Identifying Resource Efficiency Improvement Potential to Enhance Competitiveness of Sri Lanka's Hotel Industry

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Summary

Sri Lanka’s hotel industry has grown rapidly, since the end of the conflict. The government’s Tourism Master Plan is now encouraging the industry’s growth to meet a potential 2.5 million tourist arrivals by 2016. Tourism is expected to attract foreign direct investment of $3 billion over the next five years and provide employment to half a million Sri Lankans. At the same time, the country hopes to earn half a billion dollars in foreign exchange by 2016.

All this is good news for the economy, but this growth should be offset with responsible and efficient resource management. The hotel industry is a huge consumer of water and energy and discharges different kinds of wet and dry waste and wastewater into the environment. This survey was undertaken to evaluate how efficiently hotels handle their resources and what needs to be done to ensure efficient use in the future.

This survey covered three, four and five star hotels located across the island. It found that while the awareness of the need to conserve resources is high among management, there is a reluctance to implement energy efficient measures for several reasons, the high capital costs involved not being the least. One step that will help is to make available subsidized financing to encourage the hotel industry to embrace and adopt energy saving technologies, especially in air conditioning, water use, and wastewater treatment.

Attention should also be focused on the 4000 plus rooms recently sanctioned by Sri Lanka’s tourism development authority and currently under construction. Here, it has been found that an incremental expenditure of $4.21 million will ensure that energy efficient technologies are implemented right at the beginning. With the industry poised on a springboard ready to take off, the time to act is now. With this growth, it becomes important that Sri Lanka’s pristine environment, so highly valued by tourists, does not suffer.
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1.1. Introduction

Sri Lanka enjoyed a vibrant and growing tourism industry until 1980. It then declined drastically in the mid-1980s due to ethnic unrest and conflict. In the 1990s, the Government of Sri Lanka tried to revive the tourism sector with the Tourism Master Plan. Attractive incentives were offered to foreign investors to develop the tourism sector but there was little development till the civil conflict ended in 2009. Since then, the tourism sector has experienced a period of exceptional growth with tourist arrivals growing rapidly every year.

Tourism is an important source of foreign exchange earnings for Sri Lanka. It accounted for 2.6 percent of foreign exchange receipts in 2009. Foreign exchange earnings from tourism increased by 41.4 percent from $575 million in 2010 to $830 million in 2011. According to the Sri Lanka Tourism Development Authority (SLTDA), the number of persons employed directly in the tourism sector was 51,306 in 2008, which increased by 1.5 percent in 2009 to 52,071 persons, compared with a decline of 15.2 percent in 2008 from 60,516 in 2007.

1.2. Recent Growth in Hotel Industry

According to SLTDA Statistical Report 2011, tourist arrivals in Sri Lanka surpassed all previous records and reached a new milestone of 1,005,606 in 2012, a 17.5 percent increase over 2011.

The growth of the tourism sector is also reflected by the increase in tourist accommodation infrastructure or number of rooms in the country from 455 in 2002 to 906 in 2011. There was also a substantial increase in average occupancy of hotels from 43 to 77 percent during this period.

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1 Sri Lanka Tourism Development Authority- Annual Statistical Report, 2011
1.3. Types of Tourist Accommodation

Sri Lanka Tourism Development Authority (SLTDA), the government body set up to develop tourism in the country, has classified tourist accommodation into four types:

- **Boutique Villas and Hotels**
- **Guesthouses**
- **Home Stay Units**
- **Tourist Hotels**

Lodging establishments registered with SLTDA in 2011 numbered 906, with a total capacity of 20,794 rooms. This was dominated by tourist hotels, which accounted for 70.5 percent (14,653 rooms) of the industry’s total room capacity in 2012. SLTDA defines tourist hotels as establishments that maintain international standards of operations.

1.4. Tourist Arrivals by Region

Based on SLTDA research, more than 70 percent of tourists who visited the country during 2009-2010 heard about Sri Lanka from someone who had visited the country earlier. It is extremely important to ensure that tourists enjoy their visit and promote Sri Lanka among their peers back home as a prime tourist destination. Positive word of mouth is a powerful promotional tool for tourism.

Currently, Sri Lanka attracts tourists from around the world. Figure 1 breaks up tourist arrivals in Sri Lanka by region.

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**Tourist arrivals by region in 2011 and 2012**

![Bar chart showing tourist arrivals by region in 2011 and 2012](chart.png)

**Figure 1**

Tourist Arrivals by Region

**Source**

SLTDA Monthly Statistical Bulletin December 2012

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1.5. Future Outlook of Tourism Sector

The government has set a target to attract 2.5 million high spending tourists by 2016. The five year master plan prepared by the Ministry of Economic Development for 2011 to 2016 addresses a range of issues related to the country’s tourism strategy including environmental, social, cultural, economic, institutional, and promotional aspects. Some key objectives to be achieved through the five year period include:

- Increase tourist arrivals from 650,000 in 2010 to 2.5 million by 2016
- Attract $3 billion as foreign direct investment in the tourism sector over the next five years
- Increase tourism related employment from 125,000 in 2010 to 500,000 by 2016 and expand tourism based industries and services
- Increase foreign exchange earnings from the tourism sector from $500 million in 2010 to $2.75 billion by 2016.

According to estimates, 2.5 million tourist arrivals by 2016 will require around 45,000 hotel rooms. In 2010 the country had only 22,735 SLTDA approved hotel rooms. This means the industry will need to add around 22,500 rooms to its current capacity during the next five years. At the same time, existing facilities will also need to be refurbished.

Figure 2 shows the trend in tourist arrivals and accommodation capacity over the last 10 years and the expected growth over the next five years.

In terms of resource consumption, in 2011, the Sri Lankan hotel industry accounted for 196 Gigawatt hours or two percent of the country’s total electricity sales, a growth of 3.5 percent compared to 2010. Apart from electricity, the hotel industry also uses a significant amount of primary energy and water. In 2010, tourist hotels accounted for around one percent of water supplied by government agencies in the country, equivalent to 2,197,000 cubic meters. This is an increase of around 15 percent over 2009. If the targeted growth is achieved, energy consumption in the hotel industry will double or triple in comparison to 2011. Apart from higher operating costs, this will also lead to severe environmental impacts due to higher carbon emissions and waste generation.

Since the hotel industry is a major consumer of energy and natural resources, the growth of the sector could be a cause for environmental and social concern if it is not combined with resource efficiency improvements.

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2 Statistical Digest 2011 - Ceylon Electricity Board
3 Sri Lanka National Water Supply and Drainage Board Annual Report - 2010
This survey aimed to evaluate the resource efficiency improvement potential of Sri Lanka’s hotel industry in the context of high levels of resource consumption both now and in the future, given the high projected growth of tourism.

