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Concept Paper

Energy Efficiency Standards & Labeling for Appliances

Nepal

Nexant

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CONCEPT PAPER

ENERGY EFFICIENCY STANDARDS AND LABELING FOR APPLIANCES IN NEPAL

Prepared for

United States Agency for International Development

Under

South Asia Regional Initiative for Energy

Prepared by

NEXANT SARI/Energy

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Executive Summary

Nepal has no commercially viable gas or oil reserves and only small reserves of coal. Hence, the country is dependent on imported fuels, costing billions of Nepalese Rupees (NR) to fulfill the country's primary energy requirements. Nepal has tremendous hydroelectric power potential, estimated at about 83,000 MW, of which about 44,000 MW is considered to be economically viable. However, only about **1%** of the hydropower potential has currently been developed. Moreover, the current generation capacity has been unable to cope with rising electricity demand and electricity consumers in several sectors have been affected by regular load shedding.

Given the shortages of electricity supply and the need to reduce imported fuels for electricity generation, His Majesty's Government of Nepal has underlined the development of its vast hydropower potential as a key national economic development policy. As a result, Nepal hopes to double its hydropower generation capacity within the next few years. The private sector is now playing a more active role in hydropower development. However, the hydropower investment projects and corresponding electricity grid expansions, worth billions of dollars, have become a significant burden on the country's balance sheet.

SCOPE OF THE CONCEPT PAPER

This concept paper aims to highlight to policymakers in Nepal the importance of Energy Efficiency Standards and Labeling (EE S&L) as a tool for sustainable economic development within an energy sector development strategy. This report also presents information on the broad experiences of similar programs in Asia and worldwide. The experience of EE S&L programs in many countries demonstrates the potential for substantial electricity peak demand reduction and energy savings with attractive cost/benefit ratios. This concept paper also reveals key appliances for EE S&L programs in Nepal, including potential electricity peak demand reduction and energy saving.

APPROACH INVOLVED IN THE CONCEPT PAPER

Demand-side Management (DSM) studies conducted recently in several Asian countries have shown that the cost of saving a unit of energy through energy efficiency strategies generally is much less than producing a unit of energy through new generation. This current study is designed to estimate the potential in Nepal for low cost energy savings through implementation of an effective EE S&L program primarily for domestic appliances. This estimate is based on currently available data and information.

Energy standards involve a set of procedures that define the energy performance of manufactured products, sometimes prohibiting the sale of products where energy consumption is higher than the minimum standard. Energy labels, on the other hand, are the informative labels affixed to manufactured products in order to provide consumers with the data necessary for making informed purchases. An EE S&L program is a demand-side option that offers numerous potential benefits to Nepal. These include reduction in electricity peak demand; increased energy security for sustainable economic development; and increased consumer awareness of energy and the environment.

In the absence of recent statistical data on appliances and electricity load profiles for Nepal, the analysis in this concept paper was based on data gathering from literature researches, questionnaires and expert interviews. Estimates of potential efficiency improvements of domestic appliances based on overseas experience also were used in the analysis.

MAJOR FINDINGS

The electricity supply in Nepal has not been able to meet the rising electricity demand. The industrial and residential sectors are the two largest consuming sectors, each sector currently accounting for about **41%** of total energy consumption. However, the residential sector plays a more significant role in the variation of daily electricity demand, which sharply increases inthe evening due to the use of domestic appliances. Primary home electrical appliances such as lamps, fans and televisions typically add about 100 - 150 MW to the evening peak demand. It is estimated that **50%** of consumers in the residential sector use electricity only for lighting and most of the lamps being used are incandescent lamps.

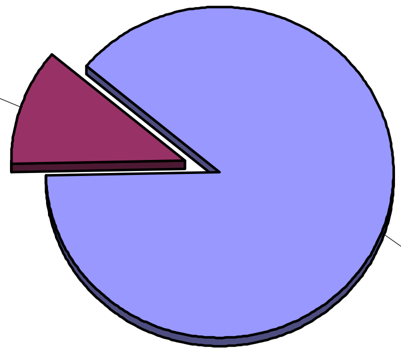
Introduction of an EE S&L program in Nepal covering fluorescent lighting, rice cookers and refrigerators, complemented by a public awareness campaign to promote efficient appliances, could potentially save between 50 - 80 MW in peak demand over a 5-year period. Considering the high transmission and distribution losses, this corresponds to a generation capacity saving between 60 - 100 MW, or more than NRs. 7,700 million capital investment in new capacity. The corresponding reduction in energy consumption is estimated at 215 GWh, or NRs. 990 million over the five-year period.

5-Year Standards and Labeling Program Saving Potential	
Peak Demand Reduction:	50 – 80 MW
Generating Capacity Saving *(Peak Demand Reduction + 25% system loss):*	60 – 100 MW
Cost of 100 MW Power Plant *(100MW x NRs. 77 million/MW[1]):*	**NRs. 7,700 million**
Cumulative Energy Saving:	215 GWh
5-Year Government Saving *(215 GWh x NRs. 4.62/kWh[2]):*	**NRs. 990 million**
Total Standards and Labeling Financial Gain	**NRs.8,690 million**

[1] Based on average US$ 1 million per MW derived from Upper Tamakoshi HEP and Kulekhani-III HEP construction costs. (US$ 1.00 = NRs. 77)

[2] Based on NEA's generation marginal cost at USc 6 per kWh (US$1.00 = NRs. 77)

5-Year Standards and Labeling Program Potential



Total Potential Financial Gain: NRs. 8,690 million

CHALLENGES AHEAD

To achieve a successful EE S&L program, it would be necessary for His Majesty's Government of Nepal to focus on proper planning as well as initiating collaboration among relevant stakeholders. The absence of information on appliance saturation and end-user consumption in different segments of the residential sector in Nepal is one of the key challenges that need addressing in the short term. Other challenges in pursuing the EE S&L concept include:

- Short-term and long-term funding to support EE S&L programs
- A legal framework to facilitate implementation of EE S&L programs
- Availability of local energy performance testing facilities

KEY RECOMMENDATIONS

To establish a sustainable EE S&L program, the following steps are recommended:

1. Establish a Steering Committee with the responsibility of setting energy efficiency standards and labeling for appliances. Such a committee should ideally be comprised of representatives from the following major stakeholders:

   - Nepal Bureau of Standards and Metrology
   - Royal Nepal Academy of Science and Technology, Ministry of Science and Technology

- Inland Revenue Department, Ministry of Finance
- Ministry of Industry, Commerce and Supplies
- Office of Energy Efficiency Services (OEES), Ministry of Industry
- Nepal Electricity Authority (NEA)
- Federation of Nepalese Chambers of Commerce & Industry (FNCCI)

2. Prepare a Plan of Action for the EE S&L program over a specified period.
3. Conduct a detailed feasibility study to include: market surveys on customer awareness and preferences; appliance saturation and usage profiles; scope of appliance efficiency gains; detailed cost/benefit analysis; institutional framework for S&L; and power system characteristics that are likely to impact on S&L.
4. Establish a mechanism to harmonize standard setting and labeling programs with ongoing programs in neighboring countries.

1.1 SARI/ENERGY

The South Asia Regional Initiative for Energy (SARI/Energy) promotes mutually beneficial energy linkages among the nations of South Asia. SARI/Energy is sponsored by the U. S. Agency for International Development (USAID). The first phase of the program began in 2000 and will end by the end of 2003. Under the Energy Efficiency (EE) component, SARI/Energy has identified energy efficiency standards setting and labeling of end-use appliances as an important element to help meet the ever-increasing demand for electricity, which is a major challenge faced by all SARI member countries.

EE Standards and labeling of end-use appliances have been proven to be effective tools to curb electricity demand in many countries. However, due to the poor penetration of EE appliances in most developing countries, there are a number of barriers to their implementation that need to be overcome, such as lack of awareness of the benefits from EE appliances, high initial cost, and non-availability of EE appliances in the market.

Under the technical assistance component of the SARI/Energy Program, Nexant SARI/Energy is proposing to undertake a series of activities to promote Energy Efficiency Standards & Labeling of appliances in the region. The objectives of these activities are to:

- Assist the local standards institutions to understand the benefits from EE standards & labeling;
- Communicate the role and benefits from EE standards in competitive markets;
- Develop a mechanism and network for regional standards setting;
- Evaluate the benefits from regional testing facilities & recognize regional testing bodies for labeling to support EE standards; and
- Establish a monitoring process to determine impacts.

1.2 THE ENERGY STANDARDS AND LABELING CONCEPT PAPER

Nepal has an opportunity to achieve significant energy savings at low cost by implementing energy standards and labeling strategies for a range of domestic appliances. However, there are several components of the program that need to be considered. To achieve a tangible result, the standards and labeling (S&L) programs require coordination and participation from various stakeholders, especially key support from His Majesty's Government of Nepal. This concept paper aims to update policy-makers on the importance of an EE S&L program and its potential benefits; the status of EE S&L programs worldwide, including case studies with cost and benefits; and identify key appliances for EE S&L programs in Nepal, including potential benefits.

2.1 DEFINITIONS

Energy Standards and Labeling programs have been shown to be a cost-effective method to help countries cope with rapidly rising electricity consumption resulting from the proliferation of electrical appliances in the domestic sector. Energy efficiency standards are a set of procedures that define the energy performance of manufactured products, sometimes prohibiting the sale of products where energy consumption is higher than the minimum standard. The term “standard” commonly encompasses two possible elements:

1. A well-defined protocol (or laboratory test procedure) by which to obtain a sufficiently accurate estimation of the energy performance of a product in the way it is typically used, and;
2. A target limit on energy performance (usually a maximum use or minimum efficiency) formally established by an international agency, a widely recognized manufacturer association, or a government-based agency based upon a specified test standard. Minimum Energy Performance Standard (MEPS) is the common term for an energy standard that products must meet before they can be sold.

Energy labels, on the other hand, are the informative labels affixed to manufactured products in order to provide consumers with the data necessary for making informed purchases. They always serve as a complement to the energy standards. The energy labels indicate a product’s energy performance.

