Demand Side Management (DSM) Options for Hotel Industry in Malaysia

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May, 1996

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Acknowledgements

We would like to thank various hotels who participated in the study. Maintenance / Engineering personnel of the participant hotels took time out to fill the questionnaire and answer our queries. Of these, four hotels participated in the walk through energy audits and provided data for detailed analysis. We specially thank them. We thank the university for funding the study.

May 1996

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Executive Summary

DSM Programmes: Demand Side Management refers to activities designed to change electricity consumption at consumer's end and historically, DSM programmes have been carried out through active intervention by utilities. Utilities adopt several measures including incentives such as rebates, soft loans, time of the day tariff to involve customers in the DSM programmes. A DSM programme may result in energy conservation or reduction in demand for electric power or both for the customer. Energy efficiency programmes are most widely implemented form of DSM programme. However, in many cases such programmes can be carried out by the consumers alone, without active participation by the utility. The savings from energy efficient equipments are sufficient to justify their adoption in such cases.

DSM programmes have been in operation in several developed countries for a long time, and have made significant impact on pattern and quantum of electricity consumption. In the U.S. alone, DSM programmes estimated to have eliminated need for 20GW of generating capacity and resulted in cost savings of US$ 21 billion. Encouraged by the success, several billion dollars are expected to be invested by 2000 AD in DSM programmes in the U.S.

Why DSM?: Electricity is a major item of expenditure in commercial and industrial establishments, and DSM programmes help in reducing this cost. At national level, DSM programmes can reduce need for capacity expansion in electricity sector, and reduce related pressure on resources and infrastructure. Environmental considerations also require that energy use is minimized world over. International trends in this area also indicate necessity to take up the programmes that would reduce energy consumption. The movement for sustainable development also calls for measures that would help efficient use of resources. DSM addresses all these issues.

Malaysia is a developing economy with a high growth rate. The growth rate has been 7.5% in past and Malaysia's Vision 2020 visualises a growth rate of 7% until 2020. Service sector expansion is expected to contribute more and grow at a much higher rate. Hotel industry is

one of the important component of the service sector in Malaysia and its growth is evident from the growth of tourism and travel in Malaysia.

Consumption of electricity is quite closely related to growth of the economy and hotels are quite intensive users of electricity. Therefore electricity consumption in hotels is expected to increase much above the rate of growth of economy. Hence, it may be worthwhile to explore possibilities of electricity conservation in this important and growing industry.

DSM Options for Hotels: A variety of DSM options are available for hotels. These include use of energy efficient equipments for lighting, air conditioning, and water heating etc. and demand shift and control through load control, shifting operations from on-peak to off-peak time, improving power factor, using thermal storage to use off-peak electricity. Recent practices in this area include building envelope programmes and advances such as modern computer and communication technology based building energy management systems. Sound housekeeping practices including regular monitoring of energy consumption, and other innovative measures such as fixing sun control film on glass windows and doors to prevent solar heat gain in the rooms, heat recovery from laundry waste water, use of solar energy systems are also part of DSM. Utilities rate structure is an important consideration in deciding a DSM option. Therefore utility rate design is an important component of major DSM programmes.

DSM / Energy Conservation Awareness, Barriers and Policy Measures: The study investigated awareness of DSM / energy conservation measures in the hotels, barriers in the conservation, institutional mechanism the hotels would prefer and policy measures needed to implement energy conservation. In addition to this, potential for efficient lighting and reducing air conditioning load through better insulation and installation of sun control film was also explored.

Awareness: The survey indicated a high level of awareness in the hotels on issues related energy consumption. In case of lighting, a majority of hotels were using compact florescent lamps, at least in the hotel lobby. Most of the hotels were however not aware of the heat pumps that offer substantial potential for savings. Some of the hotels had keytag system to save energy when the guest leaves the room. However, implementation of the system was not adequate. Some hotels were also in process of considering solar energy system for water heating. Demand shift and control was not applicable to most of the hotels due to LT connections. However, load control was being done through devices such as timer to reduce energy consumption. Also, measures to improve power factor were taken by the hotels to avoid penalty. Installation of sun control film and recovery of heat from laundry waste water were areas where hardly any action has been taken. Most of the hotels considered that their housekeeping practices were sound. This was however not supported from the observation during visits. Substantial scope for improvement on this count remains.

The hotels considered efficient air conditioning and lighting to be the very important measures for the hotels to save energy. Automation and control and solar systems were also considered important by some of the respondents. reception of the utility in Malaysia. Training and good practices, including repair and servicing , energy monitoring and auditing were also rated important by some hotels.

Barriers: Maintenance problem emerged as the most important barrier followed by high cost of efficient appliances. An important finding was that "Implementing agency non-availability" was considered equally important barrier as cost, implying that hotels would prefer if energy conservation / DSM measures could be carried out by some agency. High payback period, product unreliability, lack of technical expertise, disruption in changeover and non-availability of money followed in importance in that order as barriers. Uncertain benefits, problem of availability, lack of information on energy efficient products, and non-availability of consultants, uncertain delivery were other barriers at lower ranking levels.

Methods of Conservation, Financial and Institutional Mechanisms: As methods of conservation, retrofitting, replacement and adding new systems, all the three were acceptable to a majority of the hotels. Acceptable payback periods were two years in most cases. On financing mechanism for energy conservation, a majority of the hotels preferred energy service companies (ESCOs) to carry out the job to take care of financing aspect of energy conservation. On institutional mechanism, expert / consultants was most preferred option, followed by ESCOs and utility at same level of preference. This indicates that if the utility were to take initiative on this, hotels would welcome and participate enthusiastically. Governmental agencies, financial institutions, and industry association were other preferred alternatives in that order.

Policy Measures: Among the various policy issues, technical assistance was considered most important requirement, followed by financial incentive, availability of institutional mechanism such as energy service companies. Availability of experts/consultants was next in importance, followed by need for education and training programmes, and seminars and workshops on energy conservation / DSM. Other policy measures in decreasing order of importance ratings were energy audits, pilot demonstration programmes, awareness campaigns through media, energy conservation literature and availability of finance from banks and financial institutions.

General Observations: These are based on visits to various hotel in course of the study (limited to hotel lobbies in a majority of cases), stay in hotels during the study, and a walk through energy audit of four hotels. A majority of big and medium size hotels in Langkawi are relatively newly established, and most of the hotels offer Chalet type accommodation spread over large areas. The hotels therefore use room air conditioners and geysers for the guest rooms instead of centralised facilities. Many hotels have already taken to use of Compact Florescent Lamps (CFLs), although to a limited extent in most cases. A majority of hotels near the beaches have open lobby and restaurants, eliminating the need for air conditioning and lighting (during day time). Some hotels use keytag system to guard against wastage of energy in guest rooms. However, several practices and systems that lead to wastage of energy were observed in several hotels during the visit.

Potential Savings in Lighting: Investigation of energy conservation opportunity in lighting indicated substantial scope for switching over to use of CFLs from the incandescent lamps. Payback period for replacement of a 60W incandescent lamp by 13W CFL was found to be less than 1.5 year for the hotels in Malaysia. Annual savings of above $11 were calculated for replacement of one lamp. Taking into account reduced load on air conditioning due to low wattage of the bulb, the savings work out more than $17. Additional savings from CFL use include maximum demand reduction for hotel and peak reduction for the utility. Guesstimates at national level indicated substantial potential for energy and peak demand savings. For example, through replacement of just one lamp in 25% of the hotel rooms, energy savings at national level work out to about 1.3GWhr and peak reduction between 0.6 to 1.2 MW. Estimation of this however would require further detailed survey covering hotels in major cities.

Air Conditioning: Substantial savings in air conditioning load were identified through provision of better insulation on hotel roofs, walls and windows. Annual electricity savings through better insulation were demonstrated to be quite high for a typical hotel room, based on data collected during the survey. Annual electricity savings through provision of better insulation for a typical hotel room worked out to 840 KWh, a savings of $ 177 at prevailing electricity rate. Sun control film was also found to be attractive option for hotels that have windows exposed to the sun. For a typical 200 room hotel with one window exposed to the sun, annual savings of 49600 KWh through installation of sun control film (that reduces air conditioning load) were calculated. This gives an annual savings of $10400 and a payback period of about two years.

Two Hotels; Energy Consumption Comparison: In an interesting example of comparison of energy consumption between the two similar level hotels, it was found that energy costs per guest room occupied were 50% higher in one hotel compared to other. All of the higher cost were accounted for by the higher electricity usage. On further analysis (based on observation), it was found that it was due to reasons such as higher lighting and air conditioning load in rooms , lobbies and restaurants, hotel architecture and housekeeping practices. Substantial scope for energy efficiency was observed even in the hotel that had lower cost.

Utility Policy on Energy Conservation / DSM: Although the utility (Tenaga National) appears to be a progressive utility with a DSM senior Manager, recent revisions of peak and off-peak rates go against the successful strategies for DSM programmes. Information about utility DSM programmes and tariffs could not be obtained from the utility.

Recommendation for Further Work: The hotels in Langkawi were mostly Chalet type. Further detailed study covering several hotels in different cities of Malaysia is recommended. The study should have active participation from utility and appliance manufacturers. Energy audits of a few selected hotels is also recommended for this purpose. A DSM plan for hotels in Malaysia can be worked out based on such a study.

Demand Side Management (DSM) Options for Hotel Industry in Malaysia

1.0 Introduction:

Demand Side Management refers to activities designed to change electricity consumption at consumer's end. Historically, DSM has developed as an active intervention by the utility to influence their customer's electricity consumption. Therefore, DSM is defined as the planning, implementation, and monitoring of utility activities designed to influence customer use of electricity in the desired manner. The DSM may result in energy conservation or reduction in demand for electric power or both. A customer may be interested in energy conservation as well as in demand reduction (in case he pays demand charges also), but utilities in most case may be interested only in demand reduction. Utilities adopt several measures including incentives such as rebates, soft loans, time of the day tariff to involve customers in the DSM programmes. Energy efficiency programmes are most widely implemented form of DSM programme. However, in many cases such programmes can be carried out by the consumers themselves, without active participation by the utilities. The savings from energy efficient equipments are sufficient to justify their adoption in such cases.

DSM programmes have been in operation in several developed countries for more than 15 years. Pacific Gas and Electric and Tennessee Valley Authority in the US had initiated DSM programmes in late 1970s. Electric Power Research Institute (EPRI) conducts regular survey of DSM programmes of the utilities in US. The surveys have been conducted for DSM programmes for residential, commercial and industrial sectors. According to an EPRI report, the DSM programmes reached 40 million customers in the US between 1977 to 1983 and lowered peak demand by 13000 MW (3% of the total). By 1987, 85% of the utilities in US had implemented DSM programmes (Cogan and Williams, 1987) and total expenditure by utilities on DSM programmes in 1990 are estimated to be more than US$2 billion. . The 1990 EPRI survey of industrial sector covered 417 industrial sector DSM programme conducted by 154 electric utilities and involved 49738 industrial customers (EPRI, 1990). The EPRI commercial DSM survey indicated 343 programmes by 168 utilities involving 228,927 participants, and residential DSM survey indicated 1022 programmes by 485 utilities involving 12,940,736 participants. Now more than 1300 programmes for commercial sector have been initiated involving about 500 utilities. DSM budgets of a sample of 14 utilities increased from 1.6% of their operating revenues in 1989 to 2,3% in 1991. Peak load impacts on a sample of 9 utilities was observed to go up from 1.34% in 1989 to 2.43% in 1991, and expected to reach 8.16% by 2000 (Gellings & Chamberlin, 1993b). DSM programmes of three major utilities in US alone had commitments close to $1 billion. A DSM program initiated in 1987 by New England Electric of the US had achieved 170 MW of peak demand reduction by 1989. By 2008, DSM and load control programmes will account for more than 1100 MW, about one third of this utility's resources. Similar programmes have been initiated by other utilities too. Overall, the DSM programmes in the US since 1977 have eliminated need for 20 GW of generating capacity, a cost savings of US$ 21 billion. By 2000 these programmes are expected to reduce energy use by 3% and summer peak demand by 6.7%. This amounts to a reduction of 45 GW in generating capacity, reduction in annual energy consumption by 106,000 GWh and avoided capital costs of about US$ 45 billion (Gellings and Chamberlin, 1993a).

2.0 Why DSM Programmes?

The focus of DSM programmes is on conservation of electricity and reduction of demand for power. The need for DSM arises for following reasons:

(a) Reduced energy costs: In commercial and industrial establishments, electricity is a substantial item of expenditure as it is used for several purposes such as driving motors, lighting, space heating and cooling and so on. Therefore any reduction in energy costs can increase the profits by cutting the cost.

(b) As an alternative to generating capacity: DSM programmes save electricity, and every unit of electricity saved reduces generating requirements more than one unit. This is because transmission and distribution losses are avoided; savings are at the consumer end. DSM programmes also reduce peak load and thus reduce capacity expansion requirements for the utilities. DSM is thus a substitute to building power plants, and also has the advantage of short gestation period of 1 to 2 years compared to 4 years and more for power plants.

(c) Reduced resource and infrastructure requirements: Resources such as land, water and manpower, that are required to build and operate power plants are saved as the DSM programmes are carried out in customer's premises. Resources such as fuel to produce power are saved and transport requirements eliminated.

(d) Environmental considerations: Energy and environment are very closely related. An increase in demand for electricity due to growth puts pressure on environment. In case electricity is generated through use of fossil fuels (such as coal, oil, and gas), it creates local as well as global pollution on account of emissions associated with use of such fuels. Besides, these are exhaustible resources and hence need careful planning before committing increased use. In case of hydro electricity, local ecology gets adversely effected. There are several movements to oppose construction of hydro power plants to preserve the forests, land mass and ecology. By reducing the electricity requirements DSM reduces environmental pollution and associated health impacts.

(e) Energy availability and price considerations: The issue of internalization of environmental costs with the resource use has been in forefront for quite sometime now. Once this is implemented by the governments, electricity prices are bound to up. Electricity growth may also face restriction on account of similar reasons. Electricity prices may also increase due to exhaustible nature of resources that are used to generate it.

(f) International trend: Energy prices in international market have experienced sharp fluctuation in past. This resulted in adverse impact on growth of energy importing countries. However energy conservation was seriously taken up by several countries, specially after the oil price shocks in 1973-74 and 1979-80. As a result efficient technologies for production and use of electricity were introduced. Growth of electricity consumption in several countries, specially in developed economies tapered after that. With increased stress on global environmental issues, energy conservation is once again a focal issue. There is a possibility that restrictions on energy (and electricity) consumption may be agreed by the international community to address global environmental issues. It is therefore worthwhile to get ready to face such situation.

(g) Need for sustainable development: Sustainable development is one of the major issue facing the humanity. National governments agreed in the UNCED conference held at Rio in 1992 to follow practices that help sustainable development. It is also widely accepted that present pattern of resource consumption is not sustainable. Therefore need for conservation of resources is a pre-requisite to sustainable development. Progressive and environmentally sensitive business and industry world over have pledged to follow practices that lead to sustainable development. It may have to be followed by all business in future.