This survey collected data on current resource utilization status, the equipment being used, awareness among hotel staff and management about resource efficient technologies, potential for resource efficiency, investments required, and the potential to reduce emission of greenhouse gases.

A detailed questionnaire was developed; a field survey was then conducted to identify different resources used by hotels and the potential to improve efficiency.

The study was limited to three, four and five star tourist hotels. The mapping carried out during the first part of the study showed that Sri Lanka has a total of 44 hotels in the three, four and five star category. To determine the sample size and to select hotels for the survey, the project team relied on data collected during the mapping stage. The sample size was decided based on valid statistical criteria, and 23 hotels were selected.

The following parameters were considered in selecting these 23 hotels:

- District representation
- Hotels where resource efficiency initiatives were already reported (based on Sri Lanka National Energy Efficiency Award winners list)
- Proportionate representation of all star categories (three, four and five star)
3.1. Layout of the Surveyed Hotels

The survey found that hotels did not have similar layouts. In cities such as Colombo, hotels are multi-storied with small open and green areas. Hotels closer to beaches or in small cities and towns were generally low-rise and had cottage type guest rooms.

In addition to guest rooms, almost all hotels had facilities such as multiple restaurants, bars, conference halls, banquet halls, swimming pools, spas, tennis courts, recreation areas including gyms, laundries, and shopping arcades.
3.2. Resource Consumption in the Surveyed Hotels

The field survey identified major areas of resource consumption. Table 1 presents the energy consumption in all surveyed hotels during 2011-12.

<table>
<thead>
<tr>
<th>Type of Energy</th>
<th>Total Usage</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional Energy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>60,043 Mega watt hours (MWh)</td>
<td>Grid supply (Ceylon Electricity Board+ Lanka Electricity Company (Private) Limited)</td>
</tr>
<tr>
<td></td>
<td>552 Mega watt hours</td>
<td>Captive diesel generator</td>
</tr>
<tr>
<td>Liquefied Petroleum Gas</td>
<td>678 Tonnes</td>
<td>Petroleum Corporation</td>
</tr>
<tr>
<td>Diesel</td>
<td>1,060 Thousand Liters (including electricity generation)</td>
<td>Petroleum Corporation</td>
</tr>
<tr>
<td>Furnace Oil</td>
<td>1,404 Thousand Liters</td>
<td>Petroleum Corporation</td>
</tr>
<tr>
<td><strong>Renewable Energy Sources</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>50 Mega watt hours</td>
<td>Solar photo voltaic</td>
</tr>
<tr>
<td>Biomass</td>
<td>1,485 Tonnes</td>
<td>Locally available waste wood</td>
</tr>
<tr>
<td>Biogas</td>
<td>0.78 Tonnes</td>
<td>From food waste</td>
</tr>
</tbody>
</table>

Table 1
Energy use in surveyed hotels
Source
PwC Analysis based on survey findings

Water is the other major resource in the hotel industry. Table 2 captures water consumption in the surveyed hotels in 2011-12:

<table>
<thead>
<tr>
<th>Resource</th>
<th>Total Usage</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>641,537 m³</td>
<td>Municipal Supply</td>
</tr>
<tr>
<td>Water</td>
<td>932,779 m³</td>
<td>Ground (Tube well)</td>
</tr>
<tr>
<td>Water</td>
<td>36,025 m³</td>
<td>Private Agency</td>
</tr>
</tbody>
</table>

Table 2
Water use in surveyed hotels
Source
PwC Analysis based on survey findings
Finally, Table 3 captures the waste generation profile of the surveyed hotels in 2011-12:

<table>
<thead>
<tr>
<th>Type of waste generation</th>
<th>Amount</th>
<th>Source of Waste Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Waste</td>
<td>2,439 Tonnes</td>
<td>Kitchens and restaurant</td>
</tr>
<tr>
<td>Garden Waste</td>
<td>367 Tonnes</td>
<td>Garden</td>
</tr>
<tr>
<td>Paper and cardboard</td>
<td>116 Tonnes</td>
<td>Office, guest rooms</td>
</tr>
<tr>
<td>Others (Plastic, Glass, Metal)</td>
<td>176 Tonnes</td>
<td>Guest rooms, kitchens</td>
</tr>
<tr>
<td>Waste water</td>
<td>1,183,000 m³</td>
<td>Guest rooms, laundry</td>
</tr>
</tbody>
</table>

Table 3
Waste generation in surveyed hotels

Source
PwC Analysis based on survey findings

### 3.3. Specific Resource Use and Waste Generation Levels

Estimates of resource use and waste generation were made after analyzing data collected from the surveyed hotels. When benchmarked against national averages, this will help hotels review their own performance and set targets for themselves. This will hopefully lead to establishment of “best practices” within the industry. Table 4 shows the range and average value of specific resource use and waste generation (in 2011-12) in the surveyed hotels.

<table>
<thead>
<tr>
<th>Hotel Category</th>
<th>Resource use/waste generation</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Average</td>
<td>Range</td>
<td>Average</td>
<td>Range</td>
</tr>
<tr>
<td></td>
<td>Electricity consumption (kiliwatt hours per occupied guest room per day)</td>
<td>66-130</td>
<td>97.0</td>
<td>66-130</td>
<td>97.0</td>
</tr>
<tr>
<td></td>
<td>Fuel/gas consumption (thousand kilocalorie per occupied guest room per day)</td>
<td>16-142</td>
<td>53</td>
<td>16-142</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Water consumption (m³ water per occupied guest room per day)</td>
<td>1.75-4.73</td>
<td>3.07</td>
<td>1.75-4.73</td>
<td>3.07</td>
</tr>
<tr>
<td></td>
<td>Wastewater (m³ wastewater per occupied guest room per day)</td>
<td>1.31-4.34</td>
<td>2.27</td>
<td>1.31-4.34</td>
<td>2.27</td>
</tr>
<tr>
<td></td>
<td>Food waste (kg food waste per occupied guest room per day)</td>
<td>1.8-7.38</td>
<td>4.52</td>
<td>1.8-7.38</td>
<td>4.52</td>
</tr>
<tr>
<td></td>
<td>Solid waste (including paper, cardboard, metal, plastic, glass) (kg solid waste occupied guest room per day)</td>
<td>0.24-0.79</td>
<td>0.51</td>
<td>0.24-0.79</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>Annual average occupancy (percentage)</td>
<td></td>
<td></td>
<td>62</td>
<td>78</td>
</tr>
</tbody>
</table>

Table 4
Specific resource use/waste generation in the surveyed hotels

Source
PwC Analysis based on survey findings
3.4. Energy Consumption

Major energy consuming areas in hotels are air-conditioning, lighting, laundry, kitchens, and hot water generation.

