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Energy Demand Analysis of a Sample of Five and Four Star Hotels in Kathmandu Valley

Shiva Raj Timilsina[1]*, Rabindra Nath Bhattarai[2], Bhisma Pandit[3]

[1,2] *Department of Mechanical Engineering, Pulchowk Campus, Institute of Engineering, Tribhuvan University, Nepal*
[3] *IFC World Bank Group, Country Office - Nepal*
***Corresponding author**: timilsina.shiva@gmail.com

Abstract

Hotel sector is one of the important sectors in terms of revenue collection and fuel consumption in Nepal. Yearly, a large amount of energy is consumed by hotels especially the big star rated ones for providing their services to guests. Considerable amount of non-renewable energy is used by them. The use of inefficient technologies also constitute for high fuel consumption. This leads to the green house gases (GHG) emissions and pollution. Energy demand management and selection of efficient fuel for end use technology not only reduces fuel consumption, but also increases the use of renewable energy.

The report intends to analyze the energy demand of five and four star hotels in Kathmandu valley. As of 2013, there were eight five star and two four star hotels in Kathmandu valley. A questionnaire was developed and survey was carried out in seven five star and one four star hotel. This primary data was used to develop a computer model using LEAP software. The base year for the model was taken 2013 whereas the end year was assumed 2025. Different scenarios were developed to predict the future energy consumptions of the hotels in different technological situations. The substitution of fossil fuels like diesel, LPG, furnace oil, coal etc. by clean hydro-electricity resulted in the considerable GHG emissions control. Similarly, the promotion of the devices like heat pump, induction stove instead of boilers and LPG stoves also lead to energy conservation. From all the developed scenarios the combined total potential energy savings in the year 2025 will be 101 Thousand GJ. Similarly a total of 8700 MT of GHG gases can be controlled from emission in 2025. Thus, there is a huge potential for reducing energy consumption and reducing GHG emissions in the big hotels in Nepal.

Keywords

Five and four star hotels, GHG emissions, energy consumption pattern, energy savings, LEAP, base year 2013, end year 2025

1. Introduction

Tourism industry is an important revenue generator in Nepal. This sector includes the various infrastructures and facilities oriented to the tourists visiting the country. Hotel sector is an integral part of the tourism industry. Most of the star rated and tourist quality hotels are situated in Kathmandu valley. These hotels consume huge amount of energy for daily operations and recreational activities. Many of the infrastructures of the hotels are obsolete thus resulting in the poor energy efficiency. This provides us the opportunity to save a considerable amount of energy also resulting in the monitory savings and reducing Green House Gases emissions.

From 2002/03 to 2012/13, the average growth in gross domestic product (GDP) was 3.99 percent whereas the growth in the commercial sector for the same duration was 5.17 percent [1]. Consumption of energy is quite closely related to growth of the economy. Therefore energy consumption in hotels is expected to increase above the rate of growth of economy. Hence, it may be worthwhile to explore possibilities of energy demand analysis and management in this important and growing industry.

Every year, tourists from all over the world come here for various reasons. Although they travel various parts of the country, most of them spent their considerable time in Kathmandu. The reason behind this is the presence of the one and only international airport which is the main entry and exit point for the tourists in the Kathmandu valley. Besides, there are many cultural heritage sites in the valley which are the major reasons for their visit to Nepal. Star rated hotels of the Kathmandu valley are their prime target for the accommodation of foreign tourists. Quite a large quantity of energy is consumed by them. But enough studies have not been carried out regarding energy demand by them. Therefore a thorough study of the energy demand of the star rated hotels of the Kathmandu valley for efficient energy planning and management is inevitable. Of the total star rated hotels in Nepal, a large number of them are established in the Kathmandu valley. Besides, the characteristics of the hotels within the valley and outside of the valley are similar as the services provided by these hotels and the people they accommodate are similar. Thus, it can be said that the energy demand analysis of the hotels inside the valley can be comparable to the outsiders.

