNP	National Department of Planning
EEC	European Economic Community
EPM	Empresas Publicas de Medellin
ESMAP	Energy Sector Management Assistance Program
ICONTEC	Instituto Colombiano de Normas Tecnicas
ISA	Interconecci'on Electrica S.A.
OLDE	Latin American Energy Organization
MME	Ministry of Mines and Energy
UNDP	United Nations Development Program

ABBREVIATIONS

DSM	Demand Side Management
GOC	Govemment of Colombia
LPG	Liquified Petroleum Gas
LRAIC	Long Average Incremental Cost
TOE	Ton of Oil Equivalent
US$	United States Dollar
kWh	Killo-Watt-hour

TABLE OF CONTENTS

INTRODUCTION

The objective of this report is to define feasible actions for promoting electricity efficiency in Colombia for the Technical Assistance project which is currently being prepared by the World Bank. It is an excerpt of the 'Energy Efficiency Study for the Residential, Commercial and Public Sectors in Colombia, March 1993.' The Study was conducted by the National Energy Commission (CNE) with close coordination of the National Department of Planning (DNP) and the Ministry of Mines and Energy (MME). It was funded by the World Bank/UNDP Energy Sector Management Assistance Program (ESMAP) which organized a team of international and local consultants in 1991 to assist Colombia in conducting a series of surveys and field investigations so that the nature, scope and techno-economic potential for energy efficiency improvements in the residential, commercial and public sectors could be defined.[1]

Most information on Colombia is based on the situation prevailing in 1992. The Study presents the analysis of energy consumption by the three sectors, viz., residential, commercial and public, on the basis of surveys conducted in the four major cities of Colombia, Barranquilla, Bogota, Cali and Medellin, which together account for 60% of the total energy consumption. The present report isolates the findings in the commercial and public sectors to delineate a way for the formulation of DSM programs for Colombia on grounds of techno-economic justification.

The concept of energy efficiency is new in Colombia which emphasizes the importance of putting in place the main infrastructure elements to promote efficient practices. A more comprehensive approach towards energy demand management would require the removal of existing market barriers and promotion of energy efficient technologies in ways that would achieve the consensus of consumers, utility managers and manufacturers - with a strong political commitment to continue the pursuit of energy efficiency and conservation programs.

Section 1 discusses the impetus to energy efficient practices in Colombia. Sections 2 and 3 review the energy and electricity consumption in the public and commercial sectors, respectively. Section 4 presents the energy savings potentials from the simple housekeeping measures to state of the art technology. Section 5 presents the proposed actions for electricity efficiency in buildings. Commercial and public sector energy efficient practices could be divided into two parts: (a) Existing Buildings and (b) the New Buildings. The main reason for this sub-division is to help program planning and implementation to justify energy savings from the existing buildings with pay-back periods (as technologically estimated) of approximately 3 years; and those one-time saving measures whose payback is realized over the lifetime of buildings, but they demand immediate attention in building designs (of new buildings) to capture what is called 'the lost opportunity resources.[1]

---

[1] It was agreed with the GOC that an energy efficiency study for the industry and transport sectors would be developed separately with the support from the European Economic Community (EEU).

1. BACKGROUND

1.1 Since 1986, ESMAP has supported the process of reform in the energy sector of Colombia. The Technical Assistance Study, mentioned above, was developed after the Government's initiative in 1990 to initiate Economic Modernization Program for improving efficiency in resource allocation.

1.2 Colombia has a high intensity of energy consumption. The average intensity of energy consumption in 1990 was about 430 TOE/1980 MUS$, equivalent to the average intensity of Latin American Energy Organization (OLDE). In the eighties, the average energy demand grew at an annual rate of 2.9% while exhibiting much higher growth in electricity consumption; the average electricity demand of the household sector grew at the rate of 6.5% and accounted for about a half final electricity demand. As a response to higher electricity demand mainly by the residential sector, the power sector responded by installing more generating capacity. Since the energy sector has been central to the economy, the public sector contribution has been about 45 percent in the last decade; the power sector has been absorbing 1/3rd of the total public debt. Inadequate planning, low efficiency and poor maintenance along with poor electricity demand management have led to significant macroeconomic distortions. It has been estimated that if electricity demand is not managed, external demand requirements of the power subsector would be US$ 2.2 billion over the next ten years.

1.3 In order to address the macroeconomic distortions, the Government initiated an Economic Management Program in 1990. For the energy sector, this required a revision of the policy and regulatory framework. On the institutional front, promotion of the private sector ownership has been recognized as imperative for the energy sector to achieve financial autonomy and the Government would encourage the oil and coal exports to earn revenues for alleviation of the financial burden. The concern for high growth in electricity demand on the one hand, and discovery of huge gas reserves on the other hand, has led the Government to focus on natural gas development and LPG distribution as economic substitutes for electricity.