Figure 2-1: Endorsement Labels

Generally, energy labels are categorized into two broad categories; **Endorsement labels** and **Comparative labels**. Endorsement labels, as shown in Figure 2-1, are mostly of a voluntary nature and serve as the approval seals from government agencies or institutions. However, comparative labels can be both voluntary and mandatory in nature. The visual designs of comparative labels in use around the world, as shown in Figure 2-2, can be grouped into three basic types:

1. **Dial Type:** This type of label has a “dial” or gauge, with greater efficiency linked to advancement along the gauge (more efficient represented by a clockwise arc). This type of label is used in Australia, Thailand, and Korea and has been proposed for India.

2. **Bar Type:** This type of label uses a bar chart with a grading from best to worst. All grade bars are visible on every label with a marker next to the appropriate bar indicating the grade of the model. This label is used primarily in Europe and South America.

3. **Linear Type:** This label has a linear scale indicating the highest and lowest energy use of models on the market, locating the specific model within that scale. This model is used in North America

There are also many other energy labels that have no graphic concept to support the indication of energy efficiency – these generally rely on text to explain the efficiency or some numeric indicator of efficiency. These labels are also called "Informative-Only Labels".

Figure 2-2: Comparative Labels (bar, linear, dial and informative-only)

2.2 POTENTIAL BENEFITS

Energy standards and labels can play an important role in sustainable development in developing countries. Energy efficiency improvements through S&L strategies can slow the growth in electricity demand, reduce capital expenses for energy infrastructure and also provide savings to electricity consumers. For most developing countries, financing energy sector expansion is a significant burden on the economy. It has been proven that the cost of saving 1 kWh of energy through energy-efficiency programs generally is much less expensive than producing 1 kWh of energy through a new power plant. Energy S&L also offers practical and cost-effective ways to meet both in-country and global environmental objectives. For countries reliant on imported fossil fuels for power generation, a decrease in electricity demand will save valuable foreign exchange, reduce local environmental impacts and conserve indigenous resources.

2.3 STATUS OF STANDARDS AND LABELING PROGRAMS WORLDWIDE

The status of energy S&L programs around the world and the types of equipment and appliances included vary from country to country. Figure 2-3 illustrates the effective years of energy efficiency S&L programs around the world. The most recent updates of Asian S&L programs are given in Table 2-1.

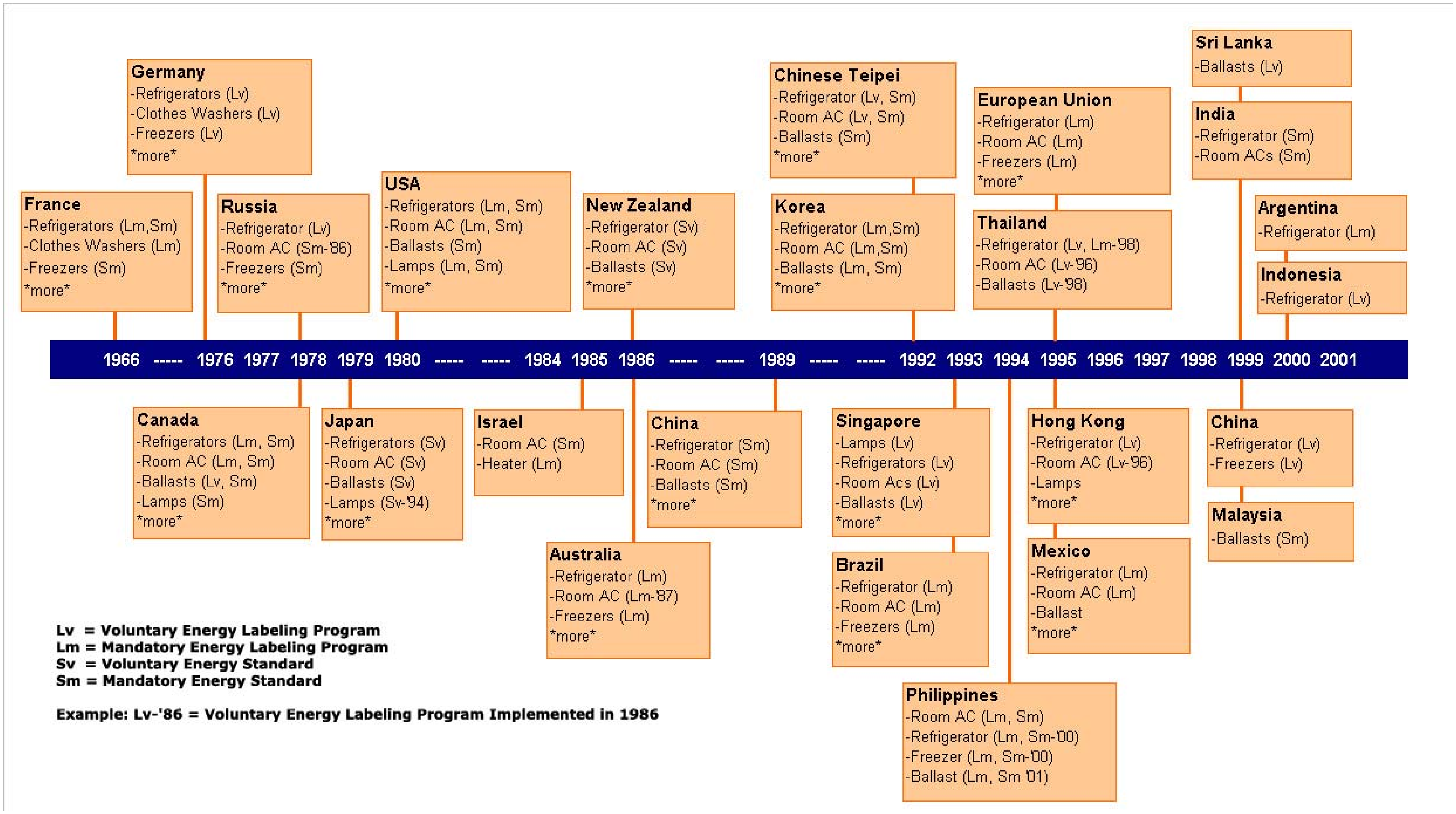

1966 ----- 1976 1977 1978 1979 1980 ----- ----- 1984 1985 1986 ----- ----- 1989 ----- ----- 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
France
-Refrigerators (Lm,Sm)
-Clothes Washers (Lm)
-Freezers (Sm)
more
Germany
-Refrigerators (Lv)
-Clothes Washers (Lv)
-Freezers (Lv)
more
Russia
-Refrigerator (Lv)
-Room AC (Sm-'86)
-Freezers (Sm)
more
USA
-Refrigerators (Lm, Sm)
-Room AC (Lm, Sm)
-Ballasts (Sm)
-Lamps (Lm, Sm)
more
New Zealand
-Refrigerator (Sv)
-Room AC (Sv)
-Ballasts (Sv)
more
Chinese Teipei
-Refrigerator (Lv, Sm)
-Room AC (Lv, Sm)
-Ballasts (Sm)
more
Korea
-Refrigerator (Lm,Sm)
-Room AC (Lm,Sm)
-Ballasts (Lm, Sm)
more
European Union
-Refrigerator (Lm)
-Room AC (Lm)
-Freezers (Lm)
more
Thailand
-Refrigerator (Lv, Lm-'98)
-Room AC (Lv-'96)
-Ballasts (Lv-'98)
Sri Lanka
-Ballasts (Lv)
India
-Refrigerator (Sm)
-Room ACs (Sm)
Argentina
-Refrigerator (Lm)
Indonesia
-Refrigerator (Lv)
Canada
-Refrigerators (Lm, Sm)
-Room AC (Lm, Sm)
-Ballasts (Lv, Sm)
-Lamps (Sm)
more
Japan
-Refrigerators (Sv)
-Room AC (Sv)
-Ballasts (Sv)
-Lamps (Sv-'94)
more
Israel
-Room AC (Sm)
-Heater (Lm)
China
-Refrigerator (Sm)
-Room AC (Sm)
-Ballasts (Sm)
more
Australia
-Refrigerator (Lm)
-Room AC (Lm-'87)
-Freezers (Lm)
more
Singapore
-Lamps (Lv)
-Refrigerators (Lv)
-Room Acs (Lv)
-Ballasts (Lv)
more
Brazil
-Refrigerator (Lm)
-Room AC (Lm)
-Freezers (Lm)
more
Philippines
-Room AC (Lm, Sm)
-Refrigerator (Lm, Sm-'00)
-Freezer (Lm, Sm-'00)
-Ballast (Lm, Sm '01)
Hong Kong
-Refrigerator (Lv)
-Room AC (Lv-'96)
-Lamps
more
Mexico
-Refrigerator (Lm)
-Room AC (Lm)
-Ballast
more
China
-Refrigerator (Lv)
-Freezers (Lv)
Malaysia
-Ballasts (Sm)
Lv = Voluntary Energy Labeling Program
Lm = Mandatory Energy Labeling Program
Sv = Voluntary Energy Standard
Sm = Mandatory Energy Standard
Example: Lv-'86 = Voluntary Energy Labeling Program Implemented in 1986

Table 2-1: Recent Update of Asian Standards and Labeling Programs

Country	Energy Standards and Labeling Program	Remarks
India	Voluntary Energy Labeling	Products: Refrigerators and Freezers, label design was completed in late 1999. The Energy Conservation Bill to foster the development of Indian labeling program was approved by Government of India in 2001.
	Voluntary Minimum Energy Performance Standards	Products: Refrigerators and Freezers (1999)
Sri Lanka	Voluntary Energy Labeling	Products: Ballasts (1999) and CFLs (2001)
Thailand	Mandatory Energy Labeling	Product: Refrigerators (Voluntary in 1995 and Mandatory in 1998)
	Voluntary Energy Labeling	Products: Air-conditioners (1996), Ballasts (1998)
	Mandatory Minimum Energy Performance Standards	Products: Compact Fluorescent lamps, Fluorescent tubes, Ballasts, Refrigerators, Air-Conditioners, Motors (2004)

2.3.1 India

Currently, India's power system has a peak demand deficit of around **14.5%** and transmission and distribution losses of approximately **23%**. This is in part due to the rapidly growing demand in the residential sector. India does not have an established S&L program at this stage. However, since the passage of the Energy Conservation Bill in August 2001, S&L is one of the priority programs to be implemented through the newly established Bureau of Energy Efficiency (BEE). The Bill legally authorizes the issue of Minimum Energy Performance Standards (MEPS) and Labels for equipment and appliances. USAID collaborated with the Ministry of Power and the Bureau of Indian Standards (BIS) to research the design and effectiveness of the label. The label design process is an excellent example of how to develop a relevant national energy label and utilize considerable consumer and stakeholder input. A sample of the label design is given in Figure 2-4.