2.1 Why Hotels?

Malaysia is a developing economy with a high growth rate. Economic growth has resulted in expansion of service sector in Malaysia and its share to GDP has been rising steadily. The growth rate of the economy at 6.7% in the fifth plan exceeded the target of 5% , and sixth plan (1991-95) target of 7.5% (Govt., 1991) has also been exceeded. The Malaysia's Vision 2020 (Hamid, 1993) visualizes a growth rate of 7% in real terms between 1990-2020, with an overall growth of 800%. Hotel industry is one of the important component of the service sector in Malaysia and its growth is evident from the growth of tourism and travel in Malaysia. The Sixth Plan of the Malaysia envisaged number of tourist arrivals to go up to 8 million by 1995 from 6 million in 1990, and hotel rooms to 55,280 (number of hotels 1020) from 45,032 (number of hotels 989). The revenue realisation from tourists increased at an average rate of 33 per cent between 1989-91 and persons engaged in the tourist establishment increased by 20 per cent during the same period. The annual travel receipts projected at $ 5000 million and direct hotel employment at 51270 (target for 1995 in the Sixth Plan) are expected to have exceeded the target. The healthy rate of growth of tourism is an indicator of growth potential for hotel industry in Malaysia. In fact, according to reports that appeared in media, the hotel industry has exceeded the projected growth rate and already crossed the target (number of rooms) that was planned for

2000. With increasing stress on tourism by the government to attract tourists from outside Malaysia, the hotel industry is poised for further growth.

Consumption of electricity is quite closely related to growth of the economy. The electricity consumption in Malaysia increased by 12.6 percent between 1991-93. Commercial sector is one of the major consumer of electricity with about 28% share in the electricity consumption. The electricity consumption growth in this sector was also of similar order; 12.3 percent during 1991-93. Since the economy is poised for strong growth, the trend of increased consumption in the commercial sector is expected to continue. Hotel industry is one of the promising part of the commercial sector, and tourism and travel services are driving force behind its growth. Therefore electricity consumption in hotels is expected to increase much above the rate of growth of economy and rate of growth of electricity consumption in commercial sector. Hence, it may be worthwhile to explore possibilities of electricity conservation in this important and growing industry.

2.1.1 How the Hotels Can Benefit from DSM / Energy Conservation: Electricity is a substantial item of expenditure, specially in high grade hotels. Hotels use electricity for several purposes such as air conditioning (and/ or space heating, cooling), water heating, refrigeration, lighting and to run a variety of appliances such as televisions, radios, washing machines, iron, kitchen appliances, fans etc. Therefore conservation of electricity can reduce operational costs of the hotels.

3.0 DSM Programmes and Options:

3.1 DSM Objectives:

For the hotels, use of energy efficient equipments and other DSM measures means reductions in energy costs. This is brought out through reduction reduced energy consumption for the same level of energy services. In case of electricity, DSM helps in reducing maximum demand also, thus providing additional savings to the consumers.

For an electric utility, DSM can have any of the following objectives:

(i) Peal clipping: This refers to reduction of the system peak load. Direct load control, that involves utility control of customer appliances is popular method for peak clipping. Utility can reduce capacity purchase costs or reduce operating costs and dependence on critical fuels.

(ii) Valley filling: Off peak loads are sought to be build up in this case. Low off-peak prices are used for this purpose and most popular application is thermal energy storage (water heating, and space heating) to replace fossil fuels use.

(iii) Load shifting: This involves shifting load from on-peak to off-peak periods. Customer load shifts, storage water heating, cool storage etc. are applications.

(iv) Strategic conservation: This is to change the load shape of the utility. It is aimed at reducing the electricity consumption and pattern of use. Appliance efficiency improvements, use of variable speed drives, weatherziation etc. fall in this category.

(v) Strategic load growth: This refers to a general increase in electricity consumption. This can be due to increased market share of the utility or use of new emerging electrical technologies to replace other fuels.

(vi) Flexible load shape: This refers to reliability of electric supply. Once the load shape is forecasts based on various utility programmes and plans, customers are offered options in terms of quality of service alongwith various incentives. The load shape can thus be flexible.

3.2 DSM Programmes:

Major utility DSM programmes can be classified as follows (EPRI, 1990):

(i) Lighting programmes: Involves installation of efficient lamps and fixtures, lighting control systems, outdoor lighting etc.

(ii) Heating, ventilating and air conditioning programmes: Include programmes dealing with space cooling and heating, ventilation and air quality equipments.

(iii) load control programmes: Utility control of customer loads or promotion of facility energy management system is included in this.

(iv) Thermal storage programmes: These programmes deal with storage air conditioning, storage water heating, storage space heating and storage refrigeration systems.

(v) Audit and building envelope programmes: The programmes deal with industrial energy conservation, building shell improvements, audits, facility energy analyses etc.

(vi) Special rate programs: Includes programmes that offer interruptible or time of use rates to the customers.

(vii) Motor and motor drive programmes: These are aimed at use of high efficiency motors and variable speed drives.

(viii) Other programmes: These include electrotechnology programmes to promote or test electrical driven technologies in the industries, economic development programmes to attract industries by offering better services or competitive prices, standby generation programmes to promote customer cogeneration or utility-dispatchable standby generation equipment at customer site, and power quality and conditioning programmes involving equipments for decreasing power disturbances or services to solve customer power quality problems.

3.3 DSM Options for Hotels:

A variety of DSM options are available for hotels. These are briefly described below:

3.3.1 Use of Energy Efficient Equipments: This refers to the technological options for various end uses or energy services required by the electricity consumers. Lighting, water heating and air conditioning represent major energy uses in hotels. In addition, several type of appliances are used in hotels. We discuss each of these.

(a) Efficient lighting systems: This includes following:

(i) Use of high efficiency lamps: Substantial scope for energy savings exists through use of efficient appliances. In a survey in Java, it was found that refrigerators and air conditioners efficiency could be improved by 40%, TVs by 20-25%. Even for Europe, it has been estimated that savings between 15-25% in energy can be achieved through use of efficient appliances (Grubb et al., 1992). Use of compact fluorescent lamps (CFL) in place of incandescent lamps can save 75% of the electricity used. Incandescent lamps are the conventional ordinary filament lamp, also referred as GLS lamps (general lighting service lamps). The CFLs provide about five times light output per watt compared to conventional incandescent lamps, and can be installed on the conventional fittings. In case of fluorescent lamps, electronic ballasts can replace the conventional magnetic ballasts and save about 15 watts (as losses in electronic ballasts are 2-3 watts, compared to about 18 watts in magnetic ballasts). Mercury lamps, that have been in use for outdoor lighting, can be replaced by more efficient high pressure sodium vapour lamps, that also provide better quality light. A recent advance in the area of lighting is **high frequency lighting.** The efficacy of fluorescent lamps increases when operated at high frequency. Thus, a 50 watts florescent lamp operating on high frequency can provide same light output as a 58 watts operating on normal frequency. The quality of the high frequency is also better, for example, it is flicker free and provides higher visual comfort. The conventional ballast operating at normal frequency (50 or 60 Hz) is replaced by an inverter circuit operating typically at 30kHz. Since ballasts last much longer than the lamp, the extra cost of ballast is recovered within lifetime of the first lamp.

(ii) Other opportunities in lighting: There are several other opportunities to improve lighting efficiency. These have been briefly discussed here. Detailed study of these can be taken up in further studies.

- **Replacement of conventional incandescent lamps by efficient lamps:** Efficient incandescent lamps are also available in the market, that are 10 to 20 % more efficient than conventional lamps. In cases where hotels may prefer to use incandescent lamps in some areas for reasons such as low number of hours of operation, need for dimming the lights, inappropriate fixtures for CFLs etc., they can use efficient incandescent lamps. Economics of their use can be calculated on similar lines.

- **Replacement of magnetic ballast by electronic ballast:** In cases where florescent lamps are still used with magnetic ballast, savings can be achieved through use of electronic ballast. Compared to magnetic ballast, that typically consumes between 12 to 18 watts (it can be as low as 6 watts also in case of energy efficient magnetic ballasts), electronic ballasts consume 1 to 3 watts.

- **Luminaries and lighting controls:** Standard luminaries in places such as hotel offices, kitchen etc. can be replaced by reflecting luminaries. Since the light output almost doubles in this case, number of lamps in fixture can be reduced to keep the same lighting level. Thus energy can be saved even though providing same level of lighting. Further, slimline florescent tubes consume 10 % less energy than conventional tubes. Slimline tubes are now widely used. However, in case conventional tubes are still in use in some hotels, these can be replaced by slimline. Lighting controls in offices through sensors to adjust the light according to availability of day-lighting and switch off lights in case of non-occupancy are other measures to save lighting energy use.

(b) Efficient appliances: Efficient refrigerators and freezers, televisions, radios, and washing machines can affect substantial savings of electricity. Most of the efficient models of these appliances can save between 50 to 90 % of the electricity compared to 1970s technology (Gellings, 1993a).

Proper sizing of the motors and using efficient motors wherever required can also save substantial electricity and payback period is normally low for such motors. Large fans and pumps are other appliances that can have as low a payback period as six months.

(c) Air conditioning and water heating: Energy consumption in air conditioning can be reduced through several measures. These includes use of efficient air conditioners, use of heat pumps (that combine use of air conditioning and water heating, by using the heat rejected from the room to heat the water), provision of better insulation on windows, doors, roof and walls, installation of solar control film on glass windows / doors exposed to the sun. Provision of better insulation can save current energy use for water heating and space cooling / heating. A major important option in this area is heat pump that offers potential efficiency gains in cooling as well as heating. Heat water pumps can save 40 to 60% of the energy compared to conventional resistance water heater systems. Heat pumps can also be used to reduce air conditioning load by extracting the heat from the space (that is required to be air conditioned), and using it for water heating. Similar in concept is heat recovery water heater, that can be used in conjunction with an air conditioner to use the energy rejected by the later to heat the water. Depending on climate, 10 to 60% reduction in energy use for water heating can be obtained using these heaters. Thus, use of heat pumps can help in eliminating (or minimizing) use of electric geysers, that are used in most of the hotels in Langkawi in guest rooms.

Sizing of pumps and motors for central air conditioning units and replacing wherever necessary can reduce energy consumption by the air conditioning plant without effecting the output.

3.3.2 Demand Shift and Control: This includes following:

(a) Load control: This measure is used to shift and control the electricity demand. This is accomplished using control devices that may alter the operation of an end-use equipment to change the maximum demand. Load control can be carried by consumers or by the utility through a signal at point of use or remote control, using the communication systems.

Consumer load control includes schemes such as time clock or switching, current limiters, cyclic control schemes, thermostat controls, interlock controls and demand control devices. In studies conducted in the US, demand savings were observed for the customers using load control devices. Energy savings were able to provide typical payback period of one to one and a half years. Load control however requires sophisticated metering systems and appropriate pricing policies by the utility.

Utilities can also carry out the load control by interrupting the loads at customers premises. This is done either through a remote control using communications system or locally using cyclic timers, time clocks and thermostats. In this case operation of appliances such as air conditioners, space heaters and water heaters is controlled by the utility. Interruptible electric service offered by the utilities also falls in this category.

(b) Shifting operations from on-peak to off-peak time: Some of the operations can be shifted to off-peak time when electricity rates are low. Demand reduction and shifting load can be combined to reduce the energy bill. This option (of load shift to take advantage of off-peak power) is applicable where tariff differential exists.

(c) Improve power factor to reduce maximum demand: Most of the utilities penalise low power factor. In addition to penalty, poor power factor also increases the demand on the system. Capacitor bank can be installed to improve power factor.

(d) Thermal energy storage: Energy for space conditioning can be stored and it is referred as thermal energy storage. The energy is stored during "off-peak hours" when the utility rates for electricity use are low, and used up at on-peak hours. The storage can be for the purpose of heating as well as cooling. For example, water heating during off-peak hours and storage, cool storage that consists of chilled water tanks and ice storage. Chilled water storage is built up during off-peak hours (say night time) and used for air conditioning during peak hours (day time).

3.3.3 Building Automation and Control: Use of advance electronic systems can help in tracking and optimizing the energy usage. Two such systems are:

(a) Infra Red activated guest room switching system: Occupancy sensors track the movement / presence in the room and if undetected for a pre-specified time, switches off the lights and other appliances automatically.

(b) Building energy management systems (BEMS): These use modern computing, control and sensor technologies to manage energy uses in buildings and manage their interactions. Thus, BEMS in a building regulates air conditioning, heating, lighting and other energy consuming functions. Use of BEMS alone can save 15-20% energy, and if lighting control systems are included, potential savings can range 30-70%. Of this, 20-40% can be realistically achieved, although upto 65% has been achieved in practice (Grubb et al., 1992). The payback period for such measures is two to two-and-a-half years.

3.3.4 Building Envelope Programmes: The programmes aim at reducing heat gain or heat loss and mitigate infiltration. Insulating building reduces the conduction of heat through building ceilings, walls, and floors. Various type of insulating materials with varying R values (higher the R value, better insulating property), such as fibreglass, mineral wool, polystyrene boards, polyurethane boards, urea foam etc. can be used to increase insulation. Insulation can save 20-40 % of the energy used for heating / cooling depending on type and amount of insulation used and climate. Air also leaks through paths within walls, ceilings, ductwork, windows, doorframes etc. This can cause 15-30% heat gain. Reduction of air infiltration through plugging these leakages can save this energy.

3.3.5 Other Innovative Measures: Some measures may be specific to hotels. A detailed study of the energy consumption in hotel can indicate possible measures. For example, following can be examined:

(a) Fixing heat control films on the windows exposed to sun: Depending on number of hours of exposure to the sun, this can reduce air conditioning load.

(b) Raising conditioned air temperature: In some cases, conditioned air temperature is very low. The comfort level of the guest may not get effected even if the conditioned air temperature is raised marginally. This needs to be examined for individual hotels.

(c) Heat recovery from laundry wash water: In case of the hotels with their own laundry wash facility, heat recovery system can be installed.

(d) Alternate energy systems: Use of solar systems for water heating. Malaysia has a tropical climate with availability of sunlight throughput the year. Use of solar water heaters to substitute electric resistance heating may be a good option.

3.3.6 Housekeeping and Monitoring: Good housekeeping practices include following;

(a) Awareness training and good practices:

- Staff awareness and training programs on energy conservation.
- Minimizing wastage of hot water (used for utensil cleaning, laundry etc.
- Switching off lights in areas not needed.

(b) Monitoring and auditing:

- Overall energy consumption monitoring on regular basis.
- Sub-metering to monitor energy consumption closely.
- Monitoring and control of air conditioning system.
- Monitoring air supply in different areas as per requirement.
- Checking conditioned air temperature in different areas and raising if possible.
- Energy auditing of the hotel.

(c) Repairs and servicing:

- Plugging leakages in hot water / steam piping.
- Repairing insulations (in rooms, piping etc.).
- Regular servicing of steam boilers, freezer units and other such equipments.

3.3.7 Rate Design by Utility: Utility rate structure is an important consideration in deciding a DSM option. Whereas some of the efficient energy equipments may justify their adoption based on energy savings (with average tariff paid by the customer), some other measures such as thermal energy storage, load control may not get implemented unless rate design by the utility is efficient. Some of the utility objectives such as peak clipping, valley filling, load shifting and strategic load growth also require appropriate rate design.