1.4 Energy efficiency and conservation activities form part of the Integrated Resource Planning of the Sector. The ESMAP's Technical Assistance Study has given a broad coverage to the analysis of the residential energy and electricity demand. Distortions in the residential tariffs and their low levels reflect significant subsidies which have been the cause of high residential demand growth in the past. Since subsidies were not well targeted to have economic justification, the end-use analysis derived by the Study reflects highest energy consumption in strata 3&4 as they receive more subsidies than lower income strata 1&2.[2] The detailed analysis of the household demand indicates that the dominant factors affecting the end-use of electricity have been the 'socio-economic strata' and 'availability of end-use'. The Government of Colombia envisages a country-wide gas substitution program, mainly for the household sector. Some fuel

---

[2] In order to present patterns of consumption in the household sector, the Study divides the residential sector into six socio-economic strata.

substitution in the power and industrial sectors would be required to make the high cost of gas transmission and distribution economically justifiable. Since tariff reform is the fore-runner in developing energy efficiency and conservation practices, the present Report does not discuss the end-use practices in the residential sector. Also the impression derived from the above Study is that energy sector restructuring, energy price reform, modernization of the economy and developing natural gas supply are the on-going actions which would significantly improve the efficiency of the energy use in Colombia. However, the commercial sector has been facing average tariff levels which have been higher than LRAIC.[3] On the commercial tariff front, the Study has identified the need for time-of-use tariffs with specific peak and off-peak periods. Beyond tariff reform (which needs substantial improvement on the residential front), the commercial and public sector need efficient technology to take advantage of opportunities that exist for energy savings.

---

[3] The public sector are close to LRAIC.

2. ENERGY CONSUMPTION IN THE PUBLIC AND COMMERCIAL SECTORS

2.1 The buildings in the **commercial sector** have been classified into four major types: offices, restaurants, hotels and retail - which are heterogeneous with respect to their size, type of energy equipment, variations in services. The size and type of buildings, the climatic variations and availability of energy sources determine the patterns of energy use. The **public sector** includes mainly government buildings (offices and services); it is more homogeneous in terms of patterns of occupation and energy use, although building characteristics vary considerably. The above variations made difficult the designing of a representative (small-size) sample for a survey in these two sectors.

2.2 Table 1 shows the estimated distribution of final energy consumption in the establishments surveyed in Bogota, Medellin and Barranquilla by consultants hired to conduct Energy Efficiency Study on Colombia under the World Bank/UNDP Energy Sector Management Assistance Program and by EPM in 1989 (non-representative sample in both cases); it underlines the importance of electricity, natural gas (in Barranquilla) and, to a lesser extent, LPG (in Medellin and Bogota). The surveys conducted divide commercial sector by two types of establishments, retail and hotels/restaurants. See Table 1.

2.3 In the **public sector**, electricity is the most important energy source in the three cities; with almost no other demand than that of electricity in Barranquilla, the public sector in Bogota satisfies about 1/3rd of demand from other sources which include an important share of diesel. The same is true for the public sector in Medellin although other demand than electricity gets shifted from diesel to LPG.

2.4 Except for retail establishments in Barranquilla which mainly consume electricity, the **commercial sector** reflects diversity of fuel use. In Barranquilla, the use of electricity and natural gas reflects high competitiveness for hotels/restaurants - with a slightly higher consumption of electricity (52%) than natural gas (46%).[4] In Bogota, retail establishments use electricity as the primary energy source. For hotels in Bogota, LPG is the main source of energy (43%) followed by electricity (36%). In Medellin, hotels' share of consumption of cocinol/gasoline is the highest (41%); the rest of demand is about equally satisfied by electricity, diesel and LPG. Retail establishments use 31% of LPG followed by diesel (26%), kerosene (23%) and electricity (20%).

---

[4] Barranquilla exists in the Atlantic coast where the consumption of gas is concentrated.

Table 1: Estimated Distribution of Final Energy Consumption in Commercial and Public Sectors (%)

	Retail	Hotels/Restaurants	Public
BOGOTA			
Electricity	67	36	78
LPG	4	43	1
Fuel Oil	25	0	4
Woodfuels	0	14	0
Diesel	3	6	11
Other	1	1	5
MEDELLIN			
Electricity	20	20	69
LPG	31	18	20
Diesel	26	22	8
Kerosene	23	0	0
Cocinol/Gasoline	0	41	0
BARRANQUILLA			
Electricity	1	52	97
Natural Gas	99	46	1
Other	0	2	2

Note: Non-representative sample.
Source: Study surveys, 1991 (Bogota and Barranquilla); EPM, 1989 (Medellin).