The energy demand analysis of the star rated hotels in the valley leads to the finding of the fuel mix pattern of the hotels. The end use demands of the hotels and the respective fuels used for fulfilling those end use demands can also be found. Thus the baseline data of the energy consumption can be developed. The energy demand analysis also leads to the future energy demand prediction of the hotel sector and future fuel mix pattern. GHG emissions form the fuel consumption and the future trend can be found. This leads to the identification and the selection of the most environment friendly fuel mix pattern. With all these future predictions, efficient policies and strategies can be implemented for the sustainable energy use by the hotel sectors.

2. Research Methodology

The principle research methodology used here is survey. A set of questionnaire was prepared and the survey was carried out on eight different five and four star hotels in Kathmandu valley. The survey data was then used for the model formulation in the computer using the software LEAP.

2.1 Modeling software LEAP (Long-range Energy Alternatives Planning System)

LEAP was used as the modeling software. LEAP follows an end use, demand driven approach, which means that the analysis starts from the end use of energy. The demand program divides the society in a hierarchical tree structure of many levels: sectors, sub-sectors, end -uses and devices. LEAP is a simulation model use to represent the current energy situation for a given area and to develop forecasts for the future under certain assumption such as population growth. It can be used to account for both energy sector and non-energy sector greenhouse gas (GHG) emission sources and sinks.

2.2 Field survey

The survey was intended to be done on all the five star and four star hotels in Kathmandu valley. According to the Ministry of Culture, Tourism and Civil Aviation, there were eight five star hotels and two four star hotel registered in Kathmandu valley in 2070. Among the hotels in Kathmandu valley, two hotels did not participate in the survey owing to various regions. These constraints made survey possible only in 8 hotels. The surveyed seven hotels were five star rated whereas one was four star rated.

Table 1: List of surveyed hotels

SN	Name of Hotel	Number of Rooms	Star Rating
1	Crowne Plaza-Soaltee	282	5 star
2	The Everest Hotel	160	5 star
3	Radisson Hotel	272	5 star
4	Hotel Yak and Yeti	270	5 star
5	Hotel de l'Annapurna	149	5 star
6	Sangri La Hotel	100	5 star
7	The Malla Hotel	125	5 star
8	Hotel Himalaya	125	4 star

2.3 Modeling

LEAP software was used for the modeling purpose. Compiled data from the survey were used as the base year data for the year 2013 in the LEAP software and the computer model was made.

The tree structures of end use demands and supply side are as below:

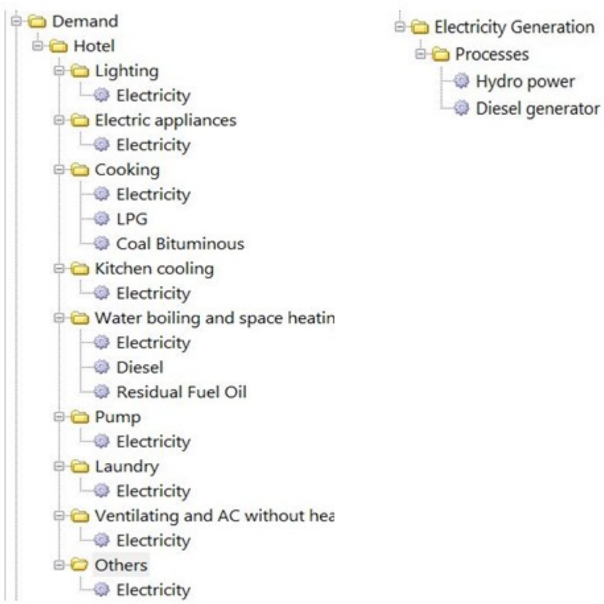

Figure 1: LEAP tree structure of end use demand and supply side

3. LEAP Model Scenario Description

Even though there are various methods to improve energy efficiency in big hotels, some of the important ones which can be modeled through LEAP were considered while making the scenarios. Various national plans and statistics were adopted while making the scenarios.