4.0 Scope of the Study

In this study we investigate awareness of DSM / energy conservation measures in the hotels, barriers in the conservation, institutional mechanism the hotels would prefer and policy measures needed to implement energy conservation. We also estimate the benefits of efficient lighting system and explore its potential for hotels based on the survey. In addition to this, we also explore possibility of reducing energy consumption in the air conditioning (one of the major electricity consuming activity in medium size and big hotels) through measures such as better insulation, installation of sun control film for the hotels in Langkawi. We also indicate how the hotels can evaluate various options with the examples of lighting and air conditioning options. Some of the housekeeping measures have also been identified. Steps already taken by some of the hotels have also been discussed. A detailed exercise to evaluate other options with involvement of the utility and manufacturers of the equipments can be considered based on results of this study. For example, heat pumps appear to be the most promising measure for hotels, but would require detailed study jointly with hotels, and manufactures of heat pumps / air conditioners.

5.0 Methodology:

The hotels have been classified in categories from one star to five star and above. Most of the hotels in a particular star category are required to have a certain level of standard facilities such as air conditioning, refrigerators in the guest rooms, laundry facilities etc. The energy using equipments and their consumption patterns are therefore expected to be similar across a particular category of hotels. Therefore, thorough energy audit of even one hotel in a specific category can give some broad idea of potential savings for that category. However, there may be differences in terms of sizing of equipments, hotel layout, efficiencies of individual equipments, monitoring and control of energy consumption, expertise of the hotel engineering / maintenance staff, occupancy in the rooms, hotel practices etc. Therefore, to account for differences across hotels, even within a category, several hotels may need to be studied.

Although potential for energy savings exist in all hotels, energy consumption is a major item of expense in big and medium sized hotels on account of variety of energy consuming services offered. Big hotels normally have engineering / maintenance departments with qualified personnel to deal with energy services. Also, since the study sought to identify awareness, barriers and policy measures preferred by the hotels, it was decided to cover as many big and medium size hotels as possible. A few small hotels were also included in the study to get their perspective on these issues.

The **big hotels,** as mentioned in this study, refer to hotels with **200 rooms and above**. The hotels with **100-199 rooms** are referred as **medium size,** and **small below 100 rooms**.

5.1 The Study Design:

The study was divided into two phases:

(i) Phase I: Energy conservation awareness, barriers and policy measures survey and;
(ii) Phase II: Walk through energy audits of a few selected hotels.

5.1.1 Phase I: Energy Conservation Awareness, Barriers and Policy Measures Survey: This phase was designed to investigate the awareness of hotels on Energy Conservation / DSM measures, barriers faced by them in energy conservation, and their preferences for financial mechanisms, institutional mechanisms and other policy measures for facilitating energy conservation.

A two part questionnaire was prepared and personally handed over to the participating hotels for this purpose. The first part was to obtain general information about the hotel, such as; number of rooms, facilities offered. The second part of the questionnaire was divided in four sections, A to D. The section A was to get information on general awareness on energy conservation, such as; decision making authority for investment in energy appliances, energy conservation measures and reviewing level, energy consumption monitoring and audits. Section B was designed to obtain awareness on specific measures such as efficient lighting, air conditioning and other appliances, automation and control, alternate energy systems, demand shift and control, heat control and heat recovery, retrofitting of pumps and motors and house- keeping measures. In this section, six options were offered to the respondents to measure degree of awareness. These were;

(i) The hotel is not aware of the option (NAW).
(ii) The hotel is aware of the technology / option and benefits but has not initiated any action (AW).
(iii) The hotel is in the process of deciding and has floated enquiries (DECID).
(iv) The hotel has implemented the option (IMPLT).
(v) The hotel has evaluated the option and did not find it suitable (NST).
(vi) It is not applicable to the hotel (NA).

The respondents were also asked to indicate importance of these measures for their hotel (with options not important, important, very important, and can not say).

In the section C of the questionnaire, respondents were asked to indicate the importance of various energy conservation barriers on a four point scale (not applicable, not important, important, and very important), and also rank top five barriers. In the section D, respondents were asked to indicate their preferences and acceptable payback period for different methods of conservation such as retrofitting, replacement of equipments, adding new systems and demand shift. This section also included ranking of financial mechanisms, institutional mechanisms and importance of other policy measures (on four point scale) for energy conservation.

Lastly, the respondents were also asked to indicate whether they would be interested in a detailed study of energy conservation measures for the hotel or not. This was to pick up hotels for second part of the study, described below.

5.1.2 Phase II: Walk Through Energy Audits: For this phase of the study, walk through energy audits were conducted, and a questionnaire (labelled as Part III) was administered to obtain details of hotel's energy consumption, and details of lighting and air conditioning appliances / systems. Based on the responses received on earlier part, this part of the study was carried out for two big and two medium size hotels. The hotels participating in this part of the study were also requested (through the questionnaire) to give detailed information on appliance ratings and consumption for these applications (lighting and air conditioning).

It was observed that a majority of big and medium size hotels in Langkawi are at beaches and standard accommodation offered is Chalet type. A few medium size hotels, mainly in the kuah town are multi-story type. Therefore, three hotels (two big and one medium size) chosen for walk-through audit were Chalet type (near beaches), and one multi-story type (medium size, Grand Continental) in the Kuah town.

The questionnaires for both the phases of the study are attached as Appendix 1 and 2.

Personal visits were made to collect the questionnaires, and in most of the cases it required follow up visits. In some cases, inspite of several visits, no response could be obtained.

5.2 The Study Sample:

The samples for the two phases of the study were as follows:

5.2.1 Phase I: Energy Conservation Awareness, Barriers and Policy Measures Survey: Following hotels were identified and administered Part I and II of the questionnaire for the study based on the tourist brochures and visits to Langkawi during initial part of the study:

Big Hotels (above 200 rooms): Berjaya Langkawi Beach Resort (400, CH), Sheraton Langkawi Beach Resort (252, CH), Holiday Villa Langkawi (240,CH), Pelangi Beach Resort (350,CH), Langkasuka Resort (214,MS), Delima Resort (1500,CH), City Bayview Hotel* (282,MS), Shearton Pardana (213,CH).

Medium (between 100-199 rooms): The Gates Langkawi (177,CH), Burau Bay Resort (150,CH), Hotel Grand Continental (197,MS), Langkawi Sea View Hotel (143,MS).

Small (below 100 rooms): Twin Peak Island Resort (60,CH), Sri Lagendra Garden Resort (97,SS), Singgahasana Kub Resort* (73,SS), Nadias Inn (99,MS).

Figures in brackets indicate number of rooms, CH indicates Chalet type, MS indicates multi-story type, SS indicates 2-3 stories but spread over large area / in blocks.

[* These are new hotels (4 to 8 months old), and were added in the list after first visit to Langkawi).

Most of the hotels selected for the study were clustered in Pantai Cenang, Pantai Kok, and Kuah town. The study covered all big hotels except a recently built big hotel (Tiara Langkawi (236 rooms), that could not be covered due to non-availability of concerned staff at the hotel. In the medium category, 4 out of total 9 were selected. Of the four two were of Chalet type and two multi-storied. Of the remaining five in this category, two were important from energy consumption perspective (The Datai, and Radission Tanjung Resort, both five star hotels), but these were far off from these locations and hence not included in the study. In the small hotel category, 4 hotels were picked up that were considered important from energy consumption perspective (relatively large size within small category).

In addition to the response to the survey from hotels, findings reported are also based on observations made during visits to these and other hotels.

Responses Received: Of the 16 hotels to whom questionnaire were distributed, response was received from 9 (56%). Of this, one (Grand Continental) was incomplete and could not be used for analysis.

No Response Cases: Of the big hotels, Pelangi Beach, Delima, and Sheraton Pardana did not respond. Among the medium category Langkawi Seaview did not respond. The hotel did not had qualified person to respond to the questions. The Grand Continental, although returned the questionnaire, could not reply most of the questions for want of qualified person. In small category, only hotel Singgahasana Kub Resort responded. Other three were willing to cooperate but they did not had qualified personnel to respond to the questionnaire.

5.2.2 Phase II: Walk Through Energy Audits: Walk-through energy audits were conducted and a questionnaire (Part III) was administered to collect information on energy consumption and appliance rating. This was carried out for two big (Berjaya Resort and Shearton Langkawi Resort) and two medium size (Burau Bay and Grand Continental) hotels. Although the hotels could give overall electricity consumption data, they could not provide individual appliance ratings and consumption data, which is necessary to evaluate alternate options. Even information such as hours of use, number of appliances could not be answered by them. Therefore the analysis carried out indicates some comparisons based on available data, potential areas for evaluation of the options, and method of evaluation with examples.

6.0 Analysis and Findings:

6.1 General Observations:

These are based on visits to various hotel in course of the study (limited to hotel lobbies in a majority of cases), stay in hotels during the study, and a walk through energy audit of four hotels.

(i) Hotels newly established and large areas with chalets: A majority of big and medium size hotels in Langkawi are relatively newly established, between 4 months to 3 year old. This is because tourism was actively promoted during and after first De Lima in 1994. All the big hotels (except Bayview and Tiara) and a majority of medium size hotels (besides several small hotels) are at beaches and with Chalet type accomodation. Chalets are mostly single or double storied wooden structures spread over large areas (too large in some cases; 70 acres in case of Berjaya Resort, 60 acres in case of Delima Resort, and 200 acres in case of The Gates).

(ii) Energy consumption: This peculiarity of the hotels (Chalet type accomodation) sets them apart from the conventional multi-storied hotels in the cities in terms of type of energy appliances used. For example, central air conditioning and central boiler to supply hot water to the guest rooms is not applicable. Instead, split type room air conditioners (1.5 to 2.5 HP) and electric geysers were used by these resorts.

(iii) Energy audit: Although big hotels monitor the energy use regularly, and some have even taken some energy conservation measures (use of CFLs for example), a majority of them appear not to be familiar with the concept of energy audit. Although all the hotels mentioned that energy audits are carried out regularly, none of those visited for walk through energy audit had handy information on different type of energy consuming appliances, their numbers, ratings, hours of use, energy consumption etc. (that would have been readily available if a thorough energy audit was carried out even once). Also, in case of electricity, no sub-metering was available to measure consumption of important appliances / systems. It appears that not knowing the concept of energy audit, energy monitoring was confused with energy audit.

(iv) Energy conservation measures taken: Maintenance / engineering executives in the big hotels were too busy in day to day operation to pay attention or scout for major energy conservation opportunities. However, it is commendable that in some hotels, despite their busy schedule they have carried out some measures resulting in substantial savings. For example, replacement of most of the incandescent lamps by CFLs in Berjaya and Lankasuka, use of timers (for pump and lighting operations), proper sealing of chillers and freezer doors etc. in Lankasuka. Lankasuka also used efficient systems for hot water circulation and air conditioning. The central air conditioning systems at Lankasuka and Grand Continental used the principle of heat pumps to provide hot water for guest room usage from the heat rejected by air conditioning system.

(v) Appliances: Since most of the hotels are less than three year old, the hotels do not have old generation appliances. The appliances in most cases appeared to be of late eighties technologies. Therefore, hotels may not feel need for retrofitting / replacement at this stage.

(vi) Use of compact fluorescent lamps (CFLs): CFL use had been adopted by almost all the hotels, although to different degrees. In some cases, it was limited to replacement of incandescent lamps in lobbies, in others, also in guest rooms and other locations. The only exception were two big hotels where no CFLs appear to have been in use (as none could be seen even in lobby), surprisingly one of them a newly built hotel. Two other newly built hotels had installed CFLs in the lobbies from the very beginning. In one of the older hotels, CFLs had been in use for more than three years in lobby (having been in use more than 10,000 hrs already). However, a majority of hotels did not had any criterion to adopt CFLs.

(vii) Open lobbies and restuarants: Several big and medium size hotels took advantage of the fact that space was no constraint and lobby and restaurants could be with high ceiling and open from several sides with greenery in and around that area. This ensured good air circulation and daylighting, and eliminated the need for lighting and air conditioning in these areas. The temperature in Langkawi does not very high (ambient between 25 to $32^{o}C$ in summers) and hence this strategy appears to have been successful too keep electricity consumption relatively low in these hotels.

(viii) Use of keytag system: Several hotels in Langkawi were using Keytag system that requires insertion of a tag (attached to the keyring) in a slot near the entrance inside the room to energize the room. Thus, as soon as key is removed to lock the door, the electric supply to the room is cut off, switching off lights and other appliances. Several variations of keytags were observed. In case of medium and big size hotels, there was a lag of about $^{1}/^{2}$ to 1 minute between taking out the tag and electric supply cut-off. The tag in these cases was flat plastic piece, that could be easily substituted by some other items such as spoon. This presumably was to keep guest convenience in view. Also, refrigerators had separate lines to allow them functioning. On the other hand, a small hotel had a keytag that would not allow such substitutes, and it would switch on and switch off the master electric switch itself. Keytag system however requires planning in initial wiring stage itself, as later rewiring may be difficult and expensive.

6.2 Specific Observations:

(i) Awareness on conservation: In one big hotel, that had several incandescent lamps in the lobby and adjoining areas (and no CFLs), all lamps and fans were found to be on during daytime. Even the areas that were away from lobby and open from two sides (where there was sufficient daylighting), several lights and fans were on with no guest or hotel personnel in sight in that area.

(ii) Energy intensive systems and practices: In yet another big hotel, the guest rooms had too many light points, with several incandescent and halogen lamps. Even the toilets had several lighting points with incandescent lighting. A few lamps had common switches, specially four toilet lamps had one common switch. The hotel has a practice of leaving one lamp on (and it was an incandescent lamp) at the entrance of the room for guest convenience. It is difficult to say how much all these measures add value to the guest comfort and how much is superfluous. Possibly, a guest survey can indicate utility of such measures. However, practices such as separate switches for different lamps, replacing incandescent lamp with CFL or incorporating a limit switch (so that lamp at the entrance gets switched on as soon as guest enters, rather than leaving it on all the time) can reduce energy waste without affecting the guest comfort.

(iii) Poor insulation: In most of the hotels, gaps between window and door frames were observed. This results in cool conditioned air escaping from the gaps and hence increasing the load on air conditioners. In some cases, large gaps between door frames and floor (from 0.5 inch to 1 inch and above) were observed. In case of multiple storied type hotels, the cool air escaped to corridors. In one case advantage of this was taken to eliminate need for operating corridor air conditioner. However, in case of one hotel where gaps were more than 1 inch, corridor doors were open to the outside surroundings.

6.3 Energy Conservation Awareness, Barriers and Policy Measures:

As already mentioned, out of 16 hotels, filled questionnaires could be obtained only from 8 hotels. The general information about these hotels is given in Table 1. Two of these were medium size and one small. The rest five were big hotels. The findings from the survey are discussed in sections that follow.

6.3.1 General Awareness on Energy Conservation / DSM: The Table 2 summarizes the responses on items related to general awareness of energy consumption related issues.