3. ELECTRICITY CONSUMPTION IN THE PUBLIC AND COMMERCIAL SECTORS

3.1 In Colombia, the share of electricity in total energy consumption reached 11.4% in 1989 which is more than double its share in 1970.[5] In 1990, the share of electricity sold to the **commercial sector** was 9.9%, **public sector** 6.7% and **public light** 3.2%. In 1989, the commercial sector absorbed 10% of electricity supplied; but electricity requirement was about 65% for meeting the total energy needs of the sector. The public sector absorbed about 7% of total electricity consumption meeting almost all its energy needs.

3.2 Tariffs imposed on the commercial sector have been rising in real terms. The high tariffs in the commercial sector include a significant portion of subsidies for the residential sector. For instance in 1991, average commercial tariffs in Bogota were 180% of LRAIC compared to 43% in the residential sector; in Medellin 114% compared to 50% residential; in Cali, 108% compared to 64% residential and in Barranquilla, the average commercial tariffs were 102% whereas the residential tariffs were only 58% of LRAIC. As a percentage of LRAIC, the public sector tariffs in Cali and Barranquilla were 98 percentage, whereas those for Bogota and Medellin were about 95 percentage.

End-Use of Electricity in the Public and Commercial Sectors

3.3 Table 2 presents the general results of the sample surveys conducted in 1989 and 1991. It may be noted that this sample is not a true representation of the pattern of electricity use in existing buildings as it does not fully account for variations that exist in commercial buildings.[6] However, the general results of surveys suggest the use of efficient lighting across all sectors; refrigeration for retail sector, and cooking for hotels and restaurants. Commercial sector air-conditioning has important shares in Barranquilla and Medellin, and water heating only in Medellin. For the public sector, lighting accounts for half of total consumption. Percentage distribution of electricity consumption by the public and commercial sectors, as reflected by Table 2, is discussed below.

3.4 Public Sector: In Bogota and Medellin, electricity lighting is the most important end-use. However, in Barranquilla, the demand for air conditioning is more than fourfold the demand for lighting. In Medellin, public sector consumption of electricity is more evenly distributed among lighting, air-conditioning and water heating (21%) contrary to what has been observed in Bogota or Barranquilla. Table 2 presents public sector demand for miscellaneous

---

[5] There is no trend identified for the commercial and public sector in the report.

[6] The survey was conducted in Bogot2 (350 establishments) and Barranquilla (29 establishments only); in Medellin the results of a previous survey were used, while no information was obtained for Cali. Two problems must be noted: (a) the three surveys did not request the same information and had different methodologies; (b) in the three cases the samples present a bias towards large and energy-intensive buildings, whose patterns of energy use are approximately reflected in the tables in order to orient energy efficiency actions.

uses subsumed under the category 'other' consisting of water pumping and sewerage disposal. More than 1/3rd of public sector electricity consumption in Bogota and Medellin, and over 50% in Barranquilla goes into such uses.

3.5 Commercial Sector:

(1) ***Retail establishments***: In Bogota, the share of lighting and refrigeration is 62% of the total electricity consumed; refrigeration absorbs about 70 percent higher electricity than lighting. In Medellin and Barranquilla, the most dominant use is that for air-conditioning; its share in Medellin is 35% and in Barranquilla 46% of the total electricity demand. In Medellin and Barranquilla, lighting and refrigeration for retail establishments is less than 1/3rd of the total demand. In Medellin, lighting absorbs 12% and refrigeration 14% ; whereas for Barranquilla, the corresponding shares are 16% and 13%.

(2) ***Hotel establishments***: The dominant demand for electricity by hotels/restaurants is for air conditioning in Barranquilla accounting for 40% of its total electricity demand; and water heating in Medellin accounting for 35% of its total demand.[7] For Medellin, after accounting for over 1/3rd of the share of electricity consumption for water heating, electricity consumption is equally distributed for lighting, air-conditioning, cooking and refrigeration; about the same share (less than 20%) of electricity is absorbed each for lighting and refrigeration in Barranquilla.[8] In Bogota, hotels and restaurants consume 24% of electricity for refrigeration followed by lighting and cooking, each of which has less than 15% share.

---

[7] In Bogota, a small percentage of electricity (3%) is absorbed for water heating and there is no electric water heating for Barranquilla for retail, hotels or public sector.

[8] Electricity consumption for ventilation, water pumping, elevators etc. subsumed in the category 'Other' in Table 2 is the only insignificant share for Medellin compared to other two cities presented.

Table 2: Distribution (%) of Electricity Use

	Lighting (%)	Air Conditioning (%)	Water Heating (%)	Cooking (%)	Refrigeration (%)	Other (%)
BOGOTA						
- Retail	23	2	2	3	39	32
- Hotels	14	2	3	13	24	45
- Public	49	6	5	1	7	32
MEDELLIN						
- Retail	12	35	4	3	14	33
- Hotel	15	16	35	15	16	3
- Public	21	21	22	4	3	30
BARRAN-QUILLA						
-Retail	16	46	0	0	13	25
-Hotel	19	40	0	3	18	20
-Public	8	35	0	1	1	56

Note: The Category 'Other' include ventilation, water pumping, elevators etc.