Table 5 summarizes energy use in the surveyed hotels:

<table>
<thead>
<tr>
<th>Energy Consuming Area</th>
<th>Percentage of share of total electricity consumption</th>
<th>Percentage of share of total thermal consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air - conditioning</td>
<td>48</td>
<td>N.A.</td>
</tr>
<tr>
<td>Lighting</td>
<td>13</td>
<td>N.A.</td>
</tr>
<tr>
<td>Laundry</td>
<td>6</td>
<td>72</td>
</tr>
<tr>
<td>Hot water generation</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>Water pumping and treatment, pool, Sewage Treatment Plant, lifts, etc.</td>
<td>11</td>
<td>N.A.</td>
</tr>
<tr>
<td>Diesel generator</td>
<td>--</td>
<td>6</td>
</tr>
</tbody>
</table>

*Table 5*
Major energy usage areas - All surveyed hotels

Source: PwC Analysis based on survey findings

3.4.1. Energy Conservation

Air Conditioning

Air conditioning consumes the most electricity in hotels. Cooling solutions include standalone air conditioners (split and packaged) and centralized chiller plants. Cottage type hotels have installed standalone air conditioners whilst multi-story hotels use centralized chiller plants. Conference and banquet halls of cottage type hotels use packaged air conditioners.

The survey found existing split air conditioners had Energy Efficiency Ratios (EER)* Cooling Capacity (W)/ Input Power (W) in the range of 2.25 to 2.80, while new energy efficient (with or without inverter technology) air conditioners had a rating of 3.50 to four.

With central air-conditioning, the efficiency of some chiller plants was in the range of one - 2.5 (kilowatt/ton)\(^1\). This is very low efficiency when compared to chillers with screw type and multi compressors that consume only 0.5 to 0.6 kilowatt/ton. Around 50 percent of the surveyed hotels had centralized chiller plants. Of these, 70 percent had efficient chillers.

\(^4\) EER - Cooling capacity (W) / Input Power (W)
\(^1\) In the case of air conditioning, TR is ton of refrigeration where one ton is a short ton equivalent to 2000 pounds or 907.18 kg.
Installation of Energy Efficient Air-Conditioning Systems:

Only one of 23 surveyed hotels had installed energy efficient split air conditioners, while eight had installed energy efficient chillers. The remaining hotels still operated either low efficiency standalone air conditioners or low efficiency chillers. None of the surveyed hotels had installed energy efficient air conditioning systems such as vapor absorption machines based on waste heat or biomass fired boilers and hybrid split air conditioners.

Standalone Air Conditioners: A few hotels had replaced normal split air conditioners (EER 2.38 Cooling Capacity (W)/Input Power (W) of 1.5 Tons of Refrigeration (TR) capacity with inverter air conditioners (EER 3.8 Cooling Capacity (W)/Input Power (W)) during refurbishment activities. This had reduced electricity consumption from 1.48 kW per TR to 0.92 kilowatts per TR. The price of an inverter air conditioner is around $1181 and estimated payback period is about five to six years allowing for 12 hours operation per day.

Central Air Conditioners: Some hotels had replaced existing chiller plants with Coefficient of Performance of less than three, with energy efficient chiller plants with Coefficient of Performance of more than seven. One hotel replaced a 185 TR chiller with an energy efficient chiller and reduced electricity consumption from 1.2 kilowatts per TR to 0.60 kilowatts per TR. The investment was around $80,000 with an estimated payback period of 1.5 years with 18 operating hours per day. Several hotels have implemented similar measures with chillers of different capacities.

Water Heating

The survey found 30 percent of hotels used fossil fuel based boilers and electric heaters to heat water. Solar water heaters are a viable and cost effective alternative to conventional water heating methods such as electric geysers and conventional fuel fired boilers. Biomass (Gliricidia, firewood, cinnamon sticks), biomass boilers and gasifiers can be used to reduce fossil fuel and/or electricity consumption to heat water. Using heat from air conditioner outdoor units (for example, with Eco-Generator6) is an option to partly meet hot water needs. This system can supply water at a temperature of around 70˚C.

Twelve hotels surveyed met their hot water requirements from solar heaters either partly or completely. Five of the remaining 11 hotels met their requirements from biomass-based boilers or gasifiers. One hotel had implemented an innovative measure to recover heat from the outer body of its biomass gasifier. A unique finding during the survey was the use of Eco-Generators to heat water.

Installation of Energy Efficient Water Heating Systems

Installation of Solar Water Heaters: Fifty-two percent of surveyed hotels had installed solar water heaters to heat water. The hotels replaced electric heaters or reduced fuel consumption of steam boilers. Most hotels had installed solar water heaters with a capacity of 300 liters per day, which in turn can serve multiple rooms. The cost of a solar heater of 300 liters per day is around $2,362 with an estimated payback period of five to six years.

Installation of Biomass Gasifier/Biomass Boiler: Six of the surveyed hotels (26 percent) had installed biomass boilers or biomass gasifiers to reduce diesel and furnace oil consumption. Steam generated from these systems heated water for guest rooms, laundry, and kitchens. The size of biomass gasifiers was in the range of 180 to 900 kilowatt thermal. In some hotels, the capacities of the biomass boilers were in the 1 to 1.5 tonnes/hr range. The cost of a biomass gasifier of 300 kilowatt thermal is around $30,000 with an estimated payback period of one to two years.

Installation of Eco-Generators to Heat Water: The Eco-Generator uses heat from air conditioner outdoor units to heat water for guest rooms. The cost of an Eco-Generator is around $630 with an estimated payback period of three to four years.

6 The Eco-Generator Water Heater extracts heat from the compressor of an air conditioner unit, before it is vented outside, to heat water.
**Lighting Systems**

Most hotels have made efforts to use natural daylight as far as possible to reduce energy consumption for lighting. Many hotels have partially or completely installed energy efficient lamps such as compact fluorescent lamps (CFLs) in place of incandescent lamps. However, some hotels still use incandescent lamps which are not energy efficient. Currently, light emitting diode (LED) lamps available in the market consume even less power when compared to CFLs. Although 78 percent of hotels had adopted LED lamps, installation was low due to the high capital cost and unreliable quality and supply. Also, most hotels did not use LED lamps in restaurants and bars because dimming is not possible.

Over 60 percent of hotels used normal fluorescent tube lights with magnetic ballast for kitchen and corridor lighting. These consume around 52W while energy efficient fluorescent tube lights (T5 and T8)\(^7\) fixtures with electronic ballast consume only 28W.