Two third of the hotels reported that investment decisions for major consuming appliances are taken by top management. In fact all the hotels reported that energy conservation measures are reviewed by top management, and frequency of review varied from weekly to yearly. All the hotels reported that energy consumption monitoring is done on regular basis and energy audits are carried out in the hotels. This indicates high level of awareness on energy related issues among top management and concerned department. There is however some doubt on energy auditing; most hotels appear to have no idea of what an energy audit is, and confused it with energy monitoring. It became clear during the walk through energy audit of four of the hotels surveyed. The hotels walk through energy audit was conducted had no sub-metering facilities for electric systems / appliances, and could not furnish data on appliance rating and consumption (that would have been handy in case energy audits are carried out).

Table 1: General Information on Hotels Surveyed

	Berjaya	Burau Bay	Sherat-on	Holiday Villa	Langk-asuka	City Bayview	Gates	Singga-hsana
Year established	1993	1990	1991	1992	1995	1995	1994	1996
Hotel category (star rating)	5	3	4	4	3	4	3	3
Total number of rooms:	400	150	252	227	214	282	177	73
- Normal	374	128	231	200	192	253	56	62
- Suites	26	22	21	27	22	29		11
Number of:								
- Restaurants	5	1	3	3	2	3	2	2
- Kitchens	6	2	5	2	1	3	2	1
- Guest corridors	4	1	9	-	6	12	14	1
Facilities offered:								
- Conference halls	1	1	2	1	1	1	-	1
- Meeting rooms	8	2	-	3	1	8	3	3
- Gymnazium	1	-	1	1	-	2	1	-
- Swimming pool	1	1	2	1	1	1	1	1
- Business centre	-	-	-	-	1	1	-	3
- Sports facilities	1	3	1	1	-	2	1	-
- Others	-	-	-	karaoke	-	-	surau	-

Table 2: General Awareness of Energy Conservation / DSM Measures

General Awareness	Response	Frequency	Percentage
Investment decisions for major energy consuming appliances are taken by:	- top management -middle management - concerned manager	6 1 2	67 11 22
Energy conservation measures taken by the hotel:	- Yes - No	7 -	100 -
Energy conservation measures reviewed by top management:	- Yes - No	7 -	100 -
Frequency of review:	- Yearly - Half yearly - Quarterly - Monthly - Weekly	1 1 1 3 1	14 14 14 44 14
Energy consumption monitoring is done on regular basis:	- Yes - No	7 -	100 -
Person responsible for energy monitoring and management:	- Energy manager - Others	2 5	29 71
Energy audits carried out:	- Yes - No	7 -	100 -
Audits are done:	- Internally -By external agencies - Both	5 - 2	71 - 29

6.3.2 Awareness of Energy Conservation / DSM Technologies and Measures: Table 3 summarizes the responses on various technologies and measures for energy conservation / DSM.

This part of the questionnaire lists out several state of the art technologies for energy end use. A general observation is that in several cases where respondents were not aware of the option, they have not chosen the proper response; ie. "The hotel is not aware of the option". Instead, they have opted for response "It is not applicable to the hotel", or "Option was evaluated and not found suitable". For example, the responses in case of heat pumps. This is one of the potential technology for commercial users like hotels that can make substantial energy savings. The level of awareness remains low due to lack of marketing efforts by manufacturers and availability. Each of the technology / option is discussed below.

(a) Efficient lighting system: A majority of hotels (5 hotels; 63%) had already implemented use of CFLs in place of incandescent lamps and one hotel (12%) is in process of implementation. Balance 25% were aware but yet to initiate any action. In case of sodium vapour lamps, it had already been implemented in most cases (75%) and not applicable to one case. The response in case of use of electronic ballasts indicated that only two hotel (25%) had taken this action. Further 25% indicated that action has been initiated. Surprisingly, one respondent mentioned that this is not applicable, although during visit to the hotel and data collected, it was observed that several florescent lamps were in operation at the hotel.

(b) Efficient air conditioning system: Three questions in this category pertained to use of heat pumps for water heating, space cooling purposes. Only one hotel (12%) had implemented this option and one mentioned that enquiries have been floated. Although 50% of the respondents mentioned that it is not applicable to the hotel, the reason appears to be non-awareness of this option. Heat pump technology, although not actively promoted by the manufacturers, is well proven even for households. In addition to hotel Lankasuka, who among the respondents had implemented this measure, one more hotel (The Grand Continental) had this technology. In case of both hotels, M/S Carrier Air Conditioners had supplied central air conditioning systems

Table 3: Awareness of Energy Conservation / DSM Technologies

DSM Technology	Frequency of Responses					
	NAW	AW	DECID	IMPLT	NST	NA
(i) Use of Energy efficient Equipments: Efficient Lighting System: (a) Compact Florescent lamps in place of incandescent		2	1	5		
(b) High pressure sodium lamps in place of mercury		1		6		
(c) Replacement of magnetic ballast by electronic		3	2	2		1
Efficient Air Conditioning and Water Heating System: (d) Use of heat pumps for water heating	1	1	1	1		4
(e) Use of heat pumps for space cooling	1		1	2		4
(f) Use of heat pumps for space cooling and water heating (combined)	1	1	1	1		4
(g) Energy efficient motors to replace standard motors	1	1	3	2		1
(h) Proper sizing of pumps and replacement		1	4	2		1
Efficient Appliances: (i) Energy efficient refrigerators and freezers	1	2	1	3		
(j) Energy efficient TVs	2	2	1	3		
(k) Other energy efficient appliances ; washing machines, fans, radios	1	2	1	3		
(ii) Other Innovative measures Automation and Control: (a) Infra red activated guest room switching systems		2	2	2	1	1
(b) Building energy management systems	1	3	1		1	2
Alternate Energy systems: (c) Use of solar water heating system	1	3	2			2
(d) Use of solar space heating systems	2	2	1			3
Demand Shift and control: (e) Load control			2	6		
(f) Thermal storage to use cheaper off-peak electricity	2	1	1			3

(g) Shifting operations from peak to off-peak time				2		4
(h) Improving power factor				7		
Heat Control and Heat recovery: (h) Fixing heat control film on windows		1	2	1		3
(i) heat recovery from laundry waste water		2	2	3		
Retrofitting of Equipments and systems: (j) Proper sizing of pumps,motors and other equipments		2	3	2		
(k) Provision of better insulation in the rooms		2	3	1		
(iii) Housekeeping and Monitoring: Awareness Training and Good Practices: (a) Staff awareness training on energy conservation			2	4		
(b) Minimizing waste of hot water		1	1	3		1
(c)Switching off lights in areas not needed				8		
Monitoring and Auditing: (d) Overall energy consumption monitoring regularly				8		
(e) Sub-metering to monitor electricity consumption		2	2	3		
(f) Monitoring and control of air conditioning systems			1	6		
(g) Monitoring air supply in different areas		2	1	5		
(h) Checking conditioned air temperature and raising if possible				8		
(i) Energy audit of the hotel		2	1	5		
Repairs and Servicing: (j) Plugging leakages in hot water piping		1		6		1
(k) Repairing insulations in rooms, pipings etc.		1		5		1
(l) Regular servicing of steam boilers, freezer units etc.		1	1	5		1

Notes: NAW: The hotel is not aware of the option.
AW: The hotel is aware of the technology / option and benefits but has not initiated any action
DECID: The hotel is in the process of deciding and has floated enquiries.
IMPLT: The hotel has implemented the option.
NST: The hotel has evaluated the option and did not find it suitable.
NA: It is not applicable to the hotel.

incorporating principle of heat pump to supply hot water to the guest rooms. The other two questions related to replacement of standard motors by energy efficient motors and proper sizing of pumps were not applicable to some of the hotels since they did not had such equipments. In other cases too since most of hotels are relatively new (less than three year old), such action may be difficult to take. Two hotels (25%) mentioned that they had taken this action and other 37-50% were in process of taking action.

(C) Efficient appliances: The questions in this area related to use of efficient refrigerators, freezers, TVs, radios, washing machines etc. 37-43% of the hotels mentioned that they had implemented this option. Others had mixed responses from non-awareness to non-applicability of the option. It was observed that since in most cases hotels are new, respondents consider whatever appliances they have, are efficient. This perception may be true in case of some hotels, if the technologies available in Malaysia only are considered. This is because Malaysia is manufacturing base for several Japanese companies. In most cases, appliances are therefore energy efficient.

(d) Automation and control: Two hotels (both less than a year old) mentioned that infra red activated guest room switching system had been implemented. Two were not aware and two were in the process of taking a decision. As mentioned earlier, some hotels in Langkawi have keytag system, that also serves the same purpose. However, method of implementation is not appropriate with keytag not necessary to keep the room energized (substituting it by spoon or other such items). As one hotel mentioned, they did find guests inserting spoons rather than keytag (and leaving it there while going out of the room), defeating the vary purpose of the system. But the hotel preferred to bear with this keeping guest comfort in view. The guest acceptability of a proper system may need to be investigated.

Building energy management system may be difficult to consider for a majority of resorts due to their large spread. It may be considered for multi-story hotels. Three hotels (37%) mentioned that it was not applicable or not found suitable. Other four hotels were either not aware or not taken any action. One hotel mentioned that it is being considered.

(e) Alternate energy systems: This part enquired about use of solar systems for water heating and space heating. For water heating, two hotels mentioned that they are in the process of taking a decision, and four (50%) had not initiated any action. Surprisingly, two hotels that mentioned it is not applicable, were using electric geysers for water heating. Its not clear why they thought it is not applicable to them.

Space heating is not needed in Langkawi since ambient temperature does not fall below 20^0C. Accordingly, most of the hotels (88%) mentioned either no action on this option or non-applicability.

(f) Demand shift and control: This section had questions on load control, thermal energy storage, shifting operations to off-peak time, and improving power factor. Many of the hotels had LT (low tension) connections with no demand charges and differential tariffs. Therefore, except power factor improvement, other options were not applicable to them. However, since several hotels were using timers or other such devices to control energy consumption, most (75%) responded they practice load control, and balance two were in process of taking a decision. Thermal storage was either not applicable or no action taken, except one respondent who mentioned that a decision on this was under consideration. However, recent (May 1996) unfavourable changes in on-peak and off-peak rates by the utility may force the hotel to abandon this idea. Two hotels mentioned that they had implemented "shifting operations" to off-peak and others mentioned its non-applicability. All the hotels had implemented power factor improvement option. This may be due to high penalty by the utility in case power factor falls below 0.85.

(g) Heat control and heat recovery: One hotel mentioned that sun or solar control film had been installed on windows exposed to sun, two were in process of deciding and three said it was not applicable. In some cases, it was observed that extension of the roofing or balcony ensures that windows are not exposed to the direct sun for long duration. In most of the Chalets, this may be true. However, in case of multi-storied hotels, this problem remains. Exposure of windows to sun depends on hotel architecture and design.

On heat recovery from laundry wash water, three felt it was not applicable, two were in process of deciding and two did not take any action. In case of a hotel, where walk through audit was carried out, potential for heat recovery from laundry system (including driers) was observed. It could be used for boiler water preheating, which was close to the laundry room.

(h) Retrofitting of equipments: The first question pertained to proper sizing of pumps and motors, that has already been covered in the (b) above. On provision for better insulation in the rooms (windows, doors etc.), one hotel mentioned it had been implemented, three were in the process of taking decision, two had not taken any action. One newly built hotel mentioned its inapplicability. However, lack of proper insulation was observed a general problem during the visits to the hotels and walk through audits. An indication of the potential savings from this has been given in the section 6.4.

(i) Housekeeping and monitoring: This section included questions related to awareness training and good practices, monitoring and auditing, and repairs and servicing. The response from the hotels on good housekeeping indicated that most of the good practices had been implemented in a majority of the hotels. Following measures; switching off lights in areas not needed, energy consumption monitoring on regular basis, and checking conditioned air temperature drew 100% implemented response from the hotels. Staff awareness and training in more than 50% hotels was another highlight. Of three hotels that mentioned sub-metering to monitor electricity consumption exists, two were relatively new. In case of third one, the walk through energy audit indicated no such sub-metering. Similarly, contrary to the response in the first part that energy audits are carried out by all (6.3.1., Table 2), only five hotels mentioned that energy audits are carried out, one was in process of taking a decision, and two had taken no action. As mentioned earlier this may be due to non-familiarity of many with the concept of energy audit, and probably confusing it with energy monitoring.

6.3.3 Ranking of Energy Conservation / DSM Measures: Hotels were also asked to rate various conservation measures covered above (6.3.2) on following scale; not important, important, very important, and can not say. The results are given in the Table 4.

Table 4: Ranking of Energy Conservation / DSM Technology and Measures

Technology / Measure	Frequency of responses			
	NImp	Imp	VImp	CNsay
(i) Use of Energy Efficient Equipments:				
Efficient Lighting systems		3	5	
Efficient Air Conditioning systems		2	6	
Efficient Appliances	1	2	5	
(ii) Other Innovative Measures				
Automation and control		2	5	1
Alternate Energy Systems	4	4		
Demand Shift and Control	2	4	2	
Heat Control and Heat recovery		3	4	1
Retrofitting Equipments / systems		5	1	2
(iii) Housekeeping and Monitoring				
Awareness Training and good Practices	1	4	3	
Monitoring and Auditing	1	3	4	
Repairs and Servicing	2		6	

Note: NImp = Not much important; Imp = Important; VImp = Very important; CNsay = Can not say

Five hotels (62%) considered efficient lighting to be a very important measure, and the balance three, important. Lighting is a major item of cost in the hotels and hence considered important. Efficient air conditioning was considered very important by even more number of respondents, 75%. This probably represents highest electricity consuming appliance in the hotels. Automation and control was also considered very important by more than 50% (five hotels), whereas alternate energy system (solar systems) had equal number of important and very important rating (four hotels each). Demand shifting and control was also considered very important by 50%. Non-applicability of this measure explains the response can-not say by 25%. Heat control and heat recovery also had somewhat similar response. Retrofitting was considered important by a majority (62%), and very important by 12%. Two respondents (25%) were however not sure on this. However, no one rated it as not important, as appears to be current perception of the utility in Malaysia. One respondent felt that awareness training and good practices, and energy monitoring and auditing were not important, all others felt these were either important or very important. Repairs and servicing was considered very important by 75%, and surprisingly, not important by the rest 25%.

6.3.4 Rating of Energy Conservation / DSM Barriers: Several barriers were mentioned and respondents were asked to rate on following scale; not applicable, not important, important, and very important. The results are summarised in the Table 5.

Maintenance problem emerged as the most important barrier, rated very important by 71%, followed by high cost (rated important by 57%). Not surprising, considering that the questionnaire was filled by the maintenance personnel, and cost may be very important to them as they may have to justify every time they propose an energy efficient option. An important finding was that "Implementing agency non-availability" was considered equally important barrier as cost, implying that hotels would prefer if energy conservation / DSM measures could be carried out by some agency.

High payback period was next important concern with 50% considering it very important, followed by equal number of very important rating of product unreliability, lack of technical

Table 5: Rating of Barriers in Energy Conservation / DSM

Barrier	Frequency of responses

	NA	NImp	Imp	VImp
High cost	1		2	4
Lack of information			5	2
Availability problem		1	4	2
Uncertain delivery	1	2	3	1
Unreliable products	1		3	3
Maintenance problems			2	5
Uncertain benefits			4	2
Not enough saving potential		1	3	3
High payback period	1		2	3
Lack of technical expertise	1		3	3
Disruption in changeover	1	1	2	3
Experts / consultants not available			5	2
Implementing agency not available	1	1	1	4
Financing not available	1	1	2	3
No application in hotel	3		2	
No barrier	2	1	2	

Note:
NA = Not applicable; NImp = Not important; Imp = Important; VImp = Very important.
expertise, disruption in changeover and money not being available. Uncertain benefits ranked next in the ratings, followed by problem of availability, lack of information on energy efficient

products, and non-availability of consultants at same rank. Uncertain delivery was the least important barrier.