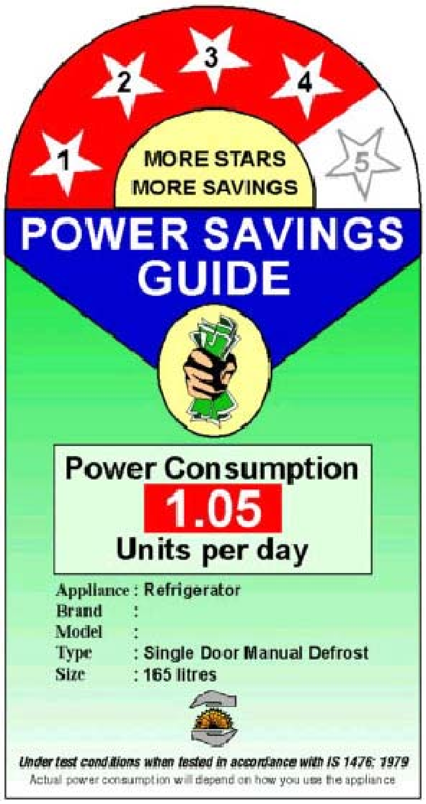


Figure 2-4: Indian Label Design

2.3.2 Sri Lanka

The Ceylon Electricity Board (CEB), in association with the Sri Lanka Standards Institute (SLSI), is currently implementing a ballast energy labeling program on a voluntary basis. This labeling program targets suppliers and large commercial end-users. A sample of the label design is given in Figure 2-5. The National Engineering Research and Development Centre (NERD) will test sample ballasts as per the Sri Lanka standards. Additional testing facilities to support refrigerators are under consideration, to be funded by the World Bank.

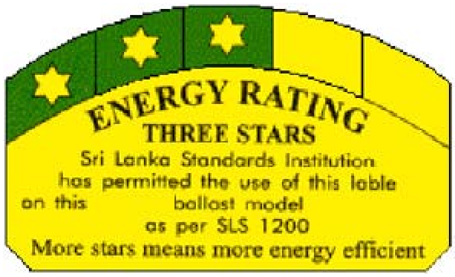


Figure 2-5: Sri Lanka Ballast Label

CEB also intends to seek further funding to cover testing facilities for other appliances, for example, air conditioners, motors, ceiling and table fans, and TVs. In addition to the ballast labeling program, CEB is also initiating a labeling program for Compact Fluorescent Lamps (CFLs).

2.3.3 Thailand

Following the success of the labeling programs for refrigerators, the Demand Side Management Office (DSM) of the Electricity Generating Authority of Thailand (EGAT) reached an agreement with manufacturers to raise the efficiency categories on the label for single-door refrigerators by **20%**, effective January 2001. The success of the energy labeling program led the government to fund the development of Minimum Energy Performance Standards (MEPS) for six types of products, i.e. refrigerators, air conditioners, compact fluorescent lamps (CFLs), fluorescent tube lamps, ballasts and electric motors. The government is expected to adopt the proposed standards in 2004. A sample of the Thai refrigerator label is given in Figure 2-6.

Figure 2-6: Thai Revised Label, 2000

2.4 SUMMARY OF SUCCESS STORIES

EE S&L programs are unique to each country. Some countries have implemented only standards; others only energy labels, and some have implemented both. Table 2-2 provides a summary of the achievements for a sample of countries.

Table 2-2: Summary of Successful Programs and Achievements

Country or Region	Program	Actual Results
Australia	Mandatory Standards and Labels	▪ **11%** reduction in energy consumption of labeled appliances (1992) ▪ Approximately equal to 630 GWh of saved energy or **1.6%** decrease in total household electricity consumption (1992) ▪ Estimated **12%** and **6%** lower electricity consumption of refrigerators and air conditioners respectively ▪ **14** - **33%** further reduction in refrigerator energy consumption with MEPS introduction
European Union	Mandatory Standards and Labels	▪ The average efficiency of the cold-appliance market has improved by approximately **27%** since the introduction of labels and MEPS. (1990/1992-1999) ▪ **6%** improvement on annual energy efficiency of refrigerators and freezers (1990/1992-1994) and an additional **4.5%** from 1994 to 1996 (only energy labeling program)
Korea	Mandatory Standards and Labels	▪ **39%**improvement in fluorescent lamp efficiency (1993-2000) ▪ **74%** decrease in refrigerator energy consumption (1993-2000) ▪ **54%** improvement in air-conditioner efficiency (1993-2000)
Philippines	Mandatory Standards and Labels	▪ **23%** improvement in energy consumption of all air conditioner units between 1992 and 1997 ▪ Energy Savings: 6 MW in demand and 17GWh in consumption (after first year)
Thailand	Voluntary Labels	▪ **12%** decrease in refrigerator energy consumption (1995-1999) ▪ Energy Savings: 168 MW in demand and 1,167 GWh in consumption. (as of June 2000)

Note: Details of successful programs are given in Appendix A.

Nepal has no commercially feasible reserves of oil or gas, and only small reserves of coal; and hence, is dependent on imported fuels to meet its primary energy needs. Nepal has tremendous hydroelectric power potential, estimated at 83,000 MW, of which about 44,000 MW is considered to be economically viable. However, only about **1%** of the hydropower potential has so far been harnessed. Current generation capacity is inadequate to meet the rising electricity demand and as a result Nepal has faced consistent power shortages over the past decade.

3.1 ENERGY POLICIES AND REGULATIONS

3.1.1 National Energy Policy

Nepal is in the process of developing a comprehensive national energy policy. At present, the only national policy relating to energy is the Hydro-Power Development Policy, published in 1992. This policy aims to encourage national and foreign private sector investment in the development of hydroelectric power in order to meet future electricity demand. Revenue generation from the export of hydroelectric power and the use of biomass and indigenous fossil fuels in lieu of electricity are also included in the policy.

3.1.2 Power Sector Demand-Side Policy and Programs

The country has experienced an average peak demand growth of **12%** during 1980 to 1990 and power supply shortages over the last decade have driven Nepal to focus on supply-side development rather than options on the demand-side. A concept paper entitled Demand-Side Management of the Power Sector was prepared for the Water and Energy Commission Secretariat in 1996, but policy or direction relating to power sector demand-side management is still under consideration by the government.

3.2 ELECTRICITY DEMAND AND SUPPLY

During the past decade, the demand of electricity in Nepal has out weighed the increase in generation capacity. As a result electricity consumers in several sectors have been affected by regular load shedding. This problem is currently being addressed through the development of hydroelectric resources.

3.2.1 Structure of Power Sector

The Ministry of Water Resources (MOWR) is responsible for all activities related to generation and supply of electricity. The Nepal Electricity Authority (NEA), established in 1985, is responsible for planning, procurement and construction of power plants, as well as generation, transmission and distribution of electricity. As stated in the Hydro-Power Development Policy of 1992, private sector investments relating to generation, transmission and distribution of hydroelectricity is the preferred option of the government.

3.2.2 Electricity Supply

Nepal's installed electricity generating capacity in 2001 was 440 MW, of which about **80%** was hydropower generation and the remaining diesel generation (Table 3-1). The hydropower supply capability in Nepal varies from month to month due to the dependence on run-of-river systems. This supply structure is in contrast to the demand structure. The electricity demand reaches peak in winter, when the generating capability of run-of-river plants is at the minimum level. The reliability of generation is also affected by the postponement of planned maintenance of power stations. Moreover, transmission and distribution losses (system losses) are currently running at approximately **25%**. Furthermore, not all installed capacity is available and as a result, the generation plants have been unable to meet system peak demand or required system reliability. The recorded system maximum demand in December 2001 was 425 MW.