High pressure sodium vapor (HPSV) lamps are the most widely used option for outdoor lighting. These are rated to be the most efficient on a lumen/watt scale. New technology LED lamps are even more energy efficient and have a longer life when compared to high pressure sodium vapor lamps. Replacing high pressure sodium vapor lamps with LED lamps will give substantial energy savings and provide white light with a good color rendering index. Moreover, the life of LED lamps is high, around 50,000 hours, which will result in more savings. The use of solar lighting and induction lamps among surveyed hotels was nonexistent while around nine percent used occupancy sensors and dimmers.

**Energy Efficient Lighting Systems**

The surveyed hotels had taken various initiatives towards energy efficient lighting systems. Table 6 displays approximate payback periods for some widely adopted measures.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Unit price ($)</th>
<th>Payback period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement of 40W incandescent lamps with 11W CFLs</td>
<td>3.1</td>
<td>Less than one year</td>
</tr>
<tr>
<td>Replacement of 40W incandescent lamps with 3W CFLs</td>
<td>11.81</td>
<td>1-2</td>
</tr>
<tr>
<td>Replacement of 11W CFLs with 3W LED lamps</td>
<td>11.81</td>
<td>6-7</td>
</tr>
<tr>
<td>Replacement of normal fluorescent tube lights (36W) with T5 (28W)</td>
<td>15.74</td>
<td>2-3</td>
</tr>
</tbody>
</table>

Table 6
Energy Efficient Lighting Measures

Source
PwC Analysis based on survey findings

**Installation of Solar Photovoltaic Panels for Guestroom Lighting**

Two hotels had installed small solar photovoltaic (PV) systems for guest room lighting with back-up connectivity to grid supply during bad weather. Capacity of solar PV systems in the surveyed hotels was in the range of 10 to 20 kilowatt. Investment incurred for a 20 kilowatt solar PV system is around $63,000 to $79,000 with an estimated payback period of 16 to 20 years.

\(^7\)T5 and T8 fluorescent tube lights offer a five percent increase in efficacy over normal fluorescent tube lights (T12), and have electronic ballast. Diameter is 12/8 of an inch for normal fluorescent tube lights whereas 5/8 of an inch for T5 fluorescent tube lights.
Power Management Measures

The surveyed hotels used capacitor banks, variable frequency drives and key-card systems as power management measures. All surveyed hotels had adopted key-card systems in guest rooms to switch off electricity when guest rooms were not occupied.

Installation of Capacitor Banks

Thirteen of 23 hotels (56 percent) had installed capacitor banks to improve power factor. After installation of capacitor banks, hotels recorded an improvement in power factor from 0.80 to 0.98. This had resulted in reduction of electricity bills. While costs vary according to size, typically, installation cost of one kilo volt ampere reactive capacitor bank is around $28 with an estimated payback period of one to two years.

Installation of Variable Frequency Drives

Variable frequency drives (VFDs) reduce electricity consumption in pumps/fans that have a variable load. Fifty-six percent of surveyed hotels had installed variable frequency drives for water pumps, chilled water pumps, and blowers to reduce power consumption when operating at reduced loads. Variable frequency drives vary from four kilowatt to 20 kilowatt depending on the rating of the pump/fan motor. Energy savings from variable frequency drives range from 20 to 30 percent, with a tentative payback period of around two years.

Laundry Operations

The laundry utilizes energy and water in large quantities. It also produces large quantities of wastewater. The survey found that the laundries in some hotels used both electricity and steam, while others used only electricity. Equipment used in the laundry includes washer extractors (with or without soft starting), dryers and iron rollers (steam or electricity based). With efficient use of washing machines and dryers, water and energy consumption can be reduced by around 10 to 20 percent.

Use of Efficient Laundry Equipment: Fifty-two percent of surveyed hotels used washing machines with soft starters which are energy efficient. One hotel had recently installed energy efficient washing machines and saved energy by 10 percent. None of the hotels had installed dryers with waste heat recovery, which are available in the market.

Kitchen Operations

The kitchen is another major resource consuming area in hotels. Here, energy consuming equipment include liquefied petroleum gas (LPG) stoves, electric ovens, cold and freezer rooms, mixers and grinders, coffee and tea making machines, induction plates, and dishwashers. Energy conservation can be achieved through proper maintenance of equipment.

Maintenance of LPG stoves is essential to achieve maximum efficiency. Kitchen equipment that runs on both electricity and LPG can reduce electricity consumption by switching to gas during peak hours when electricity tariffs are higher. Installation of counters to estimate losses due to the frequent opening of the cool room door will help reduce energy consumption of cool rooms. Maintaining a proper distance of refrigerators and freezers from high temperature cooking areas and running dishwashers at full loads are a few other energy savings measures in the kitchen.
Adoption of Renewable Energy Applications

Renewable energy technologies had not been adopted widely. Only six hotels had installed biomass gasifiers or biomass boilers, and only three used biogas for cooking. Other renewable energy technologies like solar PV were installed in two hotels and there was negligible use of wind power for energy generation.

Since installation of renewable energy applications in hotels is low, there is a lot of potential here that should be explored and utilized in the future. Solar water heaters and solar PVs can be employed in most hotels except in Colombo city hotels because of a shortage of space and shadow free area available here. Only one hotel had wind power machines installed which was not in operation due to noise and aesthetic issues.

3.5. Water Consumption

In hotels, guestrooms, laundries, kitchens, gardens and swimming pools use the most amount of water. Water consumption in guestrooms always governs the total consumption in hotels. Outdoor temperature and occupancy rates have a high impact on water consumption. Figure 3 gives a break up of how water is used in the surveyed hotels.

Figure 3

Areas of major water usage

Source
PwC Analysis based on survey findings
3.5.1. Water Conservation

Low Flow Taps and Showers

The survey found that the adoption level of low flow taps and showers was around 52 percent. Low flow taps and showers mix air with water flow so that the user is provided with the same experience as from high flow taps and showers. While the initial cost of low flow systems is higher, water savings will justify the extra cost, which can be recovered within two years.

Low Capacity Dual Flush Cisterns

Ninety-five percent of surveyed hotels had installed low capacity dual flush cisterns. Dual flush cisterns use as little as three liters of water for a short flush and six liters for a long flush, compared to regular cisterns that use nine to 13.5 liters per flush.

The current prices of dual flush cisterns and a set of low flow taps and shower are around $315 and $551 respectively.

Rainwater Harvesting

Only a few hotels (around 20 percent) had rainwater harvesting systems. Water collected through rain water harvesting can be used for gardening as well as in the toilets.