Source: Study Surveys, 1991 (Bogota, Barranquilla; EPM, 1989 (Medellin).

4. ENERGY SAVING POTENTIALS IN THE EXISTING COMMERCIAL AND PUBLIC BUILDINGS

4.1 In the four cities, Barranquilla, Bogota, Cali and Medellin, eleven (11) buildings were audited to observe the current practices in the use of electricity and assess the opportunities for energy conservation in these buildings. This small sample included three buildings in Barranquilla, one university building in Bogota, four buildings in Cali including a bank, a university and an office and three buildings in Medellin including an apartment complex, a commercial and a municipal building.

4.2 An initial assessment of energy use practices in the commercial and public sector was conducted at the end of 1992 by using the results of surveys and audits of eleven buildings in the four cities mentioned above, discussions with utility managers, engineers, architects and builders. In the commercial sector, the retail and office subsectors use the greatest amount of energy. Office equipment was not considered at this stage.

4.3 In both sectors, lighting and cooling have been observed as the two largest end-uses of electricity absorbing over 40% of energy consumption by the sectors. The Study Team evaluated and identified 26 measures with respect to energy savings potential and cost effectiveness for lighting, cooling and water heating. All measures are cost-effective compared to the incremental cost of electricity which, for Colombia, is in the range of US Cents 6.3 -7.5. Tariff and conservation measures in the commercial sector would lead to an estimated 244 GWh savings in 2005, equivalent to 5.1% of the sector's projected sales. Savings in the public sector would reach 231 GWh in 2005, equivalent to 7% of projected sales. The peak demand savings in the commercial and public sectors would reach 22 MW and 19 MW, respectively, in 2005. It amounts to only 5% of total capacity savings.[9]

4.4 **Lighting**: The technical potential for energy savings in lighting has been identified as 30%. About 18% may be feasible by the year 2005. The general practice at this end-use has been assessed as fairly efficient since 75% of lighting in Colombia is by fluorescent lamps. However, there is a good scope of energy savings once lighting practices at various end-uses are improved. Table A identifies changes in such practices and presents eight measures ranked with respect to their increasing cost and they range from simple housekeeping like delamping to the most efficient T8 electronic magnetic ballasts and on/off photocells. Table A presents the cost of each measure in US$/kWh with its annual potential energy savings when alternative practices at end-use are employed in Colombia.

4.5 The energy saving potential of housekeeping measure and high technological measures is substantial as presented by Table A. According to the estimates, energy savings are the highest, 15 GWh per year, at a negligible cost of less than one cent per kilowatt-hour when housekeeping measure like delamping of over illuminated corridors and common office areas is

---

[9] Load curves were produced for a limited number of establishments surveyed (but not presented in the report).

employed.[10] At present, fluorescent lamps are domestically produced but they do not conform to U.S. Efficiency Standards at which they could yield additional savings of 12 GWh. By replacing existing (domestically produced) magnetic ballast's with efficient ballast's would yield substantial savings at 1.6 cents/kWh. Savings could be further improved by 30% at about the same cost as efficient magnetic ballast if T8 electronic ballast's with 26 mm lamps are used. For producing T8 electronic ballast's, research is needed on lamp/ballast combinations that would permit use of such lighting with variable voltage conditions. The replacement of the inefficient mercury lamps to high pressure sodium or metal halide depends on the degree of color radiation required, i.e., the latter replacement takes place when good color radiation is needed. There could also be cases, when replacement to high pressure sodium may offer high savings but when excellent color radiation could be compromised. Day light controls with advance technology like on/off photo cell control would offer further electricity savings in lighting by 50%. Studies need to be conducted to effectively incorporate this technology into Colombian design practice.

Table A: Energy Efficient Measures For Lighting

Lighting Measures	Alternative Practices at End-Use	Potential Savings, GWh/Yr	Cost US $/kWh
Housekeeping Delamping	Removal of some lamps (from 30 ft candles to 5-15 ft) and reducing lighting in hallways and stairwells	15	.0001
Retrofits 2. Efficient Magnetic Ballast's	For use with CFLs in integral lamps. Use of larger iron cores and substitution of copper for aluminum wiring as in standard ballast's will improve power factor	11	.0159
3. T8 Electronic Magnetic Ballast	To replace conventional ballast's with 4 ft fixtures and improve consumption efficiency from 188 watts to 114 watts	14	.0164
4. Mercury Vapor to High Pressure Sodium	In parking lots and warehouse applications. Mercury lamps are the least efficient high intensity discharge lamps	6.6	.0189
5. Mercury Vapor to Metal Halide	For outdoor lighting where good color radiation is important than in parking lots and warehouse applications	3.2	.0340
6. Fluorescent to High Pressure Sodium	This retrofit to be only considered when excellent rendition which is available with fluorescent is not a critical requirements	6.6	.0276
7. Compact Fluorescent	The life of a CFL is 10,000 hrs. compared to 1,000 hrs of incandescent lamp	12	.0283
8. On/Off Photo Cell Control	Mostly in office buildings, to replace lighting controls from the central breaker panel and to encourage day light savings	10	.0410