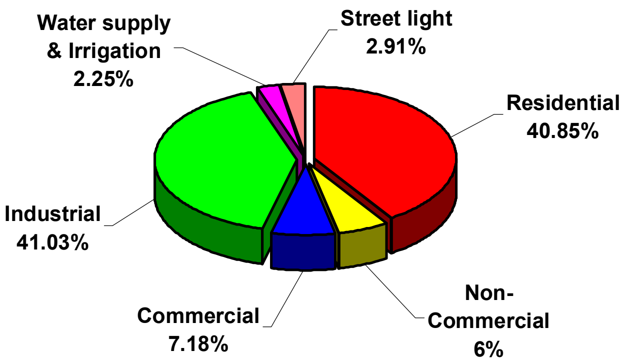
Table 3-1: Total Installed Capacity

Generating Plants	MW
Hydro Power Station	251.15
Small Hydro Power Station	18.97
Diesel Power Station	56.76
IPP	113.4
Solar	0.1
Total	**440.38**

Source: NEA annual report 2000

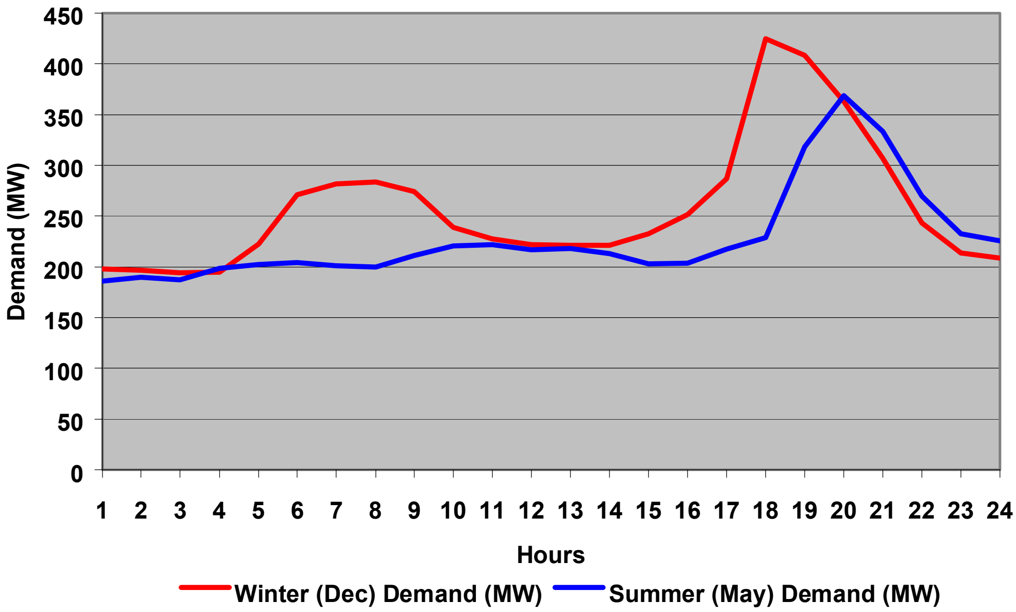
3.2.3 Electricity Demand

Currently, approximately **17%** of the population has access to electricity, and per capita energy consumption is among the lowest in the world. The number of electricity consumers in 2001 including small isolated systems was around 800,000. The industrial and residential sectors are the two largest consuming sectors, with each currently accounting for about **41%** of total energy consumption (see Figure 3-1). The average system load profile, as given in Figure 3-2, shows a significant evening peak demand both in winter and summer periods. The increase in demand in the winter months could be attributed to heating requirements. However, the evening peak, generally between 6pm to 9pm, is primarily attributed to increased demand in the residential sector through lighting, cooking and heating. Due to generation shortages, load shedding during the evening peak period is a regular occurrence.



Source: NEA

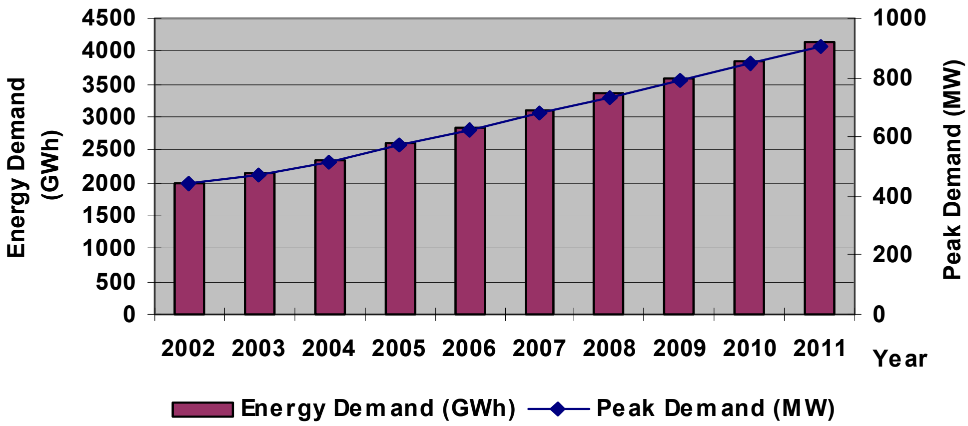
Figure 3-1: Consumption by Sectors, 2000



Source: NEA

Figure 3-2: Daily Load Profile, 2001

The average annual demand growth between 1996 and 2001 was less than **8%**, due to supply capacity constraints. The maximum system demand does not reflect the real demand but is rather an indication of available generation capacity. The load forecast for the Integrated Nepal Power System given in Figure 3-3 is a forecast based on supply constraints.



Source: NEA annual report 2000/2001

Figure 3-3: Forecast Electricity Demand

3.2.4 Power Development Plan

The "Hydro-Power Development Policy, 1992" has resulted in growing private sector investment in Nepal. The hydropower projects currently planned or under construction are expected to double the country's hydro generating capacity over the next few years. To improve efficiency of transmission and distribution networks, the Asian Development Bank (ADB) has agreed to provide US$50 million loan to Nepal for the implementation of rural electrification, transmission and distribution projects.

3.3 ELECTRICAL APPLIANCES – TYPES AND SATURATION

With only around **17%** of the population having access to electricity, the percentage of domestic households using electrical appliances is naturally very low. There is currently no available statistical data on household appliances in Nepal, but clearly the home appliances that serve needs such as lighting, heating, cooling and entertainment are among the most common.

It was estimated that **50%** of consumers in the residential sector use electricity only for lighting. In addition to lighting equipment, the urban population owns televisions, electric fans, rice cookers, refrigerators, etc. In electrified rural areas, only a small percentage of consumers use electrical appliances, however, televisions are becoming more and more popular. It is estimated that the residential sector adds an extra 100-to-150MW to electricity demand during the evening peak, which typically occurs between 1700 – 2100 hours.

A survey, conducted by CERF/IIEC, revealed that incandescent lamps, which are mostly imported from India, dominate the lighting market. According to the Federation of Nepalese Chambers of Commerce and Industry, electrical goods worth approximately NRs. 500 million are imported from India every year (Table 3-2). The growth of the lighting market in Nepal has been curbed by the quality and availability of electricity but significant growth is expected once the current supply situation is addressed. Estimates of the percentage of appliances used in domestic households, from CERF/IIEC secondary research, are given in Table 3-3.

Table 3-2: Value of Imported Electrical Goods (NRs. Million)

Origin	1994/1995	1995/1996	1996/1997	1997/1998	1998/1999
India	535	560	449	618	663
Other countries	2,103	1,874	1,876	1,272	2,132
Total	**2,638**	**2,434**	**2,325**	**1,890**	**2,795**

Source: FNCCI

Table 3-3: Electrical Appliances – Types and Saturation

Appliance	Household Saturation (%)
Lamp	17%
Television	3%
Rice Cooker	6%

Source: Industry interviews

4.1 SELECTED APPLIANCES

Among primary household appliances, all electricity consumers use either incandescent or fluorescent lighting. Based on limited sales data available, it appears that incandescent lamps[3] dominate the market. Based on experiences in other countries, it is considered that S&L for fluorescent lighting would yield the greatest energy efficiency benefits to Nepal. In addition to lighting, the impact of two other appliances—rice cookers and refrigerators—were considered. In the absence of statistical appliance data from Nepal, appliance efficiency gains from programs in other countries were used in the analysis.

4.2 ELECTRICITY DEMAND AND ENERGY IMPACTS

The estimated electricity demand and energy impacts from S&L programs for lighting, rice cookers and refrigerators were analyzed for two scenarios, as described below. The variables considered in the two scenarios are only for lighting, while the impacts of S&L for rice cookers and refrigerators remain constant. The assumptions made for the impact analysis are given in Appendix B.

4.2.1 Scenario I

Nepal introduces an energy standard that prescribes minimum quality, efficiency and lifetime for Compact Fluorescent Lamps (CFLs)[4] that are both imported and locally manufactured. In addition, an energy labeling program is introduced for CFLs supported by a public awareness campaign to promote efficient lighting. As a result of the S&L programs, CFLs penetrate the incandescent lamp market share at the rate of **10%** per annum.

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[3] An incandescent lamp works by heating a filament, a double-spiral coil of very thin tungsten wire, with an electric current until it radiates visible light. Modern tungsten filaments operate at about 2,500° C and, at that high temperature the lamp life is around 1,000 hours. Because only around 12% of the thermal radiation is visible, an incandescent lamp can deliver only 11-14 lumens per watt.

[4] Compact fluorescent lamps (CFLs) are miniaturized versions of fluorescent tube lighting. Some units consist of a lamp and a separate ballast, while others have the ballast built in. CFLs are designed with the bases that can directly fit into the conventional sockets for incandescent lamps. CFLs produce more light for less power and typically last for 6,000 to 8,000 hours. A good CFL will deliver 55-60 lumens per watt, compared to 11-14 lumens per watt for an incandescent lamp, thus an equivalent energy saving of around 80%.

4.2.2 Scenario II

As a result of an aggressive S&L program in Nepal, the market penetration of CFLs into the incandescent lamp market increases market share by **15%** per annum. In addition to the CFL program, Nepal also introduces an S&L program for fluorescent tubes[5] and as a result the market for 40W fluorescent tubes (T12) is totally transformed to using 36W fluorescent tubes (T8) within 5 years.

4.2.3 Estimated Benefits

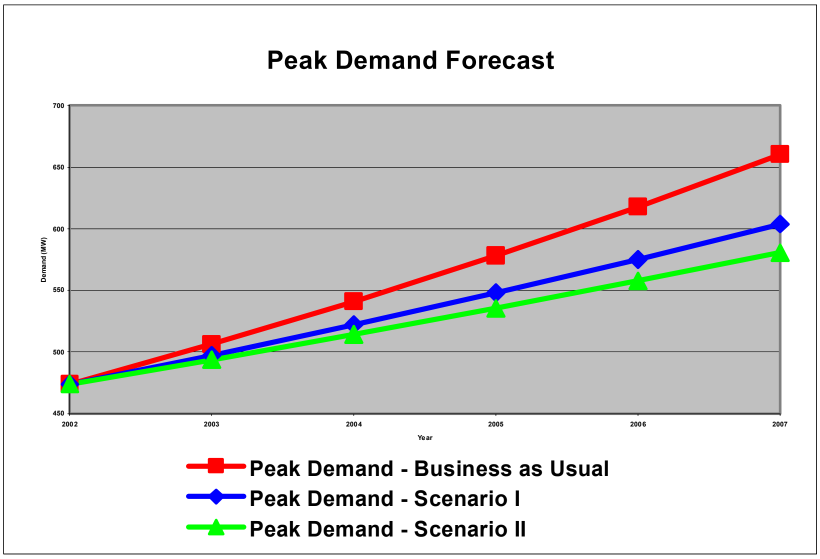
With the introduction of an energy S&L program covering fluorescent lighting, rice cookers and refrigerators, complemented by a public awareness campaign to promote efficient appliances, Nepal could potentially save between 50-to-80 MW[6] in peak demand over a 5-year period. Considering the current high level of transmission and distribution losses, this corresponds to a generation capacity saving between 60-to-100 MW or more than NRs. 7,700 million[7] capital investment in new capacity. The corresponding reduction in energy consumption is estimated at 215 GWh or NRs. 990 million[8] over the 5-year period. Impacts of the S&L programs as per scenarios I and II are illustrated in Figure 4-1 and Figure 4-2, and details of the analysis are given in Appendix B.