6.3.5 Preference for Method of Conservation: Some experts feel that retrofitting of old equipments is a cumbersome task that customers do not like. This part of the questionnaire was designed to find willingness, acceptable payback period and preferences of the respondents among various methods of conservation viz. retrofitting, replacement of equipments, adding new systems and demand shift measures. The findings are reported in Table 6.

It can be seen that retrofitting, replacement and adding new systems, all the three methods were acceptable to 75%, and demand shift to 62% (with one do not know). Acceptable payback periods were mostly two years, a rather low number for measures involving high investment. However, acceptability of payback period in such cases may depend on top management.

Ratio of on-peak to off-peak price of electricity may be difficult to indicate unless relevant options are identified and evaluated. The response were therefore mixed. However, the recent (May 1996) change in on-peak to off-peak ratio from 2.25:1 to 1.73:1 did prompt one of the hotels to indicate that a proposal for a thermal energy storage that they were considering, may have to scrapped now. For a utility to promote demand shift from peak to off-peak, such changes may create uncertainty for the customers, resulting in failure of any such programme.

Retrofitting and replacement were considered equally important, followed by adding new system and demand shift respectively. The first two are relatively low investment options with least uncertainty, and ranking reflects the low risk attitude of the respondents.

6.3.6 Policy Measures for Energy Conservation / DSM: It is clear from the voluminous material on energy conservation efforts in developed countries that several policy measures such as awareness campaigns, demonstration programmes, financial and institutional mechanisms etc. are required for success of the programmes. In this part of the survey, respondents were first asked to indicate their preferences for financial mechanisms and institutional mechanisms.

Subsequently, the respondents were asked to indicate importance of the various policy measures on following four point scale; not relevant, not much important,

Table 6: Method of Conservation

Method	Responses	Frequency	Percentage
Retrofitting:	- Yes	6	75
	- No	2	25
Maximum payback period:	- One year or less	1	17
	- Upto two years	3	50
	- Upto three years	-	-
	- Upto five years	1	17
	-More than five years	1	17
Replacing equipments / systems:	- Yes	6	75
	- No	2	25
Maximum payback period:	- One year or less	1	17
	- Upto two years	3	50
	- Upto three years	-	-
	- Upto five years	1	17
	-More than five years	1	17
Adding new system:	- Yes	6	75
	- No	2	25
Maximum payback period:	- One year or less	-	-
	- Upto two years	4	66
	- Upto three years	-	-
	- Upto five years	1	17
	-More than five years	1	17
Demand shift:	- Yes	5	62
	- No	2	25
	- Do not know	1	13
Peak to off peak ratio of electricity rates required to shift operations:	- 1.5 : 1	1	17
	- 2 : 1	1	17
	- 3 : 1	2	32
	- Above 3 : 1	1	17
	- Can not say	1	17

important and very important. The results of the importance of policy measures are included in Table 7.

Table 7: Policy Measures for energy conservation / DSM

Policy Measures	Frequency of response			
	NRel	NImp	Imp	VImp
Energy audits		1	5	2
Technical assistance			2	6
Financial incentives		1	2	5
Pilot demonstration programmes		1	5	2
Seminars and workshops on energy conservation / DSM		1	4	2
Energy conservation literature availability		2	4	2
Awareness campaigns through media		1	5	2
Education / training programmes			5	3
Availability of experts / consultants		1	3	4
Availability of finance from banks / financial institutions		1	6	1
Availability of institutional mechanism such as ESCOs			4	4

A majority of hotels preferred energy service companies (ESCOs). ESCOs is a novel concept in the area of energy conservation / DSM. ESCOs contract to carry out the modification / replacement for energy conservation at their cost and recover the cost from the savings in the energy bill of the client over an agreed period of time. Four of the respondents had ESCOs as first choice to carry out the job and take care of financing aspect of energy conservation. From other aspects too (such as technical; as follows from discussions below), ESCOs appear to be preferred alternative. Own financing was second most preferred option. However, top management option on this aspect may be more important.

On institutional mechanism , expert / consultants was most preferred option, followed by ESCOs and utility at same level of preference. This indicates that if the utility were to take initiative on this, hotels would welcome and participate enthusiastically. Governmental agencies and financial institutions were next in the list of preferred alternatives, followed by industry association, a least preferred alternative. Industry associations in several countries have made powerful impact on such programmes (Hotel Association in Thailand for example). The advantage is that communication is easy and experience sharing can be an important tool itself to assimilate the findings. The industry associations in Malaysia may have to examine why members do not have adequate faith in them.

Among the various policy issues (Table 7), technical assistance was considered most important requirement by 75% of the respondents. This is also in line with earlier findings on barriers where maintenance problem was cited most important barrier and non-availability of implementing agency second most important. Lack of technical expertise was also listed as one important barrier. Financial incentive was considered second most important measure (with 62% rating it very important), followed by availability of institutional mechanism such as energy service companies. Such mechanism take care of technical expertise as well as financial problems, and can play important role in energy conservation, if policies are properly pursued. Availability of experts/consultants was next in importance, which also points out to the same problem that the most important policy measure (technical assistance) seeks to address. The findings on this account are very consistent. Education and training programmes, and seminars and workshops on energy conservation / DSM were next in the importance rating. Both these measures are complimentary in nature to the technical assistance; the most important policy measure. Energy audits, pilot demonstration programmes and awareness campaigns through media follow after seminars in ratings, and all the three were considered equally important. Energy conservation literature and availability of finance from banks and financial institutions is last on agenda of policy measures, not difficult to understand as this problem belongs to the top management.

6.4 Energy Conservation Opportunities:

Of the several possible measures indicated in the earlier section 3.3, only opportunities related to lighting and air conditioning have been analysed in this section. As mentioned earlier, even for these applications a detailed analysis would require cooperation and detailed data from hotels, utility and appliance manufacturers. From hotels, detailed data on appliances, ratings, hours of use and actual energy consumption, life etc. would be needed, whereas from manufacturers information and details of efficient appliances that they have or can make available in Malaysia would be needed. From utility, information about tariffs (LT and HT tariffs, different slabs, demand charges, on-peak and off peak rates), load profile etc. would be needed. This detailed exercise was outside scope of this project and is recommended for the future study. The current analysis is based on limited data available for this study from hotels and information available in the literature.

6.4.1 Lighting: In this study, of the various opportunity mentioned for lighting, detailed analysis of replacement of incandescent lamps by compact florescent lamps (CFLs) has been covered.

6.4.1.1 Replacement of incandescent lamps by CFLs: AS mentioned, several hotels have CFLs in use, but to varying degrees, and substantial scope for replacement of existing incandescent lamps by CFLs remains. CFLs are normally available from 5 W to 40 W ratings. Three type of CFLs are most common;

(1) SL : It is the CFL with integral-main frequency control gear or ballast.

(2) PLC : It is the CFL with separate ballast.

(3) PLCE : It is the CFL with integral electronic ballast. This has smaller lamp dimensions and reduced weight.

When to switch to CFL use from incandescent lamp: In several cases, no clear criterion for switching to CFL use was established. The economic viability of switching over to CFL use depends on hours of use, cost of incandescent lamp and CFL, and electricity price. However, in most cases, for about 2000 hrs of use per year in Malaysia, simple payback period would be less than 1.5 years. This corresponds to about 5.5 hrs per day of use, or 8 hrs per day in a hotel guest room with an occupancy factor of 70%. Simple payback period, discounted payback period, cost of conserved energy and annualized life cycle costs are given below for a typical replacement, that applies to several points in most of the hotel guest rooms. Individual hotels can change the parameters and make calculations. The switchover can be decided based on acceptable values of payback period and annualized costs.

Economics of Compact Florescent Lamps: sample calculations

	Incandescent lamp	CFL
(i) No of hours in use per year (hours)	2000	2000
(ii) Cost of lamp	$ 1.0	$30.0
(iii) Power (Watts)	60	15 (including 2 W for consumption in ballast)
iv) Energy consumption per year (KWh)	120	30
v) Energy costs per year (@$ 0.21 per unit)	$ 25.40	$ 6.30
vi) Life of the lamp (hrs)	1000	8000

(Note: Actual cost of a 60W incandescent lamp is about $1.40. However, it is assumed that hotels can get substantial discounts to buy the lamps in bulk; at $1.0 per lamp. Since not many replacements for CFLs would be needed, its retail market price has been taken. However, during the visit it was found that some hotels were able to buy CFLs in bulk at more than 40% discount to above price).

Simple payback period (PBP): It is defined as ratio between additional investment and first year energy cost savings; ie. time taken by energy savings to recover the investment.

PBP = (CE - CC) / [PE (EC - EE)]

Where, CE is cost of the efficient technology

CC is the cost of conventional technology

PE is energy price

EE is the energy consumption with efficient technology

EC is annual energy consumption with conventional technology

Hence, in this case, PBP = (30 - 8*1)/ [0.21*(120-30)]

= 1.16 years.

(since 8 incandescent lamps will be required over the life of one CFL).

Discounted payback period (DPBP): Simple payback period does not consider time value of money (interest that can be earned on own money, or has to paid on borrowed money). Discounting corrects this problem.

DPBP = n * CRF (d,n) *(CE-CC)/[PE (EC-EE)]

= discounting factor * PBP

CRF is the capital recovery factor for discount rate d and time period n.

(taking discounting of 9%, the factor for 4 years is .309)

Hence DPBP = 4*.309* * 1.16 = 1.43 years.

(For further refinement, even CC can be discounted before formula is applied).

Cost of conserved energy (CCE): The cost effectiveness of the investment is expressed as the cost equivalent to a unit of energy saved. Discount rate and useful life of investment is considered in this. It is defined as annualized extra initial cost of the efficient technology alternative divided by annual energy savings.

CCE = CRF (d,n)* (CE-CC) / (EC - EE)

CC here is present value of 8 incandescent lamps (discounted value at 9%).

$CC = 1 + 1/(1+.09) + 1/(1+.09)^2 + ...+ 1/(1+.09)^7$

$= \$ 6.03$

Thus for the above example CCE = .309 * (30-6.03)/(120-30)

= $ .08

Thus energy saved through use of CFL has cost only $ .08 against its supply price of $.21 by the utility.

Annualized life cycle costs (ALC): It is sum of the annualized value of the initial investment and the annual energy costs.

ALC = C CRF (d,n) + PE * E

where C is the initial cost (investment) of the alternative and E annual energy use.

This gives a good measure for comparison of annual costs of two alternatives, irrespective of difference in life.

Thus for CFL;

ALC = 30 * .309 + .21 * 30

= $ 15.57 per year

For incandescent lamp;

ALC = 2 * 1 + .21 * 120

= $ 27.20

Thus net annual savings from use of one CFL work out to (27.20-15.57) = $ 11.63.

Additional savings and benefits from CFL use: The calculations given above relate only to energy savings through reduced electricity input. CFL use has following additional benefits:

(i) Frequent lamp buying and changing is avoided. In big hotels, several lamps may have to be changed everyday in case of incandescent lamp. This means extra expenses on power and inconvenience.

(ii) Since lighting energy use coincides with the peaks, reduced use may result in reduced maximum demand for hotels, and reduced peak for the utility. Thus hotels paying maximum demand charges may also be able to save additional money.

(iii) Reduced energy consumption in a room for lighting means reduced air conditioning load. In a country like Malaysia, where hotels need air conditioning almost throughout the year, savings can be substantial. The calculations are given below.

Additional load = 60-15 = 45 Watts

For 2000 hrs per year use of the lamp, this works out to;

= 45* 2000/1000 = 90 KWh per year

= 307080 btu

Taking a typical room conditioner (1.5 hp, 12000 btu/hr capacity), that consumes 1.5 * 746 watt-hr per hour.

Therefore, to extract the extra heat due to use of incandescent lamp, it will consume:

= 307080 * 1.5 * 746/(12000 * 1000) KWh per year

= 28.6 KWh

And average contribution to the peak demand from this (during the hours lamp operate;

= 28.6 *1000 / 2000 = 14.6 Watts.

Cost of this electricity = 28.6 * .21 = $ 6.01

Therefore, for an air conditioned hotel room, the annual savings from replacing one 60W incandescent lamp by 13 W CFL (with electronic ballast) are:

$ 11.63 + $ 6.01 = $17.64 approximately.

When replacement is not viable? As mentioned earlier and shown in the calculations, economic viability of replacement of a incandescent lamp by a CFL depends on hours of use, electricity rates, and prices of lamps. If we consider electricity rates and other factor as given in above calculations, the CFL payback period approaches three years with 800 hrs of use per year. Sine in most cases, for investment like this a payback period of more than three years may not be acceptable to the investors, 800 hrs of use per year (or 3 hrs per day with 70% occupancy) may be the lower limit to consider replacement. This can be modified to suit individual hotel preferences and payback period acceptability.

6.4.1.2 Savings at national level: It would require survey of hotels in various cities to estimate extent of use of incandescent lamps in Malaysia. Similarly, number of hotel rooms that use incandescent lamps, and are also air conditioned need to be estimated to arrive at saving potential at national level.

If one were to consider that about 25% of the 55000 hotel rooms in Malaysia in 1995 offered potential for this option;

Annual savings in electricity consumption = 90 * 55000 * .25 KWh = 1237500 KWh

Peak demand reduction for the utility = 45 * 55000 * .25 / 1000

= 619 KW

(considering that lighting requirement coincides with the peak)

In case, 25% of the above mentioned rooms (ie. 25 % of the 25% of 55000) are air conditioned also, the savings are:

Annual savings in electricity consumption = 133600 KWh

Peak demand reduction for the utility = 659 KW

6.4.2 Air Conditioning: As mentioned earlier, a majority of hotels in Langkawi are Chalet type, and hence most of the guest rooms have roofs that are exposed to outside environment and face sun for whole day. This results in substantial heat gain in the rooms (in absence of adequate insulation). Similarly, in several hotels (specially multi-storied type), glass windows are exposed to the sun. This also results in heat gain in the room. Provision for better roof insulation and use of sun control film on glass windows / doors exposed to the sun were identified two major areas of improvement based on the walk through energy audit. Therefore, in this study, we illustrate benefits of providing better insulation and installation of solar control films for the typical data collected during the survey.

6.4.2.1 Provision of better walls and roof insulation: The heat gain (or loss) from a wall is given by;

$Q/t = kA(T_2\text{-}T_1)/l$

where k is the conductivity of wall (btu.inch/hr.ft^2.^{o}F), A is the area of wall in square ft, l is thickness of wall in inches, and (T_2-T_1) is temperature difference between outside and inside in degree F, and t in hours.

Further simplification of this (to cater for multiple type materials /insulations in a wall) is given by;

$Q = A^* (T_2\text{-}T_1)^* t / R_t$

Where R_t is the total R value of the wall.