[10] Substantial amount of illuminance could be obtained by cleaning the dirty lenses which cover fluorescent lamps in offices and retail sites. Installation of room switches to take advantage of daylight savings in institutional buildings rather than controlling lighting for the whole building from one central breaker panel could yield substantial savings, but at may not be cost-effective at this time.

4.6 Cooling: Cooling systems, especially with respect to control and ventilation practices, are very inefficient in Colombia. Technical savings potential has been estimated at 23% with the feasibility of 12% by 2005. There is a substantial amount of cooling, with fairly constant cooling loads throughout the year, in Medellin, Barranquilla and Cali; the demand for cooling in Bogota is only 5%.

4.7 Cooling systems are by far the most efficient systems in commercial and public buildings. Most equipment is imported from USA and Japan, but control practices are poor and inefficient. Most buildings have no mechanical ventilation systems and rely on operable windows. This practice saves on fan energy but increases cooling energy use. In many buildings where windows are frequently open the net effect will be to increase energy use. Temperature control systems for cooling are operated poorly or are non-existent and in many cases cooling systems continue to operate even when the building might not require cooling. Thermostats exist in some buildings, but they are installed at the return air intake of the packaged unit for cooling. Also, cooling thermostats are usually set well below necessary[11], in particular, to try to compensate for equipment undersizing and for excessive air filtration through windows.

4.8 The use of undersized system reduces the energy load which is not a reflection of efficient practices. Most larger cooling systems are designed by mechanical contractors who are competitively bidding against other contractors. As a result, most cooling systems are undersized and use less energy than a properly sized system.

4.9 Most hotels and small commercial buildings use locally assembled inefficient window air conditioners.[12] Design changes in those systems could have a dramatic effect on overall cooling energy in the commercial sector. Large office buildings use either chillers or packaged direct expansion units which are imported from USA and are relatively efficient. In multi-story buildings, packaged units are used at each floor or several per floor. In this way, billing collection from tenants becomes feasible. Use of commercially available models of such equipment would yield substantial energy savings.

4.10 Cooling towers are used in conjunction with chillers and groups of packaged units but rarely do they have a condenser water temperature control to shut down the cooling tower fan. Condenser water temperature controls help save on fan energy in the tower as outdoor temperatures fall.

4.11 Eleven energy efficient measures were identified with the assessment of general cooling practices in Colombia. Electricity consumption can be substantially reduced by

---

[11] Many of the controls of cooling systems in the buildings visited by the consultants of the study had been set to 65 or 70 degrees F, while recommended levels would be 75-80 degrees F, with 50-60% of relative humidity (in addition most systems do not control air humidity levels).

[12] Some window air conditioners use imported parts.

employing (cost-effective) housekeeping measures 1 to 5 plus 8. See Table B which presents annual potential energy savings (GWh) with respect to the order of the cost of measures.

4.12 Refrigeration is a significant energy user in food stores and restaurants. Many of the small restaurants and stores use residential type refrigerators whereas, large systems are found in luxury hotels and super markets. Large systems appear to have average maintenance and standard practices. In general, maintenance of refrigeration systems have been observed to be generally poor and no visible thermostats were observed in large systems. By merely addressing these two housekeeping measures, substantial energy savings could be achieved. According to the technical estimates, the refrigeration system maintenance in hotels/restaurants can establish significant savings of 13 GWh/year at minimal cost of US 1.7 cents per kWh. Maintenance includes fine tuning of various control points, valves, EMS etc. and cleaning of evaporators, condensers etc. The second measure includes establishment of set point temperatures, which at US 2 cents per kWh, can save 5.8 GWh per year.

4.13 Water Heating. Little hot water is used in the commercial and public sectors, with the exception of hotels.[13] Hot water tanks have minimal insulation and hot water circulation systems run 24 hours daily. For hotels/restaurants, three measures for hot water heating include (a) low flow shower heads, which by reducing water flow from 4-8 gallons per minute to 1-2.75 gallons, have annual potential savings of 13 GWh at a cost of US 3cents per kWh; (b) reducing water temperature at less than 120 degree F will save 3.1 GWh per year and (c) use of circulatory pump clock/sensor would save 0.3 GWh per year at a cost of US 6 cents per kWh.