[5] A fluorescent tube or a fluorescent lamp is an electric discharge lamp that generates light from a phosphor-coated tube. To operate a fluorescent lamp, a device called "ballast" must be equipped in the lighting circuit. The fluorescent lamps come in a wide range of lengths and a number of different diameters. The older fat "T12", or 1.5 inch (38 mm) diameter tube is less efficient than the thinner "T8", or 1.0 inch (26 mm) diameter tube. T8 tubes paired with electronic ballasts can reach efficiencies approaching 100 lumens per watt, while the older technologies may yield about 65 lumens per watt.

[6] The potential 50 to 80 MW peak demand saving is conservatively estimated from daily usage patterns of energy efficient rice cookers (2hrs/day) and refrigerators (5hrs/day cycling), and the use of energy efficient lamps during the evening peak hours (4hrs/day). See details of the analysis in Appendix B

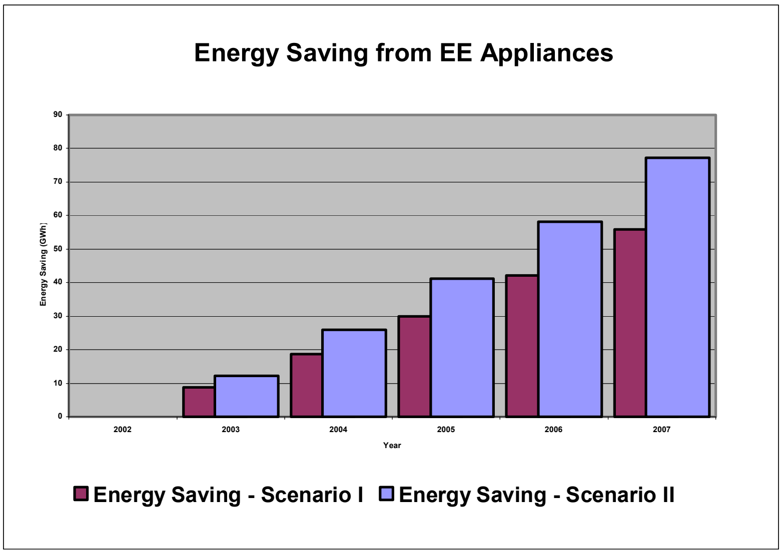
[7] Due to 25% transmission and distribution losses, 50 to 80 MW peak demand is equivalent to 60 to 100 MW generating capacity (50 to 80 MW x 125%). Based on existing hydropower plant construction, it is estimated that each MW of hydropower plant costs US$ 1 million, so Nepal requires US$ 100 million or NRs. 7,700 million to build 100 MW power plant (US$1.00 = NRs. 77). See details of the calculations in Appendix B.

[8] Based on NEA's generation marginal cost at USc 6 per kWh or NRs. 4.62 per kWh (US$1.00 = NRs. 77), to generate the cumulative 215 GWh of energy over five-year period will cost NEA NRs. 990 million. See details of the calculations in Appendix B.



Source: IIEC

Figure 4-1: Impacts of S&L Programs on Electricity Peak Demand



Source: IIEC

Figure 4-2: Impacts of S&L Programs on Energy Saving

Section 5 Recommendations

The analysis in Section 4 reveals the potential benefits of an EE S&L program for lighting, rice cookers and refrigerators in Nepal. In addition, EE S&L programs in other countries for other domestic appliances such as electric fans, ballasts, room heaters and water heaters, have been shown to yield significant benefits. However, due to limited information available in Nepal, the analysis of potential benefits of an EE S&L program for these appliances could not be undertaken.

To broaden the perspective of benefits of appliance EE S&L programs, it would be necessary for His Majesty's Government of Nepal to gather more information on appliance saturation and end-use consumption in different segments of the residential sector. Market research to determine customer awareness, appliance types and purchasing preferences also would be required.

In order to establish a sustainable EE S&L program in Nepal, the following steps are recommended:

1. Establish a Steering Committee with the responsibility of setting energy efficiency standards and labeling for appliances. Such a committee should ideally be comprised of representatives from the following major stakeholders:

   - Nepal Bureau of Standard and Metrology
   - Royal Nepal Academy of Science and Technology, Ministry of Science and Technology
   - Inland Revenue Department, Ministry of Finance
   - Ministry of Industry, Commerce and Supplies
   - Office of Energy Efficiency Services (OEES), Ministry of Industry
   - Nepal Electricity Authority (NEA)
   - Federation of Nepalese Chambers of Commerce & Industry (FNCCI)

2. Prepare a Plan of Action for an EE S&L program in Nepal over a specified period.
3. Conduct a detailed feasibility study to include: market surveys on customer awareness and preferences; appliance saturation and usage profiles; scope of appliance efficiency gains; detailed cost and benefit analysis; institutional framework for S&L; and power system characteristics that are likely to impact S&L programs.
4. Establish a mechanism to harmonize standard setting and labeling programs with ongoing programs in neighboring countries.

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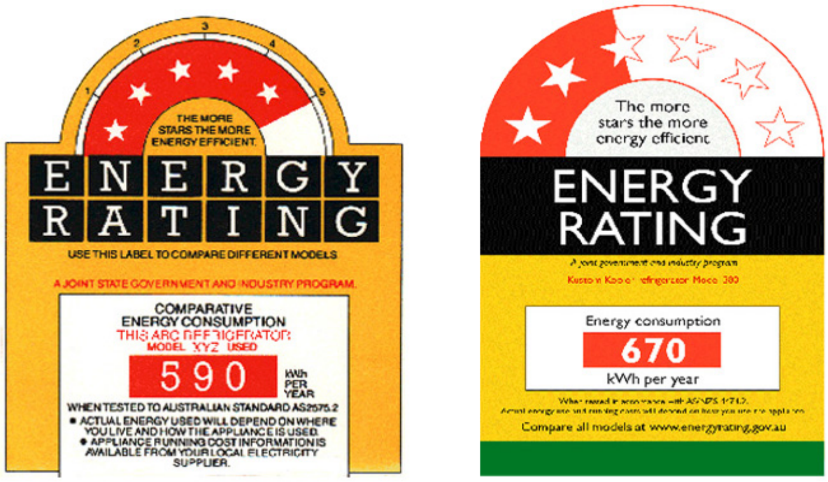
AUSTRALIA

Energy Standards and Labeling Program

The energy labeling and standards program in Australia originated in 1982, when the Government of the State of New South Wales (NSW) first realized energy savings from energy efficient appliances such as refrigerators and freezers. In 1985, after unsuccessful attempts to introduce a nationwide voluntary scheme, the NSW and Victorian governments enacted regulations mandating energy labeling for refrigerators, freezers, dishwashers and air conditioners. Australia's two largest cities, Sydney and Melbourne, account for some **60%** of the national appliance market. The mandatory energy labeling for refrigerators and freezers became effective in 1986. Labels were later introduced for room air-conditioners and dishwashers in 1987 and 1988, respectively. Now the remaining States have adopted these energy labels. To complement the energy labeling program, Minimum Energy Performance Standards (MEPS) for refrigerators, freezers and electric storage water heaters were introduced in 1999. MEPS for three-phase packaged air conditioners and three phase-electric motors were implemented in 2001/02. Fluorescent lamp ballast MEPS are under consideration for 2003.

The energy labeling program in Australia has been successful because suppliers perceived a commercial value in having 5 star products (more stars denote more efficiency). Once products have reached 5 stars, the incentive for suppliers to introduce better efficient models was reduced. Following several years of negotiation between government and industry, the Energy Rating Label was revised in 2000, increasing the efficiency levels needed to obtain equivalent star rating. For example, 4 stars under the old system may now only rate 2 or 3 stars under the new (Figure A-1).



Original Australian Label (1986) Revised Australian Label (2000)

Figure A-1: Australian Original and Revised Labels

Implementation Structures and Costs

In Australia, labeling and MEPS programs are controlled by the state rather than the national legislature. The labeling program requires the cooperation of several organizations. Firstly, each State and Territory Government is responsible for legislation, regulations and administration. This includes requiring labels to be displayed, monitoring performance and imposing penalties for non-compliance. Secondly, in order to gain consistency across the country, the National Appliance and Equipment Energy Efficiency Committee (NAEEEC) has been established to provide a coordinating role for the program. NAEEEC determines policy and sets the future directions for labeling. Finally, Standards Australia is charged with establishing test procedures and with publishing regulatory standards that show how to calculate ratings, configure the labels, and specify other program requirements.

It is mandatory for manufacturers and importers to register energy labels for designated appliances before retailers in Australia can sell them. The costs of energy performance testing as well as producing and fixing labels are passed on to consumers. All administration costs for the program that burden government or electric utilities are also passed on to consumers. These include administration costs to cover policy and regulation, check testing of appliances and costs of promotion, which include the cost of retail liaison staff and production and distribution of guides and leaflets.