For a typical Chalet in Langkawi for a big hotel, following data is collected (based on observations and information provided);

Roof area of a typical air conditioned room = 14 * 14 = 196 ft^2

Wall areas of the room 14*12 = 168 ft^2 each wall (to simplify)

Ambient temperature (summer day) 84^oF (32.5 ^oC)

Room temperature (guest room) 64^0F (20 ^oC)

R value for the roof with zinc sheet and 1.5 inch glasswool

= 5.5 + .84 = 6.4 (approx. 0.84 is for interior and exterior air film).

R value for walls (2 inch thick wood wall) = 2.4

(approx, including .84 for interior and exterior air film).

R Value for glass $^1/^8$ inch = .03 + .84 = 0.87

We make following assumptions for further simplification:

(i) Average ambient temperature is 77^oF (28^oC).

(ii) Air conditioner needs to operate for about 14 hours , and during this period only temperature difference between inside and outside exists (guest is not in the room for balance 10 hours).

(iii) Room has one single glazing (clear glass $^1/^8$ inch) 6 * 8 ft^2

Therefore per day heat gain from roof and four walls and window:

= 196 * (77-64) * 14 / 6.4 + (168 * 4 - 48) * (77-64) * 14 / 2.4

+ 48 *(77-64) * 14 / .87

= 62935 Btu per day.

The electricity consumption = 5.9 KWh per day

If additional insulation (one inch thick glasswool) were added to walls and roof, and window glass made double; R values change and new heat gain would be;

= 196 * (77-64) * 14 / 10.1 + (168 * 4 - 48) * (77-64) * 14 / 6.1

+ 48 *(77-64) * 14 /1.45
= 28174 Btu per day

Therefore savings in electricity = 3.3 KWh per day

Annual electricity savings = 843 Wh (for one room)
Annual money savings = $ 177

These savings occur every year and need to be compared with cost of insulation and acceptable payback period.

There are several other leakages through wall cracks, doors and window frames, basement etc. Air infiltration from windows and doors represents a major component of heat loss / gain (Kraushaar, 1993). Similar analyses can be carried out for other areas of heat gain based on detailed study of individual hotels. The savings at national levels can be calculated based on a survey of hotel covering the entire country.

6.4.2.2 Provision of sun control film on glass windows and doors: The analysis carried out above only pertains to heat gain through conduction. Glass windows and doors, that are exposed to the sun, can be other important source of solar heat gain through direct radiation. Glass windows exposure to sun for long durations was observed in a few hotels in Langkawi, specially in multi-storied hotels.

The calculations have been made for a typical multi-storied hotel, that had its windows exposed to the sun.

Glass area of the window exposed to the sun = 64 ft^2
Total glass area for 200 rooms = 12800 ft^2

Estimated yearly solar heat gain in Malaysia
= 160000 (Btu/hr. ft^2)hr.

Considering haze factor = 1 for Langkawi and shade or solar gain factor of 0.76 for single clear glass, the heat gain works out to:
12800*160000*1*.76 = 1556480000 Btu per year

If we install sun control film on the windows with a shading coefficient of 0.5 (films as low as 0.24 shading coefficients are available, with different transmittance values of visible light),
The heat gain will be;

12800*160000*1*0.5 = 1024000000 Btu

Thus solar heat gain reduces by 532480000 Btu

This amounts to savings of 49650 KWh energy for the hotel, as air conditioner has to work less.

Or savings of $ 10428 per year.

Cost of installation of films on all the windows may be about $20,000 (at the rate of about $ 90 per room; or $1.40 per sq ft), giving a payback period of about two years.

6.4.3 Housekeeping: Following measures were identified:

(i) Better insulation: In almost all hotels, the room insulation was poor resulting in substantial heat gain from outside. Window and door frames, gaps in the walls (in wooden structures), poor roof and wall insulations all cause increased load on air conditioners due to heat gain from outside.

(**ii) Awareness and good practices**: Street and parking lights are switched off manually or using timers in some cases. Timer settings should be reviewed from time to time depending daylighting availability during different months. In one big hotel for example, street lights were observed to be on at least one hour before these were actually needed, and similarly, were observed to have been switched off half an hour late from available daylighting considerations. Hotels can also use photo-sensors to take care of this problem.

Timers to cut-off or reduce lighting in various area (depending on need) can be used (which is already being practised by some hotels). For example, street and some other lighting can be reduced by switching off a number of points through timer control after a set time.

Housekeeping measures have not been quantified here. Other housekeeping measures, that are applicable to most of the hotels have already been described in the section 3.3.6.

6.5 Energy Consumption Comparison Between Two Hotels:

How does the energy consumption compare between similar hotels (in terms of size, facilities offered and star rating)? What accounts for differences? Is the hotel with lower energy consumption more efficient? What is scope for improvement?

To answer these questions, energy consumption data of two comparable hotels; Shearton Langkawi (a four star hotel), and Berjaya (a five star hotel) were analysed. The major energy sources used in these hotels were electricity, gas (LPG), petrol and diesel. From the 1995 monthly bills for these fuels and occupancy data, cost per room sold for electricity, gas, petrol, and diesel was worked out Total energy consumption and cost per room sold was also worked out (see Table 8). The different units of different fuels were converted to mega joules (MJ) to calculate total energy use. It was observed that Shearton Langkawi's average energy costs per room in 1995 was RM 25.74 against RM 17.12 of the Berjaya, about 50% more than Berjaya. Interestingly, average electricity costs per room sold itself were 67% higher for Shearton Langkawi. On the other hand, average occupancy during 1995 was 83% in Shearton Langkawi against 63% in Berjaya. Since a considerable amount of energy consumption does not vary with

Table 8: Energy Consumption 1995

(A): Sheraton Langkawi

Month	Occupancy	Quantity/Room (MJ)	Cost of Energy/Room (RM)

Jan	80.5	309358	27.87
Feb	88.7	294085	24.86
Mar	76.3	279622	24.63
Apr	79.6	358839	30.30
May	83.3	339138	29.02
Jun	84.8	289080	24.51
Jul	86.3	296092	26.14
Aug	86.4	346504	31.78
Sep	86.2	258518	23.81
Oct	79.3	268840	26.36
Nov	85.8	232617	22.19
Dec	83.1	184858	17.36
Average	83.4	288129	25.74

(B) Berjaya:

Month	Occupancy	Quantity/Room (MJ)	Cost of Energy/Room (RM)
Jan	64.06	164660	17.41
Feb	77.72	178321	14.89
Mar	72.65	184718	15.09
Apr	62.81	217459	17.81
May	45.27	246484	21.56
Jun	51.91	279271	25.03
Jul	66.10	149277	13.34
Aug	74.81	180684	14.17
Sep	52.48	216447	18.60
Oct	45.60	223294	19.61
Nov	71.04	165054	12.94
Dec	71.67	168436	15.00
Average	63.01	197842	17.12

Energy given by:
Electricity = 3125.74 MJ/KW; Gas = 64.23 MJ/m^3
Petrol = 36.96 MJ/litre;   Diesel = 35.28 MJ/litre

occupancy rate (for example in lobby, offices, and a large part in kitchen, restaurants and other hotel facilities), with higher occupancy rate, the energy cost per room sold should be less. If this factor is also considered, compared to Berjaya, Shearton Langkawi's average electricity consumption per room sold was between 50 to 66% higher and energy consumption between 67 to 89 % higher. Monthly variations in energy consumption are difficult to explain from the data. Normally, such variations should be explained by climatic conditions and occupancy (and special events, if any). However, variations during different months were not in same direction in case of the above hotels. In both cases, maximum monthly variation in electricity and energy consumption respectively were of the order of 96% and 83% in case of Shearton and 100% and 93% in case of Berjaya, indicating need for investigation into possible causes.

As mentioned above, the difference is mainly due to higher electricity consumption in the Shearton. From the observations made, following reasons could be attributed to this:

(i) Shearton had closed lobby requiring lighting as well as air conditioning. Berjaya had open lobby.
(ii) Shearton had some other major air conditioned area such as restaurants.
(iii) Guest rooms in the Shearton were bigger in size and with more lighting points. Some points had one common switch. Shearton also had practice of leaving one lamp near the entrance on for guest convenience.
(iv) Berjaya had already implemented use of CFLs in guest rooms, Shearton had yet to take up. It had CFLs in use in a few selected areas only. Berjaya in fact reported substantial reduction (more than 10%) in their electricity bill after they switched over to CFLs on mass scale.
(v) Berjaya had keytag system to ensure that appliances are switched off once guest goes out. Shearton had no such system.
(vi) Air conditioning load in the guest rooms in Shearton was also estimated to be higher for following reasons;
(a) Larger size room, resulting in more energy gain from the outside.
(b) Metal roof with only 1.5 inch glasswool insulation.
(c) More lighting points, and that too incandescent, resulting in larger heat gain from lighting.
However, it is also to be noted that Shearton had higher occupancy average (84% against 63% of Berjaya), and unless role of energy services in this is identified (example air conditioned restaurants), it may be difficult to justify lower level of energy services. However, even same

level of energy services as at present can be delivered more efficiently, and at lower cost. This has already been discussed in section 6.4.

6.6 Utility Policy on Energy Conservation / DSM:

Tenaga National appear to be a progressive utility with a highly qualified (with doctoral degree) person incharge of DSM programmes as Senior Manager (DSM). This is certainly a progressive step considering that most of the developing countries have yet to realise importance of utility initiating such programmes. However, information on programmes initiated by Tenaga National was not available. Hotels may offer a promising DSM opportunity for Tenaga National if pursued properly. The neighbouring country, Thailand, already has an on-going programmes for Green Hotels.

The study of hotels in Langkawi indicated that Tenaga National had provided LT as well as HT connection to the hotels. The connections had to be HT for demand exceeding 1000 KW (information is based on personal communication with a hotel personnel). The hotels with HT connection were only subjected to maximum demand charges. However, within HT category, there appeared to be further sub-categories. Among the two comparable hotels for example, only one had differential tariffs (peak and off-peak). The information from utility on tariffs was not available.

Tenaga National recently revised their rates. In the process, the peak to off-peak ratio has been reduced to 1.73:1 from earlier 2.25:1. The reason for this is not clear. However, as mentioned earlier, in case the utility wants to promote DSM, specially measures that would reduce peak demand, tariff policies need to be consistent. The viability of several DSM measures such as thermal storage and shifting some operations that may need extra investment depends on the tariff ratios. Such investment decisions, once taken by the customers have long term commitments. Inconsistent changes in tariff policies may question the viability of such options and shake faith in the utility policies. This may in turn result in failure of DSM programmes. Issues like this need to be discussed with utility and investigated further.

7.0 Conclusions and Recommendations:

7.1 DSM / Energy Conservation Awareness, Barriers and Policy Measures:

The study investigated awareness of DSM / energy conservation measures in the hotels, barriers in the conservation, institutional mechanism the hotels would prefer and policy measures needed to implement energy conservation. In addition to this, potential for efficient lighting and reducing air conditioning load through better insulation and installation of sun control film was also explored.

The survey indicated a high level of awareness in the hotels on issues related energy consumption. In case of lighting, a majority of hotels were using compact florescent lamps, at least in the hotel lobby. Most of the hotels were however not aware of the heat pumps that offer substantial potential for savings. Some of the hotels had keytag system to save energy when the guest leaves the room. However, implementation of the system was not adequate. Some hotels were also in process of considering solar energy system for water heating. Demand shift and control was not applicable to most of the hotels due to LT connections. However, load control was being done through devices such as timer to reduce energy consumption. Also, measures to improve power factor were taken by the hotels to avoid penalty. Installation of sun control film and recovery of heat from laundry waste water were areas where hardly any action has been taken. Most of the hotels considered that their housekeeping practices were sound. This was however not supported from the observation during visits. Substantial scope for improvement on this count remains.

The hotels considered efficient air conditioning and lighting to be the very important measures for the hotels to save energy. Automation and control and solar systems were also considered important by some of the respondents. reception of the utility in Malaysia. Training and good practices, including repair and servicing , energy monitoring and auditing were also rated important by some hotels.

Maintenance problem emerged as the most important barrier followed by high cost of efficient appliances. An important finding was that "Implementing agency non-availability" was considered equally important barrier as cost, implying that hotels would prefer if energy conservation / DSM measures could be carried out by some agency. High payback period, product unreliability, lack of technical expertise, disruption in changeover and non-availability of money followed in importance in that order as barriers. Uncertain benefits, problem of availability, lack of information on energy efficient products, and non-availability of consultants, uncertain delivery were other barriers at lower ranking levels.

As methods of conservation, retrofitting, replacement and adding new systems, all the three were acceptable to a majority of the hotels. Acceptable payback periods were two years in most cases. On financing mechanism for energy conservation, a majority of the hotels preferred energy service companies (ESCOs) to carry out the job to take care of financing aspect of energy conservation. On institutional mechanism, expert / consultants was most preferred option, followed by ESCOs and utility at same level of preference. This indicates that if the utility were to take initiative on this, hotels would welcome and participate enthusiastically. Governmental agencies, financial institutions, and industry association were other preferred alternatives in that order.

Among the various policy issues, technical assistance was considered most important requirement, followed by financial incentive, availability of institutional mechanism such as energy service companies. Availability of experts/consultants was next in importance, followed by need for education and training programmes, and seminars and workshops on energy conservation / DSM. Other policy measures in decreasing order of importance ratings were energy audits, pilot demonstration programmes, awareness campaigns through media, energy conservation literature and availability of finance from banks and financial institutions.

7.2 Potential Savings in Lighting and Air Conditioning:

Investigation of energy conservation opportunity in lighting indicated substantial scope for switching over to use of CFLs from the incandescent lamps. Payback period for this option was found to be less than 1.5 year for the hotels in Malaysia. Additional savings from CFL use identified were reduced maximum demand and reduced load for air conditioning. The savings from reduced air conditioning load were estimated to contribute further 50% savings. Guesstimates at national level indicated substantial potential for energy and peak demand savings. Estimation of this however would require further detailed survey covering hotels in major cities.

Substantial savings in air conditioning load were identified through provision of better insulation on hotel roofs, walls and windows. Annual electricity savings through better insulation were demonstrated to be quite high for a typical hotel room, based on data collected during the survey. Sun control film was also found to be attractive option for hotels that have windows exposed to the sun. A payback period of two years was estimated.

In an interesting example of comparison of energy consumption between the two similar level hotels, it was found that energy costs were 50% higher in one hotel compared to other. The data was analysed and reasons for this were identified. Use of energy efficient lighting and good house keeping practices besides difference in air conditioning load were identified principal reasons.

The utility (Tenaga National) has a Senior Manager incharge for DSM programmes. However information on utility DSM programmes and tariffs could not be obtained. Recent revision of the peak and off-peak tariff by the utility was surprisingly against the DSM interests.

7.3 Recommendation for Further Work:

The hotels in Langkawi were mostly Chalet type. Further detailed study covering several hotels in different cities of Malaysia is recommended. The study should have active participation from utility and appliance manufacturers. Energy audits of a few selected hotels is also recommended for this purpose. A DSM plan for hotels in Malaysia can be worked out based on such a study.

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From Grubb book add in literature survey.