4.14 It has been realized that most energy/electricity savings could be achieved through improvements in the new building designs which, at present, are dictated by architects and engineers who appear to have little training and interest in energy performance of buildings; for whom design decisions are predominantly based on aesthetics and cost. In the traditional practice, the proposed design for buildings undergoes numerous changes during construction to lower the first cost which results in reduced efficiency and overloaded systems. Building designs, would require a set of building codes and guidelines to assure maximum energy savings. Measures for building designs would include: proper layout designs for achieving maximum energy efficiency, proper location of water heaters, insulation pipe from heater to point of use, location of thermostats, lighting design guidelines to maximize the use of day lighting, electric wiring to ensure energy efficiency etc. Also, to reduce air conditioning loads, reflective window film and reflective roof paint would aim at reducing heat from daylight. Solar heat gain through windows (especially with large glass area) can be a major contributing factor to load on air-conditioning equipment and results in higher than cooling energy requirements. The reflective window film is an adhesive used to paint the inner side of the window or alternatively tinted or reflective plastic can be installed. Reflective roof paint can be incorporated as a design measure. In addition, roof insulation would reduce substantially the energy consumption when efficient

---

[13] In the commercial sector, most water systems are electric because piped natural gas is not accessible in most areas.

air-conditioners are used. Such measures, along with all feasible measures for lighting should be the focus for developing new designs for buildings.

Table B: Energy Efficient Measures For Cooling

Cooling Measures	Alternative Practices at End-Use	Potential Savings GWh/Yr.	Cost US$/ kWh
1. Chilled Water Set point Adjustment	Adjustments to improve chilled water temperature which improves coefficient of performance of chillers	4.8	.0003
2. Install Thermostats	System to work at different loads to avoid wasteful use of energy; installation in the work area where air is not heated	4.8	.0026
3. Temperature Set-point Adjustment & Lock Box Install	Controls to be given to building managers to set temp. at 76-80 F; Thermostats locked in plastic lock box with slots for air circulation to avoid tampering	6.6	.0023
4. High Efficiency Tower Motors	Using improved alloys, tighter windings, & higher bearing tolerances to improve motor efficiency in commercial HVAC system, refrig, swimming pools, industrial processes	0.2	.0062
5. Cooling Tower Controls	Installation of controls for condenser water temperature in cooling towers in an effective way	6.7	.0132
6. High Efficiency Chiller	In large offices, chillers using R-22, R123 & R-134 to replace R11 & R12 of centrifugal chillers; replacement of refrigerant with current efficiency of 0.75 kw/ton by .65/ton & retrofitting of centrifugal chillers with oversized condensers or multiple staging controls to improve efficiency	11	.0137
7. High Efficiency Water Pump Motor	Performance efficiency improved and reducing peak demand in commercial/industrial demand for cooling, ventilation, refrig. & indus processes - by using thinner steel lamination in the stator & rotor cores; minimize gaps between them & using more copper in stator windings;	0.4	.0171
8. Clean Coils	Cleaning of evaporator coil or filters would improve compressor suction pressure and reduce condenser temperature thus reducing energy requirement	8.8	.0271
9. High Efficiency Packaged DX system	Uses 50 tons of air cooling with EER of 10.5 (will be commercially available in 5 years)	22	.0283
10. Efficient Belt Drives	Belts with notches along its length avoids its compression improving efficiency of use of electricity	0.7	.0294
11. High Efficiency Window Cooling Unit	In hotels & small commercial buildings, EER efficiency to increase to 8.5 to 10.2 which requires increasing condenser & evaporator areas & use of more efficient fan motor & compressor	25	.0638
NEW Buildings 1. Reflective Roof Paint	For exterior surfaces of roofs to reduce air conditioning loads - implies that design measure to change	1.7	.0100
2. Reflective Window Film	Reflective or tinted plastic on windows' inner surface to reduce heat producing sunlight while allowing sufficient light to penetrate for daylight purposes; lasts 10-20 years	24	.0155

5. PROPOSED ACTIONS FOR PROMOTING ELECTRICITY EFFICIENCY IN BUILDINGS

5.1 As mentioned above, energy efficiency in buildings is new in Colombia which requires those actions that would establish the platform for energy efficient practices. These actions comprise of education, committee action, development of standards, testing procedures and development of testing facilities. For commercial and public sectors, the program activities need to focus on:

Energy Load Analysis

5.2 It is the technical capability which needs to get established in Colombia. Development of simulation models to establish, monitor and evaluate the effects of energy saving measures, mentioned above, requires compilation of hourly weather data into usable formats. All these activities could fall under Research Centers which, by international collaboration, develop activities that would include identification of conservation potentials for each sector country-wide on the basis of specific energy efficient measures that are conducive to Colombia[14]

Testing and Monitoring of Buildings and Equipment

5.3 Measures which offer potentially large energy savings, but may not be suitable or cost-effective for Colombia requires testing of such technology. Testing or research and development of efficient technologies will be needed to ascertain those measures which are the most cost-effective in Colombia. Full use should be made of the previous testing work in other countries, although local testing should incorporate climatic differences which would help determine the need for developing energy efficient equipment in Colombia - adaptable to the reliability of electricity supply.