Sub Water Metering

Over 50 percent of the hotels surveyed had not installed sub-water meters to monitor water consumption across different areas in the hotel. By installing sub-water meters and continuously monitoring water consumption patterns, hotels can identify areas where it is possible to reduce consumption of water.

Efficient Porch Water Fountain and Reuse of Air Conditioner Condensate Water

One hotel had installed an effective filtration system in the front porch water fountain. The filtering system led to water saving of 6,480 m³ per annum. The initiative involved an investment of around $3,937, with an estimated payback period of around one year. The same hotel implemented a system by which air conditioner condensate water collected into the tank of a fish pond. This saved 10,000 liters of water per annum.
3.6. Waste Generation

Waste generation is another area where there is an urgent need for proper management and optimal use. Hotels produce different kinds of waste. Food waste, for instance, is largely generated from the kitchen and restaurants. Paper and cardboard waste is generated by office and guest rooms. Other wastes like plastic, glass, and metal are generated from guest rooms, kitchens, and bars.

Figure 4 below shows that waste generated from food is the major contributor to total solid waste in the surveyed hotels (79 percent), followed by garden waste (12 percent). Others include plastic, glass, metal (five percent) and waste from paper and cardboard (four percent). Most hotels did not measure or document solid waste generated and collected. The data in Figure 4 is based on estimations made during interviews and approximations made by hotel staff.

**Waste Generation by Source (percentage)**

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Waste</td>
<td>79</td>
</tr>
<tr>
<td>Garden Waste</td>
<td>12</td>
</tr>
<tr>
<td>Paper and Cardboard</td>
<td>4</td>
</tr>
<tr>
<td>Others (Plastic, Glass, Metal, etc)</td>
<td>5</td>
</tr>
</tbody>
</table>

**Figure 4**
Waste Generation by Source

**Source**
PwC Analysis based on survey findings

Page 17
3.6.1. Waste Minimization Initiatives

**Sewage Treatment Plant**

Twenty of the 23 hotels had sewage treatment plants on the premises. All wastewater generated in these hotels was treated and used for gardening.

**Biogas Generation**

The survey revealed that only 13 percent of the hotels used kitchen waste for biogas generation while the remaining disposed it to piggeries. According to the management of hotels with biogas plants, they recovered the investment made on these plants in just one to two years.

**Solid Waste Segregation and Recycling**

Almost all hotels (90 percent) segregated their waste through various means before disposing. Waste such as paper, plastic, metal, and glass were separated and sold to a third party for recycling.

**Composting of Garden Waste**

Twenty-two of the surveyed hotels composted garden waste on the premises.

3.7. Operational Practices of Surveyed Hotels

Tables 7 and 8 list both the efficient and inefficient operational practices that were observed during the survey.

<table>
<thead>
<tr>
<th>Areas</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy management</strong></td>
<td>Sub metering systems were not installed in most surveyed hotels to measure electricity consumption in different areas such as air conditioning, lighting and kitchen.</td>
</tr>
<tr>
<td><strong>Water management</strong></td>
<td>In kitchens, some hotels wasted a lot of water by defrosting food under running taps. More than 50 percent of hotels had not installed sub metering for water consumption to measure consumption in different areas such as guest-floor, kitchen, and laundry.</td>
</tr>
<tr>
<td><strong>Waste management</strong></td>
<td>80 percent of surveyed hotels did not use bulk dispensers in guest rooms</td>
</tr>
<tr>
<td></td>
<td>Official letters (paper based) were still being used for internal communication between departments.</td>
</tr>
</tbody>
</table>

*Table 7*

Inefficient operational practices observed in the surveyed hotels
Temperatures in guestrooms were kept between 24 to 26 °C, and equipment was turned off when not in use.
- Maximum use of daylight for lobby, restaurant, corridor, guest rooms, etc.
- Set point of calorifier was kept at optimum level for hot water generation.
- Key-cards were used to control energy use in guestrooms.
- Sub-electric meters were installed to monitor electricity consumption in different areas.
- Some hotels had installed counters to estimate losses due to frequent opening of doors of cool rooms.
- Energy efficiency training and awareness programmes were carried out for staff.
- Due to a three-part tariff in force, most energy-intensive activities were carried out during off-peak periods in many of the hotels.
- Energy management work was assigned to competent staff (engineers).

- Pipes, taps, and showers were checked for leaks at least once a month.
- Housekeeping staff checked and closed running taps whenever guests left the rooms.
- To ensure water saving, water-flow restricting valves were used on guest floors.
- Most hotels had adopted a linen and towel reuse programme to reduce water and consumption of chemicals.

- Bathroom amenities were replaced only when the room was unoccupied or when the guest requested it in some hotels. Also, refillable containers were used.
- Solid waste segregated and sold to third parties for recycling was common.
- In most hotels, garden waste was used for composting.
- One hotel used glass bottles for prevention of soil erosion.
- In the kitchen, employees checked inventory before issuing purchase requirements to avoid wastage.
- To reduce waste generation, some hotels used cloth napkins instead of tissues and did not use straws.
- Almost all hotels used grease traps in the kitchen to separate oils from kitchen waste.

Table 8
Efficient operational practices observed in the surveyed hotels.
3.8. Level of Awareness of Resource Efficient Technologies

The survey discovered that 50 percent of hotels had conducted energy audits in the recent past. Most participate regularly in the Sri Lanka National Energy Efficiency Awards (SLNEEA). Around 35 percent of hotels have won awards at SLNEEA over the last three years. Additionally, most surveyed hotels were registered with Greening Sri Lanka Hotels, an initiative funded by European Union under the Switch Asia program. Around 15 percent of surveyed hotels were also registered with Earth Check and Green Globe programs.

Around 44 percent of hotels regularly conducted capacity building and awareness generation programs for staff on resource efficiency and sustainability. Some hotels also set targets to reduce resource consumption and gave incentives to staff that helped achieve this.

An assessment on knowledge of resource efficiency technologies was also undertaken to evaluate awareness on resource efficient technologies among top management (including owners/chief engineers/general managers). Around 90 percent of surveyed hotels were aware, particularly about solar water heaters, biomass boilers, CFLs, LED lamps, solar street lighting, occupancy sensors, card key switches, variable frequency drives, capacitor banks, and efficient washing machines. Almost all surveyed hotels were aware of various water conservation, waste minimization, and renewable energy measures.

Around 60 percent of hotels were aware of energy efficient technologies, particularly inverter air conditioners, solar air conditioners, vapor absorption machines, T5 fluorescent tube lights and dryers with waste heat recovery. Around 40 percent were aware of latest technologies such as hybrid air conditioners, heat pumps, and induction lamps.
A major concern of the hotel industry is the rapid increase in the prices of fuel, electricity, and water over the past few years, as depicted in Figure 5.