Formatting

Tables

Recommendations for further work:

References:

Dear participant,

Subject: Energy Conservation / DSM Survey for Hotels in Malaysia

As you are aware, energy forms an important component of cost in the hotels. Therefore efficient use of energy can cut cost in hotels. In addition to cost cutting through reduced energy consumption, this also helps improve environment. The term "Green Hotels" has come to signify the hotels that help in improving environment through efficient use of energy.

There are several areas in hotels that can be examined for efficient energy usage. Some of these are: air conditioning, lighting, hot water supply, boiler operation etc. Energy audits of hotels can bring out the areas where improvements are possible. The hotels can even cut energy costs by shifting some of the energy consuming activities to "off peak" times. The "off peak" refers to the time of the day when electricity rates are lower. This may however need a proper study of energy consuming activities, and sometimes additional equipments.

The current study is to explore possible energy conservation / DSM measures that can be taken by hotels in Malaysia. The enclosed survey questionnaire is divided in three parts. Part I is general information about the hotel and the Part II is to investigate level of awareness, barriers and preferences for policy measures by the hotels for energy conservation. We request all the participants to complete these two parts.

Part III requires some detailed information for evaluation of three of the suggested measures viz., lighting, air conditioning and hot water supply. The data requested in this part will be used to explore and evaluate possible measures to use energy more efficiently in these areas and reduce costs. It will be carried out on pilot-test basis for a few selected hotels. If you are willing to participate in Part III of the survey, please indicate accordingly. This part may have to be filled up along-with one of our research project team member.

Your cooperation in the survey will be highly appreciated. The information given by you will be used for research purposes and kept confidential. The research findings will be communicated to you, and we are sure you will find that useful.

Yours sincerely

Appendix 1

QUESTIONNAIRE

PART 1. General Information

1. Name of the Hotel

2. Address

Tel:
Fax:

3. Contact person (for this study)

4. Hotel category (star rating)

5. Number of rooms

(i) Single (ii) Double

(iii) Suites (Category-wise; write against applicable)

-Standard

-Deluxe

-Other types (Please specify)

6. Number of

(i) Restaurants (ii) Kitchens

(iii) Guest corridors (iv) Lobbies

7. Facilities offered: Please tick mark if offered, and specify numbers, wherever applicable.

(i) Conference halls (Nos) (ii) Meeting rooms (Nos)

(iii) Gymnazium (iv) Swimming pool

(v) Office facilities room (vi) Games and sports facilities

(vii) Others (please specify)

PART II: Energy Conservation / DSM Awareness, Barriers and Preferences Survey

A. General Awareness:

Please circle appropriate responses.

(1) The investment decisions for major energy consuming appliances are taken by

(i) top management (ii) middle management (iii) concerned manager

(2) Energy conservation measures are taken by the hotel.

(i) Yes (ii) No

If yes :

(a) Who is responsible for that?

(b) Are the energy conservation measures reviewed by the top management?

Yes / No .

If yes, frequency of review;

(i) yearly (ii) half yearly (iii) quarterly (iv) monthly (v) weekly

(3). Energy consumption monitoring is done on regular basis.

Yes / No.

If yes , who is responsible for energy monitoring and management?

(i) Energy manager (ii) No one in particular
(iii) Others (Please specify).

(4) Are the energy audits carried out?

Yes / No

If yes,

(a) are the audits done

(i) internally (ii) by external agencies (iii) both

(b) Frequency of energy audits

B. Awareness of Energy Conservation/ DSM Measures:

Following is the list of possible energy conservation and demand side management (DSM) measures for hotels (DSM refers to the programmes normally designed by utilities to manage electricity demand at consumer end). Please circle one of the following responses against each measure/ option:

(A) The hotel is not aware of the option (NAW).
(B) The hotel is aware of the technology / option and benefits but has not initiated any action (AW).
(C) The hotel is in the process of deciding and has floated enquiries (DECID).
(D) The hotel has implemented the option (IMPLT).
(E) The hotel has evaluated the option and did not find it suitable (NST).
(F) It is not applicable to the hotel (NA).

(i) Use of Energy Efficient Equipments: This refers to the technological options for various end uses or energy services required by the electricity consumers.

	NAW	AW	DECID	IMPLT	NST	NA
Efficient Lighting System						
(a) Compact fluorescent lamps (CAL) in place of incandescent lamps.	A	B	C	D	E	F
(b) High pressure sodium vapour lamps in place of high pressure mercury lamps.	A	B	C	D	E	F
(c) Replacement of magnetic ballasts by electronic ballasts.	A	B	C	D	E	F

Efficient Air Conditioning System

(d) Use of heat pumps A B C D E F for water heating purposes

(e) Use of heat pumps for space cooling purposes A B C D E F

(f) Use of Heat pumps for cooling and heating combined. A B C D E F

(Note: Heat water pumps can save 40 to 60% of the energy compared to conventional resistance water heater systems. Heat pumps can also be used to reduce air conditioning load by extracting the heat from the space (that is required to be air conditioned), and using it for water heating).

(g) Energy efficient motors to replace standard motors. A B C D E F

(h) Proper sizing of pumps and motors, and replacing wherever oversized. A B C D E F

Efficient Appliances

(i) Energy efficient refrigerators and freezers. A B C D E F

(j) Energy efficient TVs. A B C D E F

(k) Other energy efficient appliances such as washing machines, fans, radios etc. A B C D E F

(ii) Other Innovative Measures:

Automation and Control

(a) Infra Red activated guest room switching system. A B C D E F

Note: Occupancy sensors track the movement in the room and if undetected for a pre-specified time, switches off the lights and other appliances automatically.

(b) Building automation A B C D E F

systems.

Note: Building automation systems are computer based Building Energy Management Systems that regulate air conditioning, heating, lighting and other energy consuming functions.

Alternate energy systems

(c) use of solar systems A B C D E F
for water heating.

(d) use of solar systems A B C D E F
for space heating.

Demand shifting and Control

(e) Load Control A B C D E F

Note: This is accomplished using control devices (such as time clocks, thermostats etc.) that may alter the operation of an end-use equipment to change the maximum demand.

(f) Thermal energy A B C D E F
storage to use cheaper
"off peak" electricity.

Note: Energy for space conditioning can be stored and it is referred as thermal energy storage. The energy is stored during "off peak hours" (time of the day when the utility rates for electricity use are low), and used up during "peak hours" (when utility rates are high). The storage can be for the purpose of heating as well as cooling.

(g) Shifting operations A B C D E F
from peak to off peak time
(wherever possible).

(h) Improve power factor A B C D E F
to reduce maximum demand.

Note: This requires installation of capacitors.

Heat Control and Heat Recovery

(h) Fixing heat control A B C D E F
films on the windows
exposed to sun.

(i) Heat recovery from A B C D E F
laundry wash water.

Retrofitting of Other Equipments/ Systems

(j) Proper sizing of pumps,motors, and other equipments in various systems and replacing wherever necessary. A B C D E F

(k) Provision of better insulation (on windows and doors) to avoid energy losses. A B C D E F

(iii) Housekeeping and Monitoring:

Awareness Training and Good Practices

(a) Staff awareness and training programs on energy conservation. A B C D E F

(b) Minimizing wastage of hot water (used for utensil cleaning, laundry etc. A B C D E F

(c) Switching off lights in areas not needed. A B C D E F

Monitoring and Auditing

(d) Overall energy consumption monitoring on regular basis. A B C D E F

(e) Sub-metering to monitor energy consumption closely. A B C D E F

(f) monitoring and control of air conditioning system. A B C D E F

(g) Monitoring air supply in different areas as per requirement. A B C D E F

(h) Checking conditioned A B C D E F

air temperature in different
areas and raising if
possible.

(i) Energy auditing of the hotel. A B C D E F

Repairs and Servicing

(j) Plugging leakages in hot water / steam piping A B C D E F

(k) Repairing insulations (in rooms, piping etc.). A B C D E F

(l) Regular servicing of steam boilers, freezer units and other such equipments. A B C D E F

other measures (please specify).

Ranking of Measures

Rank importance of these measures for your hotel in terms of potential for savings and cost effectiveness.

The ranking scale details are:

Not much important	NImp
Important	Imp
Very important	VImp
Can not say (no idea)	CNsay

(i) Use of Energy Efficient Equipments:

Efficient Lighting System NImp Imp VImp CNsay

Efficient Air Conditioning System NImp Imp VImp CNsay

Efficient Appliances NImp Imp VImp CNsay

(ii) Other Innovative Measures:

Automation and Control NImp Imp VImp CNsay

Alternate energy systems NImp Imp VImp CNsay

Demand shifting and Control NImp Imp VImp CNsay

Heat Control and Heat Recovery NImp Imp VImp CNsay

Retrofitting of Other NImp Imp VImp CNsay Equipments/ Systems

(iii) Housekeeping and Monitoring:

Awareness Training and Good NImp Imp VImp CNsay Practices

Monitoring and Auditing NImp Imp VImp CNsay

Repairs and Servicing NImp Imp VImp CNsay

C. Barriers to Energy Conservation/ DSM:

Here we try to identify barriers to energy conservation on a broad and general basis. Although barriers may be different for different type of energy conservation measures (for example high cost may not be barrier for efficient lighting system, but may be a barrier for thermal storage system for air conditioning), we are not considering barriers to individual measures here. Please indicate your opinion on overall basis.

Circle importance of each barrier for each energy conservation / DSM measure as per following scale:

Not applicable NA
Not Important NImp
Important Imp
Very Important VImp

Also rank top five barriers in you opinion (1 most important, 2 less than 1, and so on upto five ranks).

(a) High cost NA NImp Imp VImp Rank_____
(b) Lack of information NA NImp Imp VImp Rank_____

(c) Availability NA NImp Imp VImp Rank_____
problems
(d) Uncertain delivery NA NImp Imp VImp Rank_____
(e) Unreliable products NA NImp Imp VImp Rank_____
(f) Maintenance problems NA NImp Imp VImp Rank_____
(g) Uncertain benefits NA NImp Imp VImp Rank_____
(h) Not enough potential NA NImp Imp VImp Rank_____ for savings

(i) High payback period NA NImp Imp VImp Rank_____

(j) Lack of technical expertise NA NImp Imp VImp Rank_____

(k) Disruption in changeover. NA NImp Imp VImp Rank_____

(l) Experts/consultants not available NA NImp Imp VImp Rank_____

(m) Implementing agency not available NA NImp Imp VImp Rank_____

(n) Financing not available NA NImp Imp VImp Rank_____

(o) No application in the hotel NA NImp Imp VImp Rank_____

(p) No barrier NA NImp Imp VImp Rank_____

(q) Others (pl specify) NA NImp Imp VImp Rank_____

D. Preferences and Policy Measures

(1). Method of Conservation:

Retrofitting : It refers to upgradation of existing equipments by replacing only a few components or a part of the system (for example chiller pump in an air conditioning system) to improve the energy use efficiency. The energy savings over a period of time as a result of retrofitting pay for the cost of the component / equipment replaced.

(i). Are you willing to get your equipments (such as boilers, air conditioning systems) retrofitted to improve their energy efficiency?

Yes / No

(ii). If your answer is yes, what maximum payback period (the time in which your investment gets recovered from savings in energy consumption) is acceptable to you?

(a) one year or less (b) upto two years (c) upto three years
(d) upto five years (e) More than five years also acceptable

Replacing equipments / systems: It refers to switching over to more efficient equipments / systems. For example changing the complete air conditioning system, boiler etc. Economic analysis is carried out to find out payback period of the efficient system.

(i). Are you willing to get your equipments (such as boilers, air conditioning systems) replaced to improve their energy efficiency?

Yes / No

(ii). If your answer is yes, what maximum payback period (the time in which your investment gets recovered from savings in energy consumption) is acceptable to you?

(a) one year or less (b) upto two years (c) upto three years
(d) upto five years (e) More than five years also acceptable

Adding new systems: This refers to addition of new systems or equipments that help achieve reduced energy consumption. For example, occupancy sensors in guest rooms to switch off lights and other appliances automatically when room is not in use, building automation system etc. Building automation systems are computer based Building Energy Management Systems that regulate air conditioning, heating, lighting and other energy consuming functions. Such systems also payback the investment through savings in energy consumption.

(i). Are you willing to add new systems such as building automation system, occupancy sensor systems to improve energy use efficiency.

Yes / No

(ii). If your answer is yes, what maximum payback period (the time in which your investment gets recovered from savings in energy consumption) is acceptable to you?

(a) one year or less (b) upto two years (c) upto three years
(d) upto five years (e) More than five years also acceptable

Demand Shift:

(a). In case difference in "peak" and "off peak" rate of electricity increases, will you be able to shift some of your energy consuming activities to "off peak" hours? (For example laundry, thermal energy storage for air conditioning etc.).

(i) Yes (II) No (iii) Do not know

(b).If your answer is yes, what activities do you have in mind?

(c) Approximately what "peak" to "off peak" ratio of electricity rates will be required to shift these operations?

(i) 1.5 : 1 (ii) 2:1 (iii) 3:1 (iv) Above 3:1 (v) Can not say

Ranking of Preferences

Rank your preference (1 to 4; 1 most preferred, 4 least)

	Rank
Retrofitting	_______
Replacement	_______
Adding new systems	_______
Demand shift	_______

(2). Policy Measures

(i) Financing:

Please indicate order of preference (1 most preferred, 2 second most and so on).

	Rank
1. You will arrange your own financing.	______
2. You will require financing arrangement (such as banks, financial institutions etc.).	______
3. You will prefer ESCOs to do the job.	______
4. Any other method (pl specify)	______

(ESCOs refers to Energy Service Companies. It is a novel concept in which an ESCO will contract to carry out the modification / replacement for you at their cost. The ESCO will recover the cost from the savings in your energy bill over an agreed period of time).

(iii). Institutional Mechanism:

Rank your preference for the agency to implement energy conservation / DSM measures (1 most preferred, 2 second choice and so on);

	Rank
Utility (Tenaga National)	_____
Energy Service Companies	_____
Governmental Agencies	_____
Experts / Consultants	_____

Financial Institutions ______

Industry Associations ______

No need for any agency ______

Others (pl specify and rank) ______

(ii). Other Policy Measures for Energy Conservation: Circle importance of the measures for implementation of energy conservation / DSM programmes as per following scale:

Not Relevant NRel
Not much important NImp
Important Imp
Very important VImp

Also rank top five policy measures that are most important in your opinion (1 most important, 2 less than 1, and so on upto five ranks).

(a) Energy audits NRel NImp Imp VImp Rank____

(b) Technical assistance NRel NImp Imp VImp Rank____

(c) Financial incentives NRel NImp Imp VImp Rank____

(d) Pilot demonstration programmes NRel NImp Imp VImp Rank____

(e) Seminars and workshops on energy conservation/ DSM NRel NImp Imp VImp Rank____

(f) Energy conservation literature (pamphlets etc) availability NRel NImp Imp VImp Rank____

(g) Awareness campaigns through media by Govt./ industry associations NRel NImp Imp VImp Rank____

(h) Education / training programmes on energy conservation by Govt./ NRel NImp Imp VImp Rank____ industry associations

(i) Availability of experts / consultants NRel NImp Imp VImp Rank____

(j) Availability of finance from banks / financial institutions NRel NImp Imp VImp Rank____

(k) Availability of institutional mechanisms such as energy service companies (ESCOs) NRel NImp Imp VImp Rank____

Thank you for devoting your valuable time to give us feed back on issues related to energy conservation / DSM. Now that you may have some idea of a variety of measures to reduce energy consumption, will you be interested in a detailed study of energy conservation measures for your hotel?