Development of Standards and Guidelines

5.4 Prior to developing energy efficient Standards and Guidelines, a working document composed of existing Standards and Guidelines needs to be prepared. The first set of Standards should offer simple and energy efficiency measures which would define specific components rather than target overall building efficiency. The design of building standards would complement the programs for electricity substitution[15], equipment certification and labeling (to encourage the supply of more efficient equipment in the marketplace-both imported and domestically manufactured), and careful planning for the successful implementation of DSM pilot programs. To provide reasonable guidance to designers and owners, it is recommended that

---

[14] Activity (B) below may be combined with research activities or developed separately in Testing centers.

[15] See Section 7.6 below.

two levels of Standards be provided where applicable: (a) Minimum Efficiency Standards which will have a potential of energy and peak demand reductions by 30-35%; and (b) High Efficiency Standards which could produce reductions by 50-60%. Due to this high potential savings, the program is very cost effective. Therefore, developing the first draft of standards is a priority activity for the new commercial and public buildings.

5.5 It has been proposed that a Review Committee, consisting of representatives of building professionals (electrical, architectural, mechanical), equipment suppliers, energy sector operators, as well as government entities, ICONTEC, and universities/research centers-such as Universidad Nacional, Universidad de los Andes, Universidad Javeriana (Bogot2); Universidad del Valle (Cali) will be established by the MME and DNP. It would be responsible for developing Standards and Guidelines by collaborating with a multi-institution, multi-discipline committee. Government representation would provide policy oversight whereas the technical input to the development and implementation of such Standards by the Review Committee requires:

- Review of the selection of the contents of energy Standards, including measures covered, formats, and stringency of requirements and providing guidance accordingly. The contents and formats will probably vary by city, indicating the need for appropriate regional representation.

- Guidance in the identification, scope definition, and accomplishment of any needed research, analysis or related studies.

- Guidance in the implementation of the energy codes and Standards. This can include: information dissemination and technology transfer activities; establishment of regulatory mechanisms; development, implementation, and oversight of compliance procedures.

- Finally, setting of Guidelines and Standards based on the economic analyses for energy efficiency and cost-effective measures. This may involve the revision of Standards for final presentation.

Information Dissemination, Technology Demonstration and Training

5.6 Information dissemination would be mainly through literature distribution which is taken as the first step towards cost-effective demand side management program. Some engineering audits, which may be expensive, need to be done to make the information program more effective. Professional auditing training is very important for commercial buildings as they vary by type, size and system designs. Training, to determine engineering estimates for energy savings by the use of efficient technology, need to be imparted to utility employees, building managers, engineers, architects, equipment suppliers and energy sector decision makers.

5.7 Since lighting holds a promise for substantial energy savings, demonstrations of daylighting controls installed in case study buildings would provide direct examples of the

effectiveness of this technology. Retrofit measures should have a pre-determined payback of about two years. This requires selection of the cost-effective measures by type, size and system design of the buildings. Demonstration buildings should be chosen with care to insure that the buildings are representative of the stock of buildings to be targeted. Special attention should be paid to offices and medium-sized retail buildings which account for a large share of sector-electricity consumption. Showcase building retrofits or demonstration projects can help persuade skeptics of the benefits of efficiency improvements and help determine the actual cost of the retrofits. Specifically for New Buildings, such demonstrations could show that through proper design, lighting quality with energy savings can be improved. Thus, the concept of energy savings through technology demonstration and its direct relationship to reduced energy bills and indirect effects on environment would be the basic training program which should be imparted to the commercial users and some selected household consumers.

5.8 In the professional training of engineers, architects, builders, contractors and university teachers, incorporating new design strategies for achieving maximum energy savings would establish a solid platform for developing energy conservation measures in the Colombian construction industry. The course material to be developed will include information on Standards compliance, general efficiency in buildings, specific strategies and methods such as lighting and daylighting calculations on the basis of illuminating criteria, calculations of external loads imposed on air-conditioning, internal load calculations, ventilation requirements/methods etc. The workshops equipped with computers would provide hands-on experience in energy and economic analysis with software tools selected to fulfill the purpose of load analysis, daylight analysis and lighting power calculations. Broader cooperative arrangement in research and teaching efforts between the domestic and international counterparts working on energy efficiency is needed to promote the state of the art technology adapted to Colombia.