Consequently, it is widely acknowledged that accelerated deployment of resource efficient technologies is required to sustain growth. However, there are many barriers to large-scale adoption of these technologies. This survey has identified these barriers, based on response from the hotels:

**Lack of awareness:**

Although the overall awareness levels of senior management of hotels are reasonably high in Sri Lanka, they do not possess full knowledge of the latest technologies available in the country and elsewhere that could result in huge resource savings.
Dedicated manpower:
Some hotels, except those which are part of large national hotel chains, do not have dedicated manpower to undertake resource efficiency initiatives.

Financing of capital-intensive measures:
Hotel managements are willing to adopt low cost resource efficient technologies, but are reluctant to adopt initiatives with relatively longer payback periods. Generally, those with payback periods of more than five years are treated with caution. However some exceptions were observed where some hotels had implemented energy efficiency initiatives with 10 to 20 year payback periods. The unavailability of specific subsidized sustainability-focused funding schemes is another constraint, which prevents quicker and more widespread adoption of resource efficient technologies.

Availability of suppliers and vendors:
Equipment suppliers are not many at present and only a limited number of reliable and quality suppliers operate in the country.

Availability of reliable after sales service and maintenance:
After sales service and maintenance networks are not developed in the country; especially for new technologies such as renewable energy. Sometimes, availability of spare parts is also an issue.

Shortage of free space in city hotels:
Installation of renewable energy equipment such as solar panels require a significant amount of free space. With the rapid increase in the number of high rise commercial buildings, especially in cities like Colombo, most areas are covered by shadow and not much free space is available for installation of solar panels.

Behavior and motivation:
Lack of prioritization, with many businesses viewing resource efficiency as a ‘non-core’ business activity, is a behavioral barrier that was noticed during the survey. Successful implementation of resource efficiency initiatives depends on staff cooperation. This can involve changing long established work patterns. Managements need to invest time and resources to create attitudinal and behavioral changes in their staff.

Hidden Cost:
Another barrier to adoption of resource efficient measures is the perception of hidden costs. These are items such as management time involved in gathering information, analysis, negotiation, and procurement of technologies. Other hidden costs listed included documentation, auditing and regulatory compliance costs. Some managers also cited disruption of business and inconvenience while implementing resource efficient measures.
### 5.1. Resource Efficiency Improvement Potential in Surveyed Hotels

Parameters such as operating hours, fuel and electricity prices, occupancy rates, and present resource consumption levels were used to estimate annual savings potential of resource efficiency measures proposed for each hotel. Estimates of tentative investments, cost of proposed resource efficient equipment and technologies were obtained from reliable suppliers in Sri Lanka.

Table 9 identifies resource efficiency measures in surveyed hotels.

<table>
<thead>
<tr>
<th>Resource consuming area</th>
<th>Resource use</th>
<th>Efficient Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-conditioning</td>
<td>Energy</td>
<td>• Energy efficient (high EER) split air conditioners</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Energy efficient (high coefficient of performance) centralized chiller plant</td>
</tr>
<tr>
<td>Lighting</td>
<td>Energy</td>
<td>• Installation of CFLs, LED lamps, T5 fluorescent tube lights</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Solar PV system for guest room lighting*</td>
</tr>
<tr>
<td>Hot water and laundry</td>
<td>Energy and water</td>
<td>• Installation of solar water heaters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Installation of biomass gasifier / biomass boiler</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• More efficient laundry equipment</td>
</tr>
<tr>
<td>Motors and pumps</td>
<td>Energy</td>
<td>• Installation of variable frequency drives</td>
</tr>
<tr>
<td>Demand reduction</td>
<td>Energy</td>
<td>• Installation of capacitor bank</td>
</tr>
<tr>
<td>Toilets and bathrooms</td>
<td>Water</td>
<td>• Efficient water fixture (Low flow taps and showers, Dual flush)</td>
</tr>
<tr>
<td>Kitchen</td>
<td>Waste</td>
<td>• Biogas generation unit</td>
</tr>
</tbody>
</table>

*Considered only if the hotel showed their willingness

**Table 9**

Identified resource efficiency measures in the surveyed hotels

**Source**

PwC Analysis based on survey findings
Table 10 gives estimated resource efficiency improvement potential and investments required based on measures identified through the survey and subsequent analysis.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Total savings potential</th>
<th>Percentage savings potential of total consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity savings (Mega watt hours/Year)</td>
<td>6,320</td>
<td>10.50</td>
</tr>
<tr>
<td>Diesel savings (Thousand Liters/Year)</td>
<td>261</td>
<td>25</td>
</tr>
<tr>
<td>Furnace Oil savings (Thousand Liters/Year)</td>
<td>386</td>
<td>27</td>
</tr>
<tr>
<td>LPG savings (Tonnes/Year)</td>
<td>37</td>
<td>5†</td>
</tr>
<tr>
<td>Water savings (Thousand m³/Year)</td>
<td>125</td>
<td>8†</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total estimated investment required (million $)</td>
<td>4.76</td>
</tr>
<tr>
<td>Reduction of tonnes of CO₂ emission††</td>
<td>5,952</td>
</tr>
</tbody>
</table>

Table 10
Resource efficiency improvement potential and investment required in the surveyed hotels

Source
PwC Analysis based on survey findings

A detailed analysis was carried out to evaluate area wise resource efficiency potential and investment required. Some interesting correlations and findings emerged.

Resource Efficiency Potential

- Air conditioning has the highest potential for electricity savings (70 percent of total estimated electricity savings potential) followed by lighting, including installation of solar PV (15 percent), hot water and laundry (10 percent) and motors and pumps (five percent).

- All diesel and furnace oil savings result from implementing measures in the hot water and laundry area.

- Of the total savings of LPG, around 97 percent results from using food waste to generate biogas in the kitchen area. The remaining three percent of savings is from the laundry.

- Toilets and bathrooms have the highest potential for water saving (50 percent of total estimated water savings potential) followed by sewage treatment plants (46 percent) and hot water and laundry (five percent).

* LPG savings has been calculated due to the bio gas generation only
† Water savings has been calculated due to efficient laundry machines and efficient guest rooms taps, showers and flushes.
†† Carbon footprint calculator available on website of Greening Sri Lanka Hotels - the EU funded SWITCH ASIA Program
**Investment Required**

- Implementation of energy efficiency measures in air conditioning requires $1.62 million, which is the major part of the total estimated investment followed by hot water and laundry ($1.11 million), and lighting, including solar PV ($440,000).