3.1 Business as Usual Scenario

In Business as Usual Scenario, the growth of the hotel rooms in the future was considered. All other end use demand values were assumed same. Table **??** shows the number of available room-days and occupied room-days of five star hotels of the Kathmandu valley. Here, the number of rooms was multiplied by the number of days the room being operated.

Table 2: Available and occupied room-days of different years

Year	Available room-days	Occupied room-days	Occupancy Rate
2011	538375	355925	66.11
2012	539850	360407	66.76
2013	575240	358787	62.37

Table **??** accounts only five star hotels in the Kathmandu valley. The number of occupied room-days for five and four star hotels in Kathmandu valley would be 403082 in 2013. The number of room-days of the year 2013 was increased according to the increase in tourist numbers in the future years. The growth rate of the tourists was used for the estimation of the room-days of the hotels from year 2014 to year 2025.

3.2 Efficient Lighting Scenario

In the base year 2013, 30% of the total energy consumed in the lighting was though incandescent lamps, 20% through fluorescent lamps, 36% through CFL, 7% through LED and remaining 7% through others.

In this scenario it was assumed that by 2016, 80% of the incandescent bulbs and 25% of the fluorescent and CFL bulbs will be replaced by LED bulbs. Similarly, by 2019, 90% of the incandescent bulbs and 100% of the fluorescent and CFL bulbs will be replaced by LED bulbs. The conversion factor taken in this thesis was 0.25 for incandescent bulbs and 0.67 for fluorescent and CFL bulbs [2].

3.3 Efficient Cooking Scenario

The efficiency of induction stove is 84%. [3]. The efficiency of LPG stove is 53.6%. And that of wood stove is 22.8% [4]. Here the efficiency of the coal stove was considered of the same as of the wood stove.

Induction stove uses electricity. Currently there is electricity deficiency in Nepal. But, many hydropower plants are being built in Nepal and there has also started the tradition of electricity trade between Nepal and India. So, in near future the electricity deficiency of Nepal will be considerably reduced. On the other hand, LPG has to be imported as Nepal doesn't have its reserve. This makes use of LPG in cooking expensive compared to electricity. The following table shows the monthly life-cycle costs of cooking in urban households.

Table **??** shows that use of electricity is still cheaper compared to the use of LPG with subsidy for cooking from 2012 onwards. Thus in this scenario, the use of LPG in cooking was gradually replaced by electricity. Here, it was assumed that 5% of the LPG use will be replaced by 2016. Similarly, by 2019, 10% of the LPG consumption will be replaced by electricity and by 2022 and 2025, 15% and 25% will be replaced by electricity respectively.

Table 3: Monthly life-cycle cost of cooking with different fuels

Year	Kerosene (NRs.)	LPG (NRs.)	Electricity (NRs.)
1997	180	350	605
2000	270	410	680
2003	340	510	790
2012	1640	1030 (with subsidy)	940

Only a small amount of coal was used in the hotels. And the use of coal is not efficient and it also causes air pollution. So, in this scenario it was assumed that all coal will be replaced by LPG by 2016.

3.4 Improved Boiler Efficiency Scenario

The efficiency of a boiler is normally 80%. With the addition of non-condensing economizer in the boiler system, the efficiency reaches to 85%. With further improvement, the efficiency reaches up to 89%. It's the maximum possible efficiency of the boiler [5].

On average the efficiency of the boilers of the surveyed hotels was found to be 75%. In this scenario, it was assumed that the efficiency of the boiler will improve to 80% by 2016, 85% by 2019 and 89% by 2022. This improvement in boiler efficiency results in the reduced consumption of diesel and furnace oil.

3.5 Efficient Heating Scenario

Currently, boilers are used in the hotels for the purpose of water heating and space heating. Only a small share of electricity is used for this purpose. Boiler consumes diesel and furnace oil. This causes pollution as well their use is not cheap. Heat pumps can be good alternative to the boilers. Heat pump uses electricity so there does not arise the problem of pollution. In today's world the heat pump can be found with the COP of up to 4 [6]. So, the use of heat pump is efficient and cost effective compared to the boilers.