Results

The Australian energy labeling program has been very successful. Among randomly selected appliance buyers who participated in a 1993 survey, nearly **90%** were aware of the energy label and **45%** used the information on the label to compare models in the market. In another survey (1991), it was found that **28.4%** of respondents considered the energy-efficiency rating to be the most important factor when purchasing a new electrical appliance. The energy labeling program has been attributed to reducing energy consumption of the labeled appliances by an estimated **11%**, or 94 GWh, in 1992. Refrigerators and air conditioners consumed **12%** and **6%** less electricity, respectively. This amounted to a **1.6%** decrease in the total household electricity consumption in Australia. With an introduction of MEPS, a further reduction of between **14%-33%** in refrigerator energy consumption has been achieved.

EUROPE

Energy Standards and Labeling Program

After 16 years of debate, the European Commission (EC) enacted a Framework Directive for mandatory energy labeling in 1992. This grants the EC authority to issue energy labels for appliances (refrigerators, freezers, air-conditioners, washing machines, clothes dryers, dishwashers, ovens, water heaters, and lighting sources) without seeking additional political approval from the Council of Ministers or the European Parliament. It is the responsibility of each individual Member State to translate directives into laws, only then do the labeling requirements become mandatory. In terms of legal implementation, all 15 EU Member States have now implemented the directives, but most were late in doing so. Only four countries met the implementation deadline of January 1995, an additional seven countries completed the procedure within one year after the deadline, and the remaining four were staggered over the next three years. The EU appliance energy labels all follow a similar format. The energy efficiency of a given appliance is ranked into one of 7 bins graded from A to G, A being the *most efficient* and G being the *least efficient*.

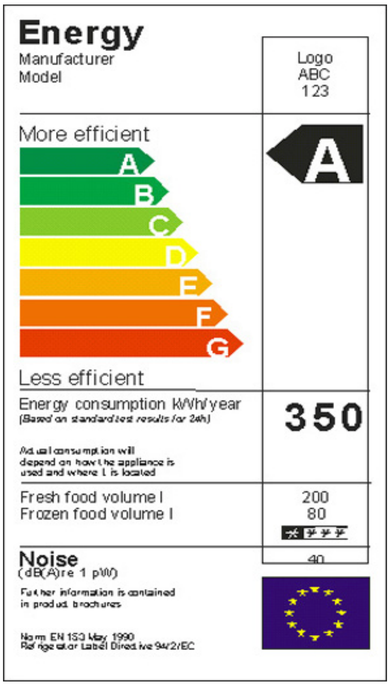


Figure A-2: European Label

There have also been attempts to improve appliance efficiencies in a non-regulatory manner but those efforts are not uniform. Another EC directive in 1992 allowed for the introduction of an EU-wide eco-labeling scheme. This voluntary program covers several appliances, which must also meet energy efficiency criteria. The eco-label can be incorporated into the design of the comparative label.

Unlike energy labeling, there is no framework legislation giving the Commission authority to introduce or revise energy efficiency standards on an on-going basis. European Union members need to gain approval from the EC and the Parliament in order to introduce or revise mandatory energy efficiency standards for any product. To date only two appliances have mandatory standards. MEPS for domestic gas or oil fired hot water services were approved in 1992, taking effect in 1998, and the refrigerator and freezer MEPS, which was approved in 1996, took effect in 1999. The parliament has also recently approved a proposal covering MEPS for Fluorescent Lighting Ballasts.

Implementation Structures and Costs

Member States are responsible for all aspects of implementation including compliance, label accuracy, and educational and promotional activities. Product suppliers need to provide proof of appliance efficiency and are also responsible for the supply of labels and brochures in appropriate languages.

Results

The mandatory nature of the program has spurred manufacturers to improve the efficiency of their products. In Germany, for example, the efficiency of products in the market improved by **16.1%** from 1993 to 1996, while the efficiency of products in the market in Netherlands improved by **12.6%** from 1992 to 1995. In the United Kingdom, efficiency of refrigerator-freezers increased by **7.3%** between 1994 and 1996. The current trend in the EU suggests that the program is expected to save 278 TWh between 1996 and 2020 for refrigerators, freezers, and refrigerator/freezers; this is roughly a **10%** decrease in projected electricity demand for these appliances. The estimated savings translate into more than US$40 billion in avoided electricity spending for consumers, if constant real electricity prices are assumed.

PHILIPPINES

Energy Standards and Labeling Program

After years of co-ordination with manufacturer associations and the Department of Trade and Industry's Bureau of Product Standards (BPS), the Philippine Department Of Energy (PDOE) launched the Standards and Labeling program in late 1993, and began labeling air conditioners in early 1994. Air conditioners, both imported and domestic models, are required to meet a minimum efficiency standard and are to be labeled. Air conditioners are given priority because, while only penetrating a small fraction of households, they represent one of the fastest growing electricity end-uses in the residential sector. In 1997, the standard was tightened so that the Energy Efficiency Ratio (EER) increases **5%** every three years until 2002. In late 1999, the the Fuels and Appliance Testing Laboratory (FATL) launched the energy labeling program for refrigerators and freezers and the program became mandatory in 2000. The mandatory energy standards and labeling of electromagnetic fluorescent ballasts and split-type air-conditioners is to begin in 2002.

Figure A-3: AirCon and Ballast label

The energy label for single-package room air-conditioners is provided in Figure A-3.

Implementation Structures and Costs

The PDOE, BPS and the Association of Home Appliance Manufacturers (AHAM) jointly administer the AirCon program, while BPS is responsible for enforcing the standards. PDOE also established the Fuels and Appliance Testing Laboratory (FATL), which serves as a neutral testing laboratory to verify manufacturers' assertions of the efficiency of their units. The annual operating cost of FATL is about US$160,000 to $200,000 and the initial construction of the laboratory cost US$675,000. The average price of an air conditioner increased by US$30, about **5%** of a unit's total cost, due to the program.

The PDOE also administers the public awareness campaign. One of PDOE's most recent initiatives is a nationwide campaign, known as POWER PATROL, an awareness-building campaign initiated by the private sector and supported by the government. The campaign gives emphasis and brings into focus the significance of power conservation and the efficient use of energy through the Committee on Power Conservation and Demand Management (CPCMD). To push the campaign to cover all sectors, the CPCDM formed three task forces which serve as its implementing arms: a task force for schools and educational institutions, a task force for commercial and industrial establishments and a task force for household and villages.

Results

Before the program started, only half of the annual sales volume for small-sized, window-type air conditioners met the standard, while none of the larger units did. By forcing these units off the market, the program had an immediate and pronounced effect in the overall efficiency of air conditioners in the market. Due to the “push” of standards and the “pull” of labels, an analysis conducted by FATL suggests an improvement of **23%** in energy consumption of all air-conditioning units between 1992 and 1996. Estimates of the program are preliminary at best, but it appears that the standards component of the program resulted in first-year capacity savings of 6 MW and energy savings of over 17 GWh. The estimates do not incorporate efficiency improvements in split systems or from the labeling component of the program. The impact of the program will increase with time because the number of air conditioners in the country is rising dramatically. In 2000, the average EER of Room Air Conditioner (RAC) products sold was 10.1 for below 12,000 kJ/h and 9.6 for above 12,000 kJ/h.

SOUTH KOREA

Energy Standards and Labeling Program

A surplus of electric power capacity during the summer in Korea abruptly fell from 52% in 1987 to **5%** in 1991.[9] Major appliances, except air conditioners, are already saturated in the market. The saturation of room air conditioners has rapidly increased. The energy standards and labeling program was introduced in 1992, and it has played a key role in curbing the steep growth of electricity consumption. In the beginning, 6 items were included in the program, i.e. refrigerators and freezers, room air-conditioners, incandescent lamps, fluorescent lamps, ballast and passenger cars. The energy efficiency standards program consists of a mandatory energy efficiency rating label, a Minimum Energy Performance Standard (MEPS) and a Target Energy Performance Standard (TEPS). MEPS is mandatory; TEPS is voluntary.

The rating label established a 5-rank system for labeling the energy use of appliances. The most energy efficient models (products that correspond to TEPS) receive a grade 1, and the least efficient models (products that correspond to MEPS) receive a grade 5.

Figure A-4: Korean Label

Implementation Structure and Costs

The Ministry of Commerce, Industry and Energy (MOCIE) established the Korean Energy Management Corporation KEMCO) to implement energy efficiency and conservation programs in 1980. MOCIE is responsible for establishing the framework for the program, including setting/revising and announcing standards. KEMCO is also charged with implementation and monitoring of the program. The Korea Institute of Energy Research (KIER) is mainly involved in standards

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9 CLASP February 2001- Energy Efficiency Labels & Standards- “ A Guidebook for Appliances Equipment and Lighting”.

setting (in consultation with MOCIE, KEMCO, and with manufacturers and importers) and formulates energy efficiency standards and rating labeling rules.

Eight laboratories and research institutes provide testing services in support of the standards and labeling programs. Upon testing the product, the testing laboratory provides the manufacturer or importer with an official efficiency level, which the manufacturer or importer then reports to KEMCO.

Results

A survey in 1994 and 1996 conducted by KEMCO has shown that:

- The program has very high visibility and recognition.
- **85%** of consumers and **96%** of appliance purchasers were aware of the label.
- **72%** of consumers said they used the information to compare appliances prior to purchase.
- The result of the survey showed that consumers gave energy efficiency equal importance with other key appliance characteristics such as price, function, brand and size.

The percentage of energy efficient appliances in the market (grade 1 or grade 2) has steadily increased from **53.3%** in 1993 to **67.5%** in 2000, in spite of the reinforced and higher level energy efficiency standards and rating in 1996, 1999, 2001 for each product. Between 1993 and 2000, refrigerators and air-conditioners have shown an improvement in efficiency of **74%** and **54%** respectively.