- Installation of water efficient fixtures in toilets and bathrooms requires $660,000 which will account for 14 percent of the total investment required.

- Around $80,000 million is required for biogas units using kitchen waste.

**5.2. Resource Efficiency Improvement Potential for all Three, Four, and Five Star Category Hotels**

According to *SLTDA Statistical Report-2011*, total room capacity of three, four and five star hotels was 6,192. This survey, carried out in 23 hotels, covered 3,033 guest rooms. In order to assess resource efficiency improvement potential for all three, four and five star hotels in Sri Lanka, relevant survey findings have been extrapolated based on the total number of rooms in these categories. The following table shows the estimated resource efficiency potential and investment for all three, four and five star hotels in Sri Lanka.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Total savings potential</th>
<th>Percentage savings potential of total consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity savings (Mega watt hours/Year)</td>
<td>12,903</td>
<td>10.50</td>
</tr>
<tr>
<td>Diesel savings (Thousand Liters/Year)</td>
<td>534</td>
<td>25</td>
</tr>
<tr>
<td>Furnace Oil savings (Thousand Liters/Year)</td>
<td>789</td>
<td>27</td>
</tr>
<tr>
<td>LPG savings (Tonnes/Year)</td>
<td>75</td>
<td>5</td>
</tr>
<tr>
<td>Water savings (Thousand m³/Year)</td>
<td>256</td>
<td>8</td>
</tr>
<tr>
<td>Total estimated investment required</td>
<td>$9.72 million</td>
<td></td>
</tr>
<tr>
<td>Reduction of tonnes of CO₂ emission</td>
<td>12,152</td>
<td></td>
</tr>
</tbody>
</table>

*Table 11*  
Resource efficiency improvement potential and investments required by all three, four and five star hotels in Sri Lanka  
*Source*  
PwC Analysis based on survey findings
Table 12 breaks down total resource efficiency improvement potential in all three, four and five star hotels in Sri Lanka.

<table>
<thead>
<tr>
<th>Resource consuming area</th>
<th>Savings potential</th>
<th>Percentage savings potential of total estimated potential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electricity savings (Mega watt hours/Year)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air-conditioning</td>
<td>9,034</td>
<td>70</td>
</tr>
<tr>
<td>Lighting</td>
<td>1,907</td>
<td>15</td>
</tr>
<tr>
<td>Hot water and laundry</td>
<td>1,315</td>
<td>10</td>
</tr>
<tr>
<td>Motors and pumps</td>
<td>647</td>
<td>5</td>
</tr>
<tr>
<td><strong>Diesel savings (Thousand Liters/Year)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot water and laundry</td>
<td>534</td>
<td>100</td>
</tr>
<tr>
<td><strong>Furnace oil savings (Thousand Liters/Year)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot water and laundry</td>
<td>789</td>
<td>100</td>
</tr>
<tr>
<td><strong>LPG savings (Tonnes/Year)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td>73</td>
<td>97</td>
</tr>
<tr>
<td>Hot water and laundry</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Water savings (Thousand m³/Year)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilets and bathrooms</td>
<td>127</td>
<td>50</td>
</tr>
<tr>
<td>Sewage treatment plant</td>
<td>119</td>
<td>46</td>
</tr>
<tr>
<td>Hot water and laundry</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 12
Area wise resource improvement potential in all three, four and five star hotels in Sri Lanka

Source
PwC Analysis based on survey findings
5.3. Incremental Investment Required to Implement Resource Efficient Technologies in Hotels Under Construction

SLTDA has approved construction of 68 new tourist hotels in the last three years (2010 to 2012), of which 57 are in three to five star categories. Over 4000 new rooms will be added with the construction of these hotels. These hotels can be more resource efficient with additional/incremental investment during construction. Two sets of calculations have been done to quantify this additional investment:

- Incremental investment required on per room basis for lighting, air-conditioning, and water efficient fixtures.
- Incremental investment required on per hotel basis for renewable energy applications (like biogas, solar PV for lighting, biomass gasifier) and energy efficient equipment in laundry.

In a bid to evaluate the incremental investment per room, the quantities of resource efficient equipment, particularly LED lamps, high EER air conditioners, low flow taps and showers and dual flush cisterns are assumed to be the same across the new rooms. The evaluation of the incremental investment to employ resource efficient devices vis-à-vis the conventional equipment is tabulated in Table 13:

<table>
<thead>
<tr>
<th>Technologies and Equipment</th>
<th>Case</th>
<th>Quantity</th>
<th>Rating</th>
<th>Per unit price(^{\dagger}) (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lighting Lamps</strong></td>
<td>Non efficient incandescent lamp</td>
<td>8</td>
<td>40W</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>Efficient LED</td>
<td>8</td>
<td>3W</td>
<td>11.81</td>
</tr>
<tr>
<td><strong>Air-Conditioner</strong></td>
<td>Non efficient normal split air conditioner</td>
<td>1</td>
<td>1.5 TR (EER 2.8 Cooling Capacity (W)/ Input Power (W))</td>
<td>780</td>
</tr>
<tr>
<td></td>
<td>Efficient inverter or high EER air conditioner</td>
<td>1</td>
<td>1.5 TR (EER 3.8 Cooling Capacity (W)/ Input Power (W))</td>
<td>1,181</td>
</tr>
<tr>
<td><strong>Taps</strong></td>
<td>Efficient inverter or high EER air conditioner</td>
<td>1</td>
<td>1.5 TR (EER 3.8 Cooling Capacity (W)/ Input Power (W))</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Non efficient normal tap</td>
<td>1</td>
<td>9 liters per minute</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Efficient low flow tap</td>
<td>1</td>
<td>6 liters per minute</td>
<td>276</td>
</tr>
<tr>
<td><strong>Showers</strong></td>
<td>Non efficient normal showers</td>
<td>1</td>
<td>12 liters per minute</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>Efficient low flow showers</td>
<td>1</td>
<td>6 liters per minute</td>
<td>315</td>
</tr>
<tr>
<td></td>
<td>Non efficient normal flush</td>
<td>1</td>
<td>9 liters per minute</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficient dual flush</td>
<td>1</td>
<td>3 and 6 liters per minute</td>
<td></td>
</tr>
</tbody>
</table>

\(^{\dagger}\) Based on discussions with local suppliers

Source: PwC Analysis based on survey findings
Further, to estimate incremental investments at hotel level, we have made certain assumptions that all hotels:

- have the same laundry size
- will put up similar sized biogas plants
- will install similar sized biomass gasifiers.

Table 14 details the investment needed.