In this scenario, it was assumed that by 2016, 20% of the heating done by the boilers will be replaced by heat pump. Similarly, it was assumed that 40%, 60% and 80% of the heating done by the boilers will be replaced by heat pump by 2019, 2022 and 2025 respectively. Also the efficiency of boilers was increased as in the case of Improved Boiler Efficiency Scenario i.e. Efficient Heating Scenario also incorporated the Improved Boiler Efficiency Scenario.

3.6 Efficient Air Conditioners Scenario

Of the surveyed hotels, the COPs of the central air conditioners were found from below 2 to 3.15. On average the COP of the central ac was found to be 2.5. However the COPs of split air conditioners used in the surveyed hotels were close to 3.5.

Nowadays we have ac systems with COP above 3 [7]. Thus in this scenario, it was assumed that the COP of air conditioning systems will improve to 3 by 2019 and to 3.5 by 2025. Here the year gap was kept wider as it is difficult to improve the efficiency of the air conditioning systems beyond certain limit.

3.7 Generators Replacement Scenario

This is a supply side management scenario. As of 2013 surveyed data, 79% of the total electricity was supplied through the national grid by NEA. The remaining 21% was supplied through the diesel generator sets installed in the hotels.

Most of the electricity generated by NEA is through hydropower. Now, one multi fuel and one diesel power plant are in operation by NEA whose electricity generation is below 1% of the total electricity consumed in Nepal. Solar electricity is also nominal [8]. So, the grid electricity supplied through NEA was assumed as hydroelectricity in this scenario.

According to NEA, Nepal produced around 800 MW of electricity through NEA and independent power producers in 2014. Similarly in 2014, Kulekhani dam was completely filled with water and there was also the increase in import of electricity from India. So, in this scenario, it was assumed that the percentage of electricity supplied through national grid in the hotel sectors will increase from 79% to 81% in the year 2014.

From 2013, hydropower plants of 300 MW capacities were under construction by IPPAN which were said to be completed within 4 years. Out of those plants, 15 MW

Hewa Khola HPP and 22 MW Mai Khola HPP were said to be completed by 2015 [9]. By 2016, Chamelia HPP of capacity 30 MW will come in commission. By 2017, Tamakoshi HPP of capacity 456 MW which will also be the biggest hydropower project of Nepal will come in operation. Also 57 MW Sanjen HPP of Chilime Power Company will also come in operation [10]. NEA had forecasted the peak electricity demand for the year 2016/17 and 2017/18 as 1653.7 MW and 1837 MW. And in 2017, the total capacity of the hydropower plants in Nepal will be above 1600 MW. Also the prospect of 14 MW Kulekhani III storage HPP and buying electricity from India in winter and selling in summer leads to more secure and consistent hydropower supply by 2017 [8].

Further, Mid Bhotekoshi HPP of capacity 102 MW, 111 MW Rasuwagadi HPP and 60 MW Upper Trishuli 3A projects will come in commission between the years 2017 and 2020. Upper Karnali HPP will also come in action in the future. NEA had also started the loss reduction program to improve the efficiency of transmission and distribution and end use consumption. The contract had been signed in 2013 to improve the Kusaha - Kataiya 132 KV Transmission line for electricity import/export with India. There is also a plan to complete Nepal-India Electricity Transmission and Trade Project to import/export up to 1000 MW electricity through Hetuda-Dhalkebar-Duhabi 400 kV transmission line [10] [8].

All these above mentioned facts say that there won't be electricity deficiency in Nepal in the near future. Average cost of grid electricity is NRs 7 to 13 whereas average cost of electricity through diesel generator sets is NRs 35 to 40 [11] and as grid electricity is far cheaper compared to the electricity through the captive diesel generator sets, if available the hotel sectors will always tend to consume more grid electricity.

Thus in this scenario, it was assumed that the percentage of grid electricity in the total electricity supply in the hotel sectors will be 81%, 83%, 85%, 95% and 100% by 2014, 2015, 2016, 2017 and 2020.