THAILAND

Energy Standards and Labeling Program

Thailand has energy efficiency labeling programs for refrigerators, air conditioners and ballasts for fluorescent lamps under the national DSM plan. All programs are entirely voluntary and are not associated with minimum energy efficiency standards. The Electricity Generating Authority of Thailand (EGAT), the national generating utility, administers the programs through its DSM Office. EGAT established voluntary labeling programs for the two largest energy-consuming appliances in the residential sector – refrigerators and air-conditioners in 1995 and 1996 respectively (Figure A-5). The energy efficient ballast labeling program was introduced in 1998. Currently, the Thai government is expanding the voluntary labeling program by establishing minimum efficiency performance standards (MEPS) for air-conditioners, refrigerators, ballasts, compact fluorescent lamps (CFLs), fluorescent lamps (FLs) and motors.

The efficiency scale on the label for each model is 1 to 5, with 5 being the most efficient. Starting from January 2001, the efficiency level of each category on single-door refrigerator label was increased by **20%**.

Administrative Structure and Costs

Aside from EGAT, other government institutions involved in setting up standards and labeling programs include: the National Energy Policy Office (NEPO), the Thailand Industrial Standard Institute (TISI), the Department of Energy Development and Promotion

(DEDP) and the Office of Consumer Protection (OCP). NEPO has a mandate to formulate national energy policy while DEDP is responsible for implementing the policy. Both NEPO and DEDP have legal authority to issue energy efficiency standards and labels. Testing for EGAT's voluntary labeling programs for refrigerators and air-conditioners is done at the Thai Industrial Standard Institute (TISI).

EGAT has allocated US$ 7.8 million for the refrigerator program and US$47 million for the air-conditioner program. EGAT launched a consumer awareness campaign promoting the importance of saving energy and became one of the largest advertisers in Thailand during 1995-1996. In addition to the EGAT nationwide television campaign, manufacturers also launched promotional campaigns emphasizing the energy-saving benefits of their products.

Figure A-5: Thai Original and Revised Labels

Results

The success of the programs was due both to market pull from consumer demand and market push from the voluntary agreements made by manufacturers. When the refrigerator labeling program began in 1995, only one model earned a "5" rating. Out of the participating refrigerators (i.e. refrigerators for which manufacturers requested labels), **33%** were rated at 3, **55%** were rated at 4, and **12%** were rated at 5. The share of "5" rating refrigerators increased from **12%** in 1995 to **96%** in 1998. The average energy consumption of participating refrigerators dropped by **12%** between **1995 and 1999. The market share of "5" rating air-conditioners also increased from 19% in 1996 to 38**% in 1998.

As of June 2000, EGAT estimated that the refrigerator and air-conditioner labeling programs have reduced 168 MW in peak demand and 1,167 GWh in energy consumption. These figures have exceeded EGAT's initial expectations by more than three times.

ASSUMPTIONS USED IN THE ANALYSIS

Due to the lack of comprehensive appliance consumption data for Nepal, the analysis of potential impacts from the energy efficiency standards and labeling programs includes only those domestic appliances shown in Table B-1.

Table B-1: Types of Appliances Included in the Analysis

Appliance	Estimated Units in Operation (million)
Incandescent lamp (40W)	3.0
Fluorescent lamp (T12, 40W)	0.3
Compact Fluorescent lamp (10W)	0.05
Rice Cooker (500W)	0.3
Refrigerators (250W)	0.04

Source: Industry interviews and estimation

The estimated reduction of electricity peak demand from 2002 to 2007 resulting from a S&L program for lighting, rice cookers and refrigerators, and the corresponding energy savings is derived from the accumulation of decreased energy consumed due to energy efficient appliances over the next 5-year period. The assumptions used in the analysis are given in the table below:

Table B-2: Assumptions for Impact Analysis

Particular	Assumption	Basis or Source
Average Energy Cost	NRs. 7.00/kWh	NEA's annual report
Generation Marginal Cost	Usc 6/kWh or NRs. 4.62/kWh (US$ 1.00 = NRs. 77)	NEA
Hydro Power Plant Construction Avoided Cost	US$ 1 million/MW or NRs. 77 million/MW (US$ 1.00 = NRs. 77)	Based on the construction costs of Upper Tamakoshi HEP and Kulekhani-III HEP
Daily load profile	Same pattern for over next 5 years	NEA's statistical data
Electricity demand growth	8% per annum	NEA's forecast
Appliance market growth	6% per annum	
Electrified household (2001)	800,000	NEA's statistical data and expert interview
Number of Incandescent Lamps per household	4 Units	
Pattern of Lamps used in electrified household	Ratio Incandescent/fluorescent tube/CFL = 9/1/0.1	Industry interviews

Lamps wattage and daily burning hours	Incandescent lamps = 40W CFLs = 10W T12 Fluorescent tube = 40W T8 Fluorescent tube = 36W Daily burning hours = 4 hrs.	A fluorescent tube is equipped with a standard ballast (10W) in each lighting circuit.
Average Rice Cooker Wattage and daily usage hours	Standard Model = 500W Energy Efficient Model = 450W Daily usage hours = 2 hrs. (1 hr. in the morning and 1 hr. in the after noon)	Data published by NEA and the energy efficient model is 10% more efficient than the standard model.
Average Refrigerator Wattage and daily usage hours	Standard Model = 250W Energy Efficient Model = 220W Daily usage hours = 5 hrs.	Based on average daily kWh consumed of standard and energy efficient refrigerators in Thailand
Coincidence Factor	Lamps = 0.8 Televisions and rice cookers = 0.5 Refrigerators = 0.25	
Penetration rate of 10W (average) CFLs to 40W (average) incandescent lamp market	Scenario I: 10% per annum Scenario II: 15% per annum	
Penetration rate of 36W fluorescent tubes to 40W fluorescent tube market	Scenario I: 0% per annum Scenario II: 20% per annum	
Penetration rate of 450W rice cookers to 500W rice cooker market	Scenario I: 10% per annum Scenario II: 10% per annum	
Penetration rate of 250W refrigerators to 220W refrigerator market	Scenario I: 10% per annum Scenario II: 10% per annum	

ENERGY SAVING AND BENEFITS CALCULATION

Given the limitation of end-use data for electrical energy and appliances, the energy saving calculation is based on the daily load profile and number of key appliances in operation during the system peak period rather than on the household saturation of each appliance, unit energy consumption of each appliance and number of households. The following equations are used in the calculation of electricity peak demand and energy demand for the appliances included in the analysis.

Electricity Peak Demand (MW) = Σ [Number of each type of appliances in operation during the evening peak (in million) x Average nominal wattage (W) x Coincidence Factor] + Average daytime demand (MW) (1)

Energy Demand During the Evening Peak hours (GWh) = [2.5 x Σ Electricity Peak Demand generated by each type of appliances (MW)]/1000 (2)

Daily Energy Demand (GWh) = [Daily operating hours x Number of operating appliances (in million) x Average nominal wattage (W)]/1000 (3)

Equation (2), derived from the linear regression method, is limited only to the calculation of GWh generated by lamps during the evening peak hours, while equation (3) is used for the calculation of daily GWh from rice cookers and refrigerators.

Potential Peak Demand and Energy Saving

The potential 50 to 80 MW peak demand saving and 156 to 215 GWh cumulative energy saving over a 5-year period, shown in Table B-4, are conservatively estimated from the assumptions on daily usage pattern of energy efficient rice cookers and refrigerators, and the use of energy efficient lamps during the evening peak hours as per current system load profile. The number of energy efficient appliances increases as per assumptions in scenario I and II. The analysis of benefits from energy S&L programs in this concept paper does not include the electricity saving from the use of efficient lamps during off-peak hours and other indirect social, environmental and economic benefits.

Financial Benefits

Peak Demand Saving	= 57 to 80 MW	
Transmission and Distribution Losses	= 25%	
Generation Capacity Saving	= 57 to 80 MW/(125%) = 70 to 100 MW	(4)
Hydro Power Plant Avoided Costs	= NRs. 77 million/MW	(5)
Total Hydro Power Plant Avoided Costs	= (4)x(5) = **NRs. 5,390 to 7,700 million**	(6)
5-Year Cumulative Energy Saving	= 157 to 215 GWh	(7)
NEA's Generation Marginal Cost	= NRs. 4.62/kWh	(8)
5-Year NEA's Generation Cost Saving	= (7)x(8) = **NRs. 725 to 990 million**	(9)
Total Benefits	= (6)+(9) = **NRs. 6,115 to 8,690 million**	

Peak Demand: Base Case	2001			2002			2003		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	3.0	96.0	0.24	3.2	101.8	0.25	3.4	107.9	0.27
Fluorescent tubes (40W)	0.3	12.0	0.03	0.3	12.7	0.03	0.3	13.5	0.03
CFLs (10W)	0.1	0.4	0.00	0.1	0.4	0.00	0.1	0.4	0.00
Television (100W)	0.1	6.5	0.02	0.1	6.9	0.02	0.1	7.3	0.02
Rice Cookers (500W)	0.3	75.0	0.30	0.3	79.5	0.32	0.3	84.3	0.34
Refrigerators (250W)	0.0	2.5	0.05	0.0	2.7	0.05	0.0	2.8	0.06
Total additional peak (17.00-21.00)		192	**0.64**		204	**0.68**		216	**0.72**
Average day time demand		251			270			290	
Total peak demand		**443**			**474**			**506**	

Peak Demand: Base Case	2004			2005			2006			2007		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	3.6	114.3	0.29	3.8	121.2	0.30	4.0	128.5	0.32	4.3	136.2	0.34
Fluorescent tubes (40W)	0.4	14.3	0.04	0.4	15.1	0.04	0.4	16.1	0.04	0.4	17.0	0.04
CFLs (10W)	0.1	0.5	0.00	0.1	0.5	0.00	0.1	0.5	0.00	0.1	0.6	0.00
Television (100W)	0.2	7.7	0.02	0.2	8.2	0.02	0.2	8.7	0.02	0.2	9.2	0.02
Rice Cookers (500W)	0.4	89.3	0.36	0.4	94.7	0.38	0.4	100.4	0.40	0.4	106.4	0.43
Refrigerators (250W)	0.0	3.0	0.06	0.1	3.2	0.06	0.1	3.3	0.07	0.1	3.5	0.07
Total additional peak (17.00-21.00)		229	**0.76**		243	**0.80**		257	**0.85**		273	**0.90**
Average day time demand		312			335			360			387	
Total peak demand		**541**			**578**			**618**			**660**	