<table>
<thead>
<tr>
<th>Technologies and Equipment</th>
<th>Case</th>
<th>Rating</th>
<th>System Price(^2) ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biomass gasifier</strong></td>
<td>No installation of biomass gasifier unit</td>
<td>300 kilowatt thermal</td>
<td>No cost</td>
</tr>
<tr>
<td></td>
<td>Biomass gasifier unit</td>
<td>300 kilowatt thermal</td>
<td>31,496</td>
</tr>
<tr>
<td><strong>Biogas</strong></td>
<td>No installation of biogas unit</td>
<td>----</td>
<td>No cost</td>
</tr>
<tr>
<td></td>
<td>Biogas unit (12 m(^3) per day)</td>
<td>20 m(^3) tank size (to process 200 kg of food waste per day)</td>
<td>4,252</td>
</tr>
<tr>
<td><strong>Solar PV</strong></td>
<td>No installation of solar PV</td>
<td>----</td>
<td>No cost</td>
</tr>
<tr>
<td></td>
<td>Solar PV</td>
<td>20 kilowatt</td>
<td>62,992</td>
</tr>
<tr>
<td><strong>Washer extractors and Dryers</strong></td>
<td>Non efficient laundry equipment</td>
<td>30 kg washer extractor (2 units) 22 kg dryer (2 units)</td>
<td>29,921</td>
</tr>
<tr>
<td></td>
<td>Efficient laundry equipment</td>
<td>30 kg washer extractor (2 units) 22 kg dryer (2 units)</td>
<td>37,007</td>
</tr>
</tbody>
</table>

Table 14
Particulars for calculation of per hotel incremental investment
Source
PwC Analysis based on survey findings

Based on the assumption that the per room requirement of energy efficient equipment is the same across the additional rooms, a total incremental investment of $4.21 million will be required. Further, an additional investment of $6.09 million is required to implement hotel level initiatives listed in Table 14. The total incremental investment required to implement all listed resource efficiency initiatives across all 57 three to five star hotels under construction is estimated at $10.3 million.

Other options available include installation of energy efficient chillers instead of low efficiency chillers for central air conditioning. Similarly, building management systems are an attractive option to control all energy-consuming equipment in a hotel. The tentative cost of building management systems for a hotel of 100 rooms is around $80,000\(^3\).

---

\(^2\) Based on discussions with local suppliers
\(^3\) Based on discussions with Indian supplier
5.4. Impact on Greenhouse Gas Emission Levels

Currently, total carbon dioxide emission in Sri Lanka is estimated at around 13 million tonnes of CO₂. Of this the contribution of three, four, five star category hotels is estimated around 96,385 tonnes of CO₂ per annum. This is mainly contributed by different fuels used in these hotels. Figure 6 breaks down emissions from different energy sources in the hotels.

Contribution of different fuels in tonnes of CO₂ emission in three, four, five star category hotels (percentage)

![Pie chart showing contributions of different fuels]

- Electricity: 77.936
- Diesel: 5.835
- Furnace Oil: 8.601
- LPG: 4.013

Source: PwC Analysis based on survey findings
If all resource efficiency initiatives identified in this study are taken up by the hotels there is a potential to reduce the CO$_2$ emissions by 12,152 tonnes of CO$_2$ per annum, which is equivalent to 13 percent of current emissions. The contribution of different energy types in reduction of carbon dioxide emissions is shown in Figure 7.

### Contribution of different energy types in tonnes of CO$_2$ reduction (percentage)

- **Electricity:** 8,129
- **Diesel:** 1,441
- **Furnace Oil:** 2,366
- **LPG:** 217

Of the total reduction of carbon dioxide emissions from all types of fuels, reduction due to electricity saving is the highest at 67 percent followed by furnace oil, diesel, and LPG.

Area wise reduction of carbon dioxide emissions was also calculated. Results indicated that savings in air conditioning can contribute to 47 percent savings, followed by hot water and laundry with 38 percent, lighting area with 10 percent, and others five percent.
Conclusion

The key findings of this survey in relation to patterns of energy and water consumption, waste generation, and impact of resource consumption on operating costs of hotels are summarized below:

- Of the total electricity consumption, air conditioning consumes the highest (around 48 percent) followed by kitchen equipment with 18 percent, and lighting with 13 percent. On the thermal energy side, the major energy (diesel, furnace oil, LPG) consumers are laundry and water heating with a combined share of 72 percent. The survey showed that the kitchen consumes around 22 percent.

- The analysis of water consumption across the surveyed hotels indicates that total water consumption across 23 hotels was 1,610,000 m³. Of this, ground water meets 58 percent of requirement, 40 percent through municipal supply and the remaining two percent through other third parties. Major water usage in hotels occurs in guestrooms (42 percent), laundry (18 percent), kitchen (21 percent) and outdoor activities (19 percent) like gardens and swimming pools.

- The surveyed hotels generated around 3,097 tonnes of solid waste per annum. Solid waste generation in hotels is primarily from the kitchen, guest rooms and gardens. Waste generated from food is the major contributor to total solid waste followed by garden waste (12 percent). Others include plastic, glass, and metal (five percent) and paper and cardboard with four percent. Wastewater generation in the surveyed 23 hotels was around 1,183,000 m³ per annum.

- Resources such as energy, water, and waste management together are a significant portion of the total operating costs of hotels. On an average, these constitute 20 to 30 percent of the total operating costs of a hotel.

The primary objective of the study was to assess resource efficiency improvement potential in three to five star hotels. The analysis of the data collected indicated that significant resource efficiency potential is available. About 10.5 percent of the electricity, 25 percent of diesel, 27 percent of furnace oil, five percent of LPG, and eight percent of water can be saved. The major energy saving potential areas are air conditioning, hot water, laundry, and lighting. Major water saving potential also exists in fixtures like cisterns, taps and showers of toilets and bathrooms. Further, wet waste from kitchens can be used to generate biogas and other waste can be recycled after proper segregation.

The estimated investment required to implement all identified resource efficiency measures in the 23 surveyed hotels is $4.76 million. Extrapolating this for all 44 hotels in the country projects a cost of $9.72 million. Implementation of all identified resource efficiency measures can also reduce carbon dioxide emissions by around 13 percent or 12,152 tonnes of CO₂ for all 44 three to five star hotels in Sri Lanka.

An incremental investment of $4.21 million is needed to make all three to five star rooms currently under construction resource efficient. An additional investment of $6.09 million is required to implement hotel level initiatives in the 57 three to five star hotels under construction. The total incremental investment required to implement all listed resource efficiency initiatives across all 57 three to five star hotels under construction is estimated at $10.3 million.