3.8 The Best Case Scenario

In this scenario all the previous mentioned efficient scenarios except the improved boiler efficiency scenario were added. As the efficient heating scenario included the replacement of boilers by heat pumps and also the continuous improvement of the boiler efficiency, improved boiler efficiency scenario was not added here. The improved boiler efficiency scenario was only made to compare how much extra energy can be saved by using heat pumps in place of boilers instead of just improving the efficiency of boilers.

This scenario also incorporated the Generators Replacement Scenario. Here, all the energy efficient demand scenarios were incorporated with the supply side scenario of gradual diesel generators reduction.

4. Results and Discussion

4.1 Demand side results

4.1.1 Business as Usual Scenario

Figure 2 shows the types of fuel used in hotel sector in the year 2013 and the prediction of the change of the fuel consumption up to the year 2025 in Business as Usual scenario.

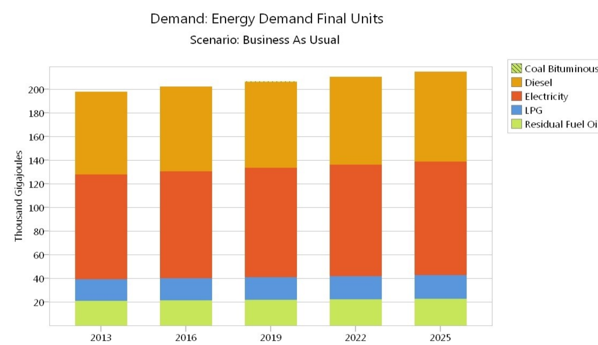

Figure 2: Energy demand according to fuel type, BAU scenario

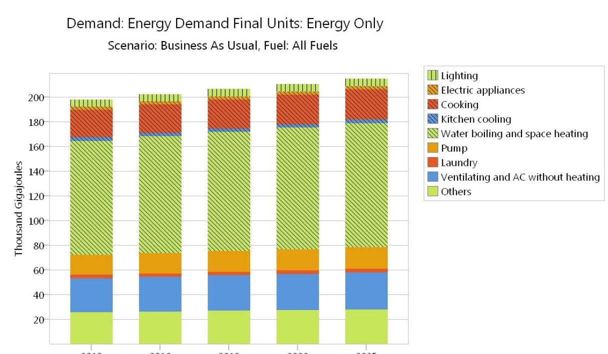

Figure 3: Energy demand according to the end use, BAU scenario

Electricity was the major source of energy followed by diesel. They represented 80% of the total fuel share in 2013. Coal was used only in trace amount for barbeque purpose. In the base year 2013, the total fuel consumed was of 198 Thousand GJ and it was 215 Thousand GJ for the year 2025.

Similarly, the graph in Figure 3 shows the energy consumption by end use type. Water boiling and space heating consumed the major share of fuel. Diesel and furnace oil were used in boilers for the purpose of generation of hot water and steam. Some hotels were also found using electricity for the same purpose. Ventilating and AC (without heating) and cooking are other major energy consuming end uses.

4.1.2 Demand side total energy savings

Four demand side scenarios were developed to find the potential energy savings in this thesis. They are Efficient Lighting Scenario, Efficient Cooking Scenario, Efficient Heating Scenario and Efficient Air Conditioning Scenario. Efficient Heating Scenario also incorporated the Improved Boiler Efficiency Scenario. In the year 2025, the combined potential energy savings from these four scenarios will be 79 Thousand GJ which is a considerable amount of energy. The following figure shows the energy demand by end uses for the year 2025 in the Business As Usual Scenario and The Best Case Scenario. We can see that a considerable amount of energy can be saved in Water Boiling and Space Heating end use. The reason behind this is the replacement of inefficient boilers by the efficient heat pumps. Similarly, energy can be saved in Cooking, Lighting and Ventilating and Air Conditioning.