5.9 Organizational framework. The above actions should be developed through a consultative approach between government, manufacturers, retailers and consumers, to ensure that a consensus is attained on the efforts for promoting energy efficient equipment and practices. Also, in order to avoid conflicts of interest and to ensure effective implementation, it will be particularly important to achieve the separation of four important functions in the program:

- standard and testing development, including: developing base standards and testing procedures; certifying testing agencies and controlling uniformity of testing; conducting random spot tests of labeled products; reporting results to government and consumer groups; this function could be fulfilled by ICONTEC;

- equipment testing: certified testing bodies would test equipment selected by ICONTEC, and provide results and recommendations on labeling or no labeling to government and ICONTEC; only one or two such bodies would be necessary at the beginning of the program;

- equipment labeling and compliance, and industry support: a government entity (probably the existing "Committee for National Industry Development and Promotion") should control the process, award and retire labels, strengthen

technology transfer and bilateral linkages (in collaboration with ICONTEC), and organize retailers training;

- consumer education and information and consumer/equipment monitoring: this function could be performed by the distribution utilities and ISA in part in the framework of the pilot and follow-up DSM programs.

REFERENCES

ESMAP Technical Assistance Study, *'Energy Efficiency Study For The Residential Commercial and Public Sectors - Colombia'*, March 1994.

Annexes to the ESMAP Technical Assistance Study, March 1994:

Summary of Rapid Audits of 11 Buildings
Description of Recommended Energy Efficiency Measures for Commercial and Public Buildings.

XENERGY, Inc., *'Current Practices and Efficiency Opportunities in the Commercial and Public Sectors in Colombia'*, January 22, 1992.

Joint UNDP/World Bank

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	*Activity/Report Title*	*Date*	*Number*
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89--	
	Francophone Household Energy Workshop (French)	08/89	103/89
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	--
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessement (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94
Comoros	Energy Assessment (English and French)	01/88	7104-COM
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (English)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings	09/95	175/95
Ethiopia	Energy Assessment (English)	07/84	4741-ET

Region/Country	*Activity/Report Title*	*Date*	*Number*
Ethiopia	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
	Energy Assessment	02/96	179/96
Gabon	Energy Assessment (English)	07/88	6915-GA
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
Guinea	Energy Assessment (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	11/87	--
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87
	Environmental Impact of Woodfuels (French)	10/95	176/95
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87
	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95

Region/Country	*Activity/Report Title*	*Date*	*Number*
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study	06/96	181/96
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
	Energy Assessment (English)	07/93	11672-UNI
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Energy Assessment (English and French)	07/91	8017-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86
	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADC	SADC Regional Power Interconnection Study, Vol. I-IV (English)	12/93	--
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	--
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
	Industrial Energy Conservation Program	05/94	165/94
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--
	Industrial Energy Efficiency Technical Assistance (English)	08/90	122/90
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86

Region/Country	*Activity/Report Title*	*Date*	*Number*
Togo	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English)	03/89	UNDP Terminal Report
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
Zambia	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
	Petroleum Management Assistance (English)	12/89	109/89
	Power Sector Management Institution Building (English)	09/89	--
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	--
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP)	12/94	--

EAST ASIA AND PACIFIC (EAP)

Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
	Energy for Rural Development in China: An Assessment Based on a Joint Chinese/ESMAP Study in Six Counties	06/96	183/96
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90

Region/Country	*Activity/Report Title*	*Date*	*Number*
Indonesia	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Energy Strategy Paper (English)	--	--
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979/SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

SOUTH ASIA (SAS)

Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study (English)	12/88	
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92

Region/Country	*Activity/Report Title*	*Date*	*Number*
India	Power Sector Reform Seminar (English)	04/94	166/94
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84Nepal
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
	National Household Energy Survey and Strategy Fomulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86
	EUROPE AND CENTRAL ASIA (ECA)		
Eastern Europe	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
Portugal	Energy Assessment (English)	04/84	4824-PO
Turkey	Energy Assessment (English)	03/83	3877-TU
	MIDDLE EAST AND NORTH AFRICA (MNA)		
Morocco	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
	Energy Sector Institutional Development Study (English and French)	05/95	173/95
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector(English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91
	LATIN AMERICA AND THE CARIBBEAN (LAC)		
LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	National Energy Plan (Spanish)	08/91	131/91

Region/Country	*Activity/Report Title*	*Date*	*Number*
Bolivia	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94
	Energy Efficiency Report for the Commercial and Public Sector	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
	Private Minihydropower Development Study (English)	11/92	--
	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--
	Management Information System Phase I (English)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
	Energy Efficiency Management Technical Assistance to the Comision Nacional para el Ahorro de Energia (CONAE) (English)	04/96	180/96
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85

Region/Country	*Activity/Report Title*	*Date*	*Number*
Peru	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR
	GLOBAL		
	Energy End Use Efficiency: Research and Strategy (English)	11/89	--
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93
	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	--
	Roundtable on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara	11/95	177/95

06/25/96