CFL for GLS market penetration rate	10%
T10 for T12 market penetration rate	0%
EE Rice Cookers penetration rate	10%
EE Refrigerator penetration rate	10%

Peak Demand: Scenario I	2001			2002			2003		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	3.0	96.0	0.24	3.2	101.8	0.25	3.0	97.1	0.24
Fluorescent tubes (40W)	0.3	12.0	0.03	0.3	12.7	0.03	0.3	13.5	0.03
Thin Tubes (36W)	-	0.0	0.00	-	0.0	0.00	-	0.0	0.00
CFLs (10W)	0.1	0.4	0.00	0.1	0.4	0.00	0.4	3.1	0.01
Television (100W)	0.1	6.5	0.02	0.1	6.9	0.02	0.1	7.3	0.02
Rice Cookers (500W)	0.3	75.0	0.30	0.3	79.5	0.32	0.3	75.8	0.30
Energy Efficient Rice Cookers (450W)	-	0.0	0.00	-	0.0	0.00	0.0	7.6	0.03
Refrigerators (250W)	0.0	2.5	0.05	0.0	2.7	0.05	0.0	2.5	0.05
Energy Efficient Refrigerators (220W)	-	0.0	0.00	-	0.0	0.00	0.0	0.2	0.00
Total additional peak (17.00-21.00)		192	**0.64**		204	**0.68**		207	**0.69**
Average day time demand		251			270			290	
Total peak demand		**443**			**474**			**497**	

Peak Demand: Scenario I	2004			2005			2006			2007		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	2.9	91.5	0.23	2.7	84.8	0.21	2.4	77.1	0.19	2.1	68.1	0.17
Fluorescent tubes (40W)	0.4	14.3	0.04	0.4	15.1	0.04	0.4	16.1	0.04	0.4	17.0	0.04
Thin Tubes (36W)	-	0.0	0.00	-	0.0	0.00	-	0.0	0.00	-	0.0	0.00
CFLs (10W)	0.8	6.2	0.02	1.2	9.6	0.02	1.7	13.4	0.03	2.2	17.6	0.04
Television (100W)	0.2	7.7	0.02	0.2	8.2	0.02	0.2	8.7	0.02	0.2	9.2	0.02
Rice Cookers (500W)	0.3	71.5	0.29	0.3	66.3	0.27	0.2	60.2	0.24	0.2	53.2	0.21
Energy Efficient Rice Cookers (450W)	0.1	16.1	0.06	0.1	25.6	0.10	0.2	36.1	0.14	0.2	47.9	0.19
Refrigerators (250W)	0.0	2.4	0.05	0.0	2.2	0.04	0.0	2.0	0.04	0.0	1.8	0.04
Energy Efficient Refrigerators (220W)	0.0	0.5	0.01	0.0	0.8	0.02	0.0	1.2	0.02	0.0	1.6	0.03
Total additional peak (17.00-21.00)		210	**0.71**		213	**0.72**		215	**0.74**		218	**0.75**
Average day time demand		312			335			360			387	
Total peak demand		**522**			**548**			**575**			**604**	

CFL for GLS market penetration rate	15%
T10 for T12 market penetration rate	20%
EE Rice Cookers penetration rate	10%
EE Refrigerator penetration rate	10%

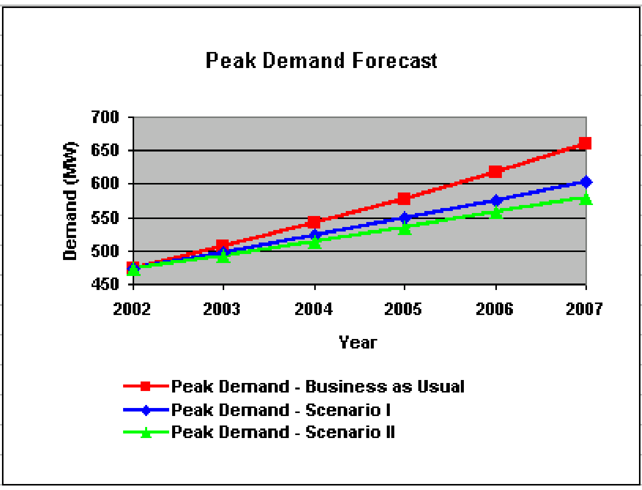
Peak Demand: Scenario II	2001			2002			2003		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	3.0	96.0	0.24	3.2	101.8	0.25	2.9	91.7	0.23
Fluorescent tubes (40W)	0.3	12.0	0.03	0.3	12.7	0.03	0.3	10.8	0.03
Thin Tubes (36W)	-	0.0	0.00	-	0.0	0.00	0.1	3.1	0.01
CFLs (10W)	0.1	0.4	0.00	0.1	0.4	0.00	0.6	4.5	0.01
Television (100W)	0.1	6.5	0.02	0.1	6.9	0.02	0.1	7.3	0.02
Rice Cookers (500W)	0.3	75.0	0.30	0.3	79.5	0.32	0.3	75.6	0.30
Energy Efficient Rice Cookers (450W)	-	0.0	0.00	-	0.0	0.00	0.0	7.8	0.03
Refrigerators (250W)	0.04	2.5	0.05	0.04	2.7	0.05	0.04	2.5	0.05
Energy Efficient Refrigerators (220W)	-	0.0	0.00	-	0.0	0.00	0.00	0.2	0.00
Total additional peak (17.00-21.00)		192	**0.64**		204	**0.68**		204	**0.68**
Average day time demand		251			270			290	
Total peak demand		**443**			**474**			**494**	

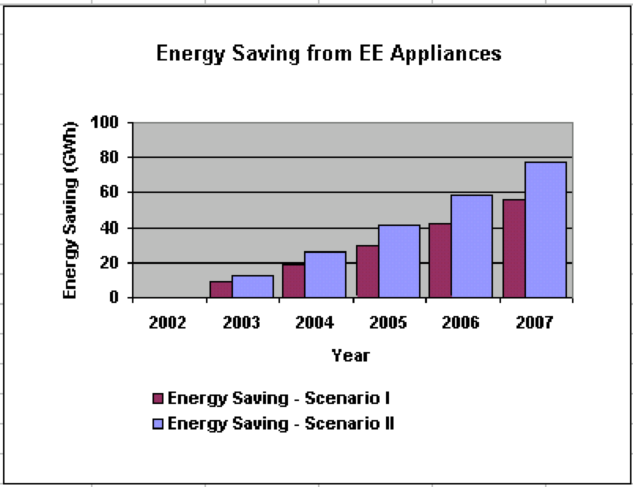
Peak Demand: Scenario II	2004			2005			2006			2007		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	2.5	80.0	0.20	2.1	66.7	0.17	1.6	51.4	0.13	1.1	34.0	0.09
Fluorescent tubes (40W)	0.2	8.8	0.02	0.2	6.1	0.02	0.1	3.2	0.01	-	0.0	0.00
Thin Tubes (36W)	0.1	6.6	0.02	0.2	10.5	0.03	0.3	14.8	0.04	0.4	19.6	0.05
CFLs (10W)	1.1	9.1	0.02	1.8	14.1	0.04	2.5	19.8	0.05	3.3	26.1	0.07
Television (100W)	0.2	7.7	0.02	0.2	8.2	0.02	0.2	8.7	0.02	0.2	9.2	0.02
Rice Cookers (500W)	0.3	70.9	0.28	0.3	65.4	0.26	0.2	59.0	0.24	0.2	51.6	0.21
Energy Efficient Rice Cookers (450W)	0.1	16.6	0.07	0.1	26.3	0.11	0.2	37.2	0.15	0.2	49.3	0.20
Refrigerators (250W)	0.04	2.4	0.05	0.04	2.2	0.04	0.03	2.0	0.04	0.03	1.8	0.04
Energy Efficient Refrigerators (220W)	0.01	0.5	0.01	0.02	0.8	0.02	0.02	1.2	0.02	0.03	1.6	0.03
Total additional peak (17.00-21.00)		202	**0.69**		200	**0.69**		197	**0.69**		193	**0.69**
Average day time demand		312			335			360			387	
Total peak demand		**514**			**536**			**558**			**581**	

Colour	Meaning
(orange)	Daily Energy Consumed from Domestic Appliances during Evening Peak Hours - Lighting & Televisions
(yellow)	Daily Energy Consumed from Domestic Appliances (both peak and off-peak hours) - Rice Cookers & Refrigerators

Table B-4: Summary of Peak Demand and Energy Saving

	2002	2003	2004	2005	2006	2007
Maximum Demand (actual & NEA's forecast)	449	482	525	571	617	667
Peak Demand - Business as Usual (MW)	474	506	541	578	618	660
Peak Demand - Scenario I (MW)	474	497	522	548	575	604
Peak Demand - Scenario II (MW)	474	494	514	536	558	581
Peak Demand saving, base case vs. scenario I, (MW)	**0**	**9**	**19**	**30**	**43**	**57**
Peak Demand saving, base case vs. scenario II, (MW)	**0**	**13**	**27**	**43**	**60**	**80**
Energy Demand from Appliances - Business as Usual (GWh)	247	261	277	294	311	330
Energy Demand from Appliances - Scenario I (GWh)	247	252	258	264	269	274
Energy Demand from Appliances - Scenario II (GWh)	247	249	251	252	253	253
Energy saving from EE Appliances - Scenario I, (GWh)	**0**	**9**	**19**	**30**	**42**	**56**
Energy saving from EE Appliances - Scenario II, (GWh)	**0**	**12**	**26**	**41**	**58**	**77**





Peak Demand Saving within 5 years - Scenario I (MW)	**57**
Peak Demand Saving within 5 years - Scenario II (MW)	**80**
5-Year Cumulative Energy Saving - Scenario I (GWh)	**156**
5-Year Cumulative Energy Saving - Scenario II (GWh)	**215**