(i) Yes (ii) No (iii) Undecided

Are you willing to participate in the PART III of the survey that involves some data collection as per the enclosed questionnaire to evaluate a few specific measures for energy conservation / DSM? A sample sheet of the Part III of the questionnaire indicating type of data needed for detailed analysis of options is also enclosed.
(i) Yes (ii) No

If yes, we will get in touch with you.

Any comments that you have.
Thanks.

Part III Energy Consumption Data and Barriers to Implementation Sample Sheet

This sheet is only to indicate type of data that will needed for detailed evaluation of options. This will be done for only a few selected hotels based on response to our last question of the previous part (are you willing to participate in Part III of the survey?). We would provide detailed data sheet to the hotels participating in Part III of the survey and may depute one of our research team member to explain and help in data collection for this part.

ENERGY CONSUMPTION DATA:

1. Month-wise Electricity Consumption 1995

No of units   Cost   Demand charges Total cost

2. Month-wise Fuel Oil and Other Fuels Consumption 1995

Quantity   Cost

4. If sub-metering exists, month-wise consumption of air conditioning plant.

5. Utility Rates for Electricity:

6. Average occupancy percentage for 1995 (month-wise, for different type of accommodation).

7. No of lighting points and ratings:

No of Incandescent bulbs and Fluorescent tubes in lobby, guest rooms, corridors etc.

8. Air conditioning plant equipments and load details.

9. Details of Boiler and Hot Water Consumption:

10. Building sun exposure data to examine need for Solar Control Film

11. Barriers in implementation of these measures.

Appendix 2

Part III Energy Consumption Data and Barriers to Implementation

ENERGY CONSUMPTION DATA:

1. Electricity Consumption 1995

	No of units	Cost	Demand charges	Total cost
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

2. Fuel Oil Consumption 1995

	Quantity in litres	Cost
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		

November
December

3. Other Fuels Consumption 1995 (if any, such as LPG, diesel etc.)

	Quantity	Cost
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

4. If sub-metering exists, consumption of air conditioning plant:

	No of units
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

5. Utility Rates for Electricity:

Demand rates

Energy rates

6. Average occupancy percentage for 1995:

	Single	Double	Suites
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			

7. No of lighting points and ratings:

(a) Lobby/ies

Incandescent bulbs

Rating	Nos	No of hours in use/day	Nos replaced everyday
40 Watt			
60 Watt			
100 Watt			
Others (specify)			

Fluorescent tubes

	Ballast type Mag. /Elect	Nos	No of hours in use/day	Nos replaced every month
Watt				
Watt				

(b) Guest Corridors

Incandescent bulbs

Rating	Nos	No of hours in use/day	Nos replaced everyday
40 Watt			
60 Watt			
100 Watt			
Others (specify)			

Fluorescent tubes

	Ballast type Mag. /Elect	Nos	No of hours in use/day	Nos replaced every month
Watt				
Watt				

(c) Guest rooms

Incandescent bulbs

Rating	Nos	No of hours in use/day	Nos replaced everyday
40 Watt			
60 Watt			
100 Watt			
Others (specify)			

Fluorescent tubes

	Ballast type Mag. /Elect	Nos	No of hours in use/day	Nos replaced every month
Watt				
Watt				

(d) Restaurants and Kitchens

Incandescent bulbs

Rating	Nos	No of hours in use/day	Nos replaced everyday
40 Watt			
60 Watt			
100 Watt			
Others (specify)			

Fluorescent tubes

	Ballast type Mag. /Elect	Nos	No of hours in use/day	Nos replaced every month
Watt				
Watt				

(e) Conference halls and Meeting Rooms

Incandescent bulbs

Rating	Nos	No of hours in use/day	Nos replaced everyday
40 Watt			
60 Watt			
100 Watt			
Others (specify)			

Fluorescent tubes

	Ballast type Mag. /Elect	Nos	No of hours in use/day	Nos replaced every month
Watt				
Watt				

(f) All Other Areas (Computer room, Gymnazium, Sauna, Swimming pool, Office facilities room, Telephone exchange room, common facilities areas etc.)

Incandescent bulbs

Rating	Nos	No of hours in use/day	Nos replaced everyday
40 Watt			
60 Watt			
100 Watt			
Others (specify)			

Fluorescent tubes

	Ballast type Mag. /Elect	Nos	No of hours in use/day	Nos replaced every month
Watt				
Watt				

Parking, road and street lighting, sport complexes and other areas

Mercury Vapour Lamps

Rating Watts	Nos	No of hours in use/day	Nos replaced every month

DETAILS OF CENTRAL AIR CONDITIONING PLANT AND OTHER AIR CONDITIONERS:

1. Peak air conditioning load of the hotel (and months)

Peak load: ________ TR; Months _________

2. Air conditioning Plant Rating and Equipment Details:

A. Supplier and date of installation

Supplier _______________

Date of installation:

B. Chiller Plant Details:

Chilling machines:

	Chilling machine types	
	Vapour compression	Vapour Absorption
No of machines		
Capacity of machines (TR)		
Electrical rating (kW)		
Steam consumption (Kg/TR)		
Make and year of installation		

Chiller Pumps:

Description	Chilled water pumps	Condenser water pumps

Numbers in
operation
and
Standby

Flow rate (GPM)

Head

Electrical
ratings (HP)

Make and year
of installation

Approximate efficiency
(if data available)

Chiller supply water temperature

Chiller return water temperature

C. Air Handling Units (AHUs):

(i). Capacity and numbers

(ii). AHU control:

Tick (a) or (b), whichever is correct. If none, specify the other method.

AHU control in guest rooms and public area is through ;

In guest rooms (a) by sensing temperature (b) manual switch
In public areas (a) by sensing temperature (b) manual switch
Method of air conditioning of guest rooms;

(a) Through air ducts with cool air (b) Through chilled water supply to fan coils units in the rooms

(iii). Is chilled water bypass provided for AHU fans (when the fans are not in operation) Yes / No

(This is normally done through a three way valve to reduce the pressure drop).

(iv) Type of cooling coils in AHU (tick correct):

(a) Plate finned type with in-line copper tubes

(b) Rippled corrugated sinewave type fins with staggered copper tubes

(c) Other type (pl specify).

(v). Type of belts in AHU (tick correct);

(a) V belts (b) Flat sandwich type (c) Other (pl specify)

D. Operating Load on the Air Conditioning Plant:

(i) Average (% of the capacity)

(ii) Maximum (% of the capacity)

(iii) For how many months (approx) the system operates on maximum load ?

(If data is available, please indicate monthly air conditioning load as % of the rated capacity).

E. Temperature and humidity that is normally maintained:

Typical temperature readings for:

(a) Lobby _____ (b) Corridors _____
(c) Business centre _____ (d) Club bar _____
(e) Health centre _____ (f) Club library _____
(g) Hair dressing saloon _____ (h) Guest room _____
(i) Coffee shop _____ (j) Restaurants _____ (k) Shopping centre _____

F. Details of Other Air Conditioning in the Hotel:

Are there other air conditioning units other than central unit?
If yes give following details;

Type of unit, Capacity Elect. Hours of Areas Remarks make and year rating
use served
of installation

Details of Boiler and Hot Water Consumption:

1. Make and year of installation of the boiler

2. Fuel used

2. Specifications

(i) Steam pressure (ii) Flue gas temperature

(iii) Feed water temperature

3. Typical steam generation rates (on low fire and high fire both):

4. Current efficiency (in case figure is available)

5. Blowdown steam / day (kg)

6. Daily hot water consumption in the hotel (litres / day)

Guest rooms

Laundry

Kitchens

Others (pl specify)

Total

7. Laundry data

(a) Total load of linen garments processes

(b) Laundry wash cycles and water temperature in each cycle

8. Distance between boiler room and laundry

9. Type of shower fittings in guest rooms and water supply rate

Data for Solar Control Film:

Exposure to the sun :

(a) Which side of the hotel has maximum exposure to the sun? (Tick correct).

East side / West side / North side / South side

(b) Number of hours of exposure to the sun on each side

(c) Glass area of the hotel on each side
(Guest rooms and public areas in square ft.).

BARRIERS TO ENERGY CONSERVATION/ DSM:

We try to identify here barriers to individual measures that are being evaluated (ie efficient lighting, air conditioning systems, and heat control and heat recovery).

Circle importance of each barrier for each energy conservation / DSM measure as per following scale:

Not applicable	NA
Not Important	NImp
Important	Imp
Very Important	VImp

Also rank top five barriers within the specific energy consumption measures (1 most important, 2 less than 1, and so on upto five ranks).

Efficient Lighting System: This includes compact fluorescent lamps in place of incandescent lamps, electronic ballasts for fluorescent tubes and sodium vapour lamps in place of mercury vapour lamps.

(a) High cost NA NImp Imp VImp Rank_____
(b) Lack of information NA NImp Imp VImp Rank_____

(c) Availability problems NA NImp Imp VImp Rank_____
(d) Uncertain delivery NA NImp Imp VImp Rank_____
(e) Unreliable products NA NImp Imp VImp Rank_____
(f) Maintenance problems NA NImp Imp VImp Rank_____
(g) Uncertain benefits NA NImp Imp VImp Rank_____
(h) Not enough potential NA NImp Imp VImp Rank_____ for savings

(i) High payback period NA NImp Imp VImp Rank_____

(j) Lack of technical expertize NA NImp Imp VImp Rank_____

(k) Disruption in changeover. NA NImp Imp VImp Rank_____

(l) Experts/consultants not available NA NImp Imp VImp Rank_____

(m) Implementing agency not available NA NImp Imp VImp Rank_____

(n) Financing not available NA NImp Imp VImp Rank_____

(o) No application in the hotel NA NImp Imp VImp Rank_____

(p) No barrier NA NImp Imp VImp Rank_____

(q) Others (pl specify) NA NImp Imp VImp Rank_____

Efficient Air Conditioning System: This includes use of heat pumps for water heating purposes, for space cooling purposes or for both water heating and space cooling combined. It also includes proper sizing of pumps and motors, and replacing wherever oversized, and using energy efficient motors to replace standard motors.

(a) High cost NA NImp Imp VImp Rank_____

(b) Lack of information NA NImp Imp VImp Rank_____

(c) Availability problems NA NImp Imp VImp Rank_____

(d) Uncertain delivery NA NImp Imp VImp Rank_____

(e) Unreliable products NA NImp Imp VImp Rank_____

(f) Maintenance problems NA NImp Imp VImp Rank_____

(g) Uncertain benefits NA NImp Imp VImp Rank_____

(h) Not enough potential for savings NA NImp Imp VImp Rank_____

(i) High payback period NA NImp Imp VImp Rank_____

(j) Lack of technical expertize NA NImp Imp VImp Rank_____

(k) Disruption in changeover. NA NImp Imp VImp Rank_____

(l) Experts/consultants not available NA NImp Imp VImp Rank_____

(m) Implementing agency not available NA NImp Imp VImp Rank_____

(n) Financing not available NA NImp Imp VImp Rank_____

(o) No application in the hotel NA NImp Imp VImp Rank_____

(p) No barrier NA NImp Imp VImp Rank_____

(q) Others (pl specify) NA NImp Imp VImp Rank_____

Heat Control and Heat Recovery: This includes fixing heat control films on the windows exposed to sun and heat recovery from laundry wash water.

(a) High cost NA NImp Imp VImp Rank_____
(b) Lack of information NA NImp Imp VImp Rank_____

(c) Availability problems NA NImp Imp VImp Rank_____
(d) Uncertain delivery NA NImp Imp VImp Rank_____
(e) Unreliable products NA NImp Imp VImp Rank_____
(f) Maintenance problems NA NImp Imp VImp Rank_____
(g) Uncertain benefits NA NImp Imp VImp Rank_____
(h) Not enough potential NA NImp Imp VImp Rank_____ for savings

(i) High payback period NA NImp Imp VImp Rank_____

(j) Lack of technical expertize NA NImp Imp VImp Rank_____

(k) Disruption in changeover. NA NImp Imp VImp Rank_____

(l) Experts/consultants not available NA NImp Imp VImp Rank_____

(m) Implementing agency not available NA NImp Imp VImp Rank_____

(n) Financing not available NA NImp Imp VImp Rank_____

(o) No application in the hotel NA NImp Imp VImp Rank_____

(p) No barrier NA NImp Imp VImp Rank_____

(q) Others (pl specify) NA NImp Imp VImp Rank_____

Any comments:

Thank you

SOME INITIATIVES IN THE AREA OF ENERGY CONSERVATION IN HOTELS

1. Sheraton Tacoma in the US: Energy consumption reduced by 13.6%. This resulted in savings of US$ 38,682 in three years. Scope for further savings has been identified (see enclosed sheet for details).

2. An energy audit of The Oberoi Intercontinental Hotel by UNDP (United Nations Development Programme, a UN agency) and Government of India experts in May 1991 estimated 16% energy savings in the hotel by adopting conservation measures. The Oberoi is a five star hotel in New Delhi with more than 200 guest rooms. Estimated money savings were equivalent to RM 200,000 per year (One time investment of about RM 180,000 was needed, but savings were every year after that).

3. Thai Hotel Association conducted a Green Hotels seminar in Bangkok in October 1995. Measures for energy conservation for hotels were discussed in the seminar.

2. Objectives of the study

The objective of the study is to explore electricity conservation potential in the hotel industry in Malaysia. Various options for conservation will be explored and demand side management options will be studied in detail. The options will be evaluated and recommendations made for implementation.

5.0 Methodology:

(i) Survey of literature for possible DSM measures for hotels.

(ii) Survey of different categories of hotels to study following:

(a) Types of electricity consuming equipments / appliances used by hotels.

b) Electricity consumption by various activities / type of appliances.

(c) Possibilities of conservation through housekeeping and other such measures.

(d) Potential for electricity conservation through DSM measures (such as installation of new appliances, retrofit / up-gradation of existing appliances etc.).

(iii) Evaluation of various measures and recommendations.

4. Output of the study:

A report containing evaluation and recommendation for DSM measures for hotel industry will be prepared. It will be possible for the hotels to prepare plans for specific measures and implement them.

5. Time Frame:

Study is expected to be completed with in 8 to 10 months. Proposed schedule is as follows:

(i) Literature review : 2 months from the date relevant literature is available at UUM.
(ii) Questionnaire design and survey: 3 to 4 months
(iii) Analysis and report writing: 3 to 4 months.

6. Budget:

Funding for the following will be needed:

(i) Procurement of literature

(ii) Survey of hotels

(iii) Travel : For the following:

(a) Literature survey
(b) Hotels survey
(c) Visiting industries (if required, to gather information related to appliance efficiencies), meeting experts, seminars/conferences (if required).

(iv) Research assistant (about 1/3 per day for 3 to 4 months) for assistance in hotel surveys and analysis.

(v) Communication and Misc: Telephone, fax, xerox, secretarial assistance and typing etc.

(In case to be budgeted)

Project Team:

**** Gellings, IGIDR, IAEEL, Tenaga, EMC (+ other measures given in the EMC), ADB, Geller II