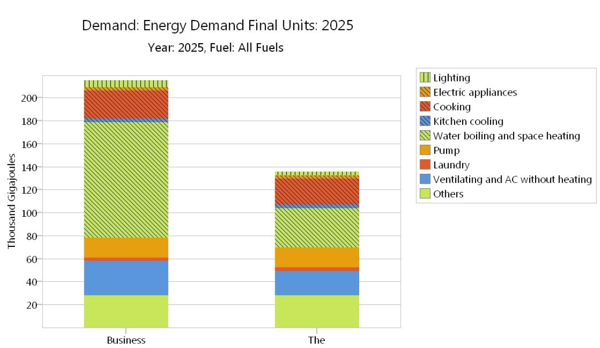

Figure 4: Net energy demand potential savings in 2025, end use wise

Similarly, the following figure shows the fuel wise energy savings in the year 2025. Considerable amount of diesel and furnace oil will be reduced in The Best Case scenario. Small portion of LPG will also be reduced. However, the consumption of electricity will rise.

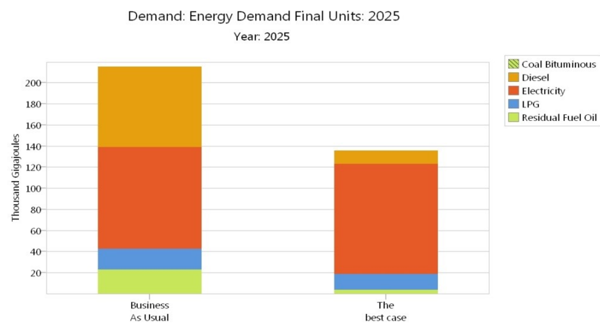

Figure 5: Net energy demand potential savings in 2025, fuel type wise

4.2 Total Energy Saving Potential

In the Best Case Scenario, the energy consumption in the end uses will be less than Business as Usual scenario due to various efficient technologies. Similarly, the energy consumption in the supply of electricity will also be less due to the replacement of diesel generators by hydropower. There will be the potential of energy savings from the year 2014 and by 2025, the energy saving potential will be around 101 Thousand GJ in year 2025. The savings in the year 2014 will be 9 Thousand GJ and the savings will increase gradually with time.

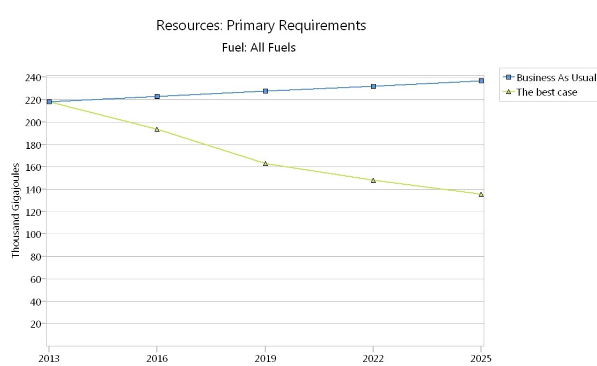

Figure 6: Total energy saving potential in The Best Case Scenario

A study conducted by NEEP/GIZ in 2012 said that a total of 203 Thousand GJ can be saved annually in the hotel sector [12]. Thus, the prediction of the future potential energy savings of the five and four star hotels in Kathmandu valley is validated by this report.

In The Best Case Scenario, diesel and residual fuel oil will be largely reduced and the share of hydroelectricity will rise. This will lead to improvement in the share of renewable and indigenous fuel like hydroelectricity thus leading to less environmental pollution as well as reducing energy security problem.

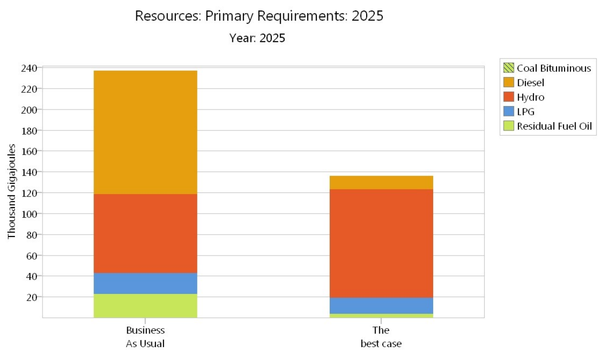

Figure 7: Reductions in Primary Resources Requirements in 2025

4.3 GHG emission reduction potential

The gradual reduction in the emission of the greenhouse gases in The Best Case Scenario compared to the Business As Usual scenario will be as shown in the figure below.

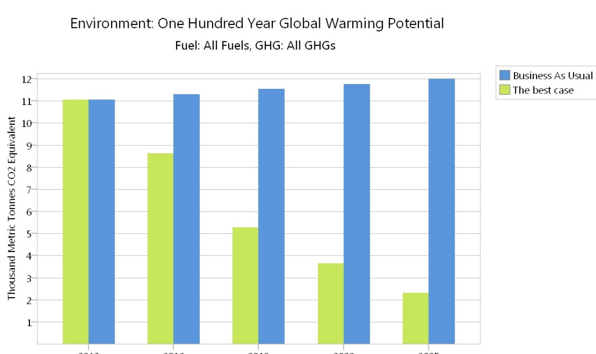

Figure 8: Net GHG emission comparisons in BAU and The Best Case Scenario

5. Conclusions and Recommendations

5.1 Conclusions

- Result showed that the eight five and two four star hotels of Kathmandu valley consumed 198 thousand GJ of energy in the year 2013 and in the normal trend, the consumption will increase to 215 thousand GJ in 2025. Also, only 79% of the total electricity consumed in these hotels was supplied through the national grid in the year 2013. The remaining 21% of the electricity was supplied through diesel generator sets. Owing to the fact that diesel generators have low efficiency, the total energy resources consumed by the hotels was 218 thousand GJ in 2013 and in Business As Usual case, will increase to 237 Thousand GJ in the year 2025.

- Different scenarios were developed in order to estimate the potential energy savings in the hotels up to the year 2025. In the Efficient Lighting Scenario, 695 Thousand kWh of electricity will be saved in the year 2025 to the normal trend. Efficient Cooking Scenario will save 1.9 thousand GJ of energy, Efficient Heating Scenario will save a total of 66.3 Thousand GJ of energy, Improved Air Conditioner Scenario will save 2366 thousand kWh of electricity and Diesel Generator Replacement Scenario will save 14 thousand GJ of energy in 2025. From all these scenarios the total potential energy savings in the year 2025 form the Business As Usual scenario is 101 Thousand GJ which is a huge potential.

- If we look the individual fuel types, 105 Thousand GJ equivalent of diesel, 5 Thousand GJ equivalent of LPG and 19 Thousand GJ equivalent of residual fuel oil will be replaced by hydro-electricity in 2025. The hydro electricity consumption will increase by 27.8 Million KWH. Hydropower is an indigenous source of energy in Nepal. So, the replacement of fossil fuels by the hydro-electricity will reduce the energy security problem in the hotels sectors.

- Further, hydro-electricity is a clean source of energy and the promotion of the hydro-electricity will save a total of 8700 MT of CO2 in 2025 compared to the Business As Usual Scenario.

- Thus a large amount of energy can be saved and large quantity of GHG gases can be stopped from emission by applying The Best Case Scenario in large hotels.

5.2 Recommendations

- Use of hydro-electricity instead of diesel generated electricity, LPG, coal, diesel and furnace oil leads to reduction in GHG emissions. Further, cost and net energy needed for electricity generation through diesel generators is more compared to the hydro-electricity supplied through grid. Thus, use of hydro-electricity should be promoted in the hotels.

- Use of heat pumps instead of boilers and the use of efficient lighting devices like LED bulbs, improved air conditioners, induction stoves for cooking purpose should be promoted as energy savings.

- Further studies should be done to promote renewable technologies like solar energy and biogas plants as they make hotels less dependent on fossil fuels.

- Further research on new technologies like load management and the use of proper insulation in hotel rooms and hot water supply pipes should be emphasized as they make hotels more energy efficient.

- Energy auditing in the hotels should be carried out as it helps to identify the potential energy saving areas.

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