

STATUS OF LIGHTING TECHNOLOGIES IN NEPAL

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ABSTRACT

Lighting is a thoughtful application of lighting source to get visibility and accomplish a specific task during the darkness by providing desirable illumination. In present context, there are numerous light sources and lighting technologies. But, with the advancement of technologies, traditional lighting technique is being gradually replaced by efficient lighting system with specific purpose and application. This study presents current status of lighting technologies, applications, challenges, policies and impacts in Nepalese scenario. This study also presents some statistic outcome, drawn from a survey of 250 sample size including different five target group. From this study, it is found that the people and government are moving toward the efficient and clean lighting technologies from traditional one. These activities on the implementation of efficient lighting technologies help the people in different sectors, such as education, health, security, economy etc., and in the improvement of living standard.

Keywords: lighting system, lighting design, lighting issues

1. INTRODUCTION

Light has a big role in the lives of all living beings. Starting from the food chain it contributes to provide all necessities required to live, such as nutrition, healthy atmosphere etc. Similarly, most of the living beings require light to see and conduct their routine tasks. In other words, light is a means to communicate in-between members of a group, and as such it is hard to survive without the presence of light [1]. From the ancient age, when people lived in caves and used fire as the source of light after blackout, the importance of lighting has increased day by day with the progression of human evolution. The light and lighting technologies, one of the routine amenities, affects human living profoundly. With the development of electric lighting, the lighting approach has become easier and initiate numerous scopes and applications [2]. Nowadays, lighting has become an essential kit in human's perception on their life style. In-house lighting helps in conducting the regular tasks and improve the effectively during night. But in current context, it is used for other special aspects of room's interior designing, work space etc., and provides opportunities to set ideal working environment [3]. Like fresh food, air and other necessities, good illumina-



Fig.1. People using fuel-based lighting for study, cooking and other activities [5,6]

tion helps to improve the health, self-empower, and efficiency of individuals [2].

In this study, the current status of lighting technologies, scopes, impacts etc. in Nepalese scenario are discussed. It is mainly focused on the current practices, implementation of illumination engineering in different sectors of Nepal. Also, the impacts of lighting system in people’s daily lives have been discussed. This study first introduces the issues and importance of lighting in human life. Section 2 presents the overview of lighting technologies existing in Nepalese market and their applicable areas. Section 3 presents the governmental policies and the standard related with lighting and renewable energy technologies in brief. In section 4, requirements and effects after implementation of lighting technologies in rural and urban communities of Nepal has been discussed. Section 5 presents some data on current practice and consumer’s perceptions. Finally, in section 6, conclusions have been drawn and presented.

2. OVERVIEW OF LIGHTING TECHNOLOGIES AND SCOPE

The use of light and the lighting system began in ancient age in Nepal similar to the rest of the

world, when the ancient people used fire as a light source. Later, people used fuel-based inflammable (fossil fuelled) lighting system. This type of lamps was made up of metallic bottle body, and fuelled with animal and/or vegetable fats. Currently, the modified version of this lamp is used in the rural community of Nepal, where the lamps are made up of metallic can or glass body, and fuelled with a petroleum product such as kerosene, diesel, bio-oil etc. The candle is another type of flammable lighting technology. Fig.1 (a, b) show the samples of traditional lamp (tukki in local language) used in rural Nepal. As per the data provided by Central Bureau of Statistics (CBS) in 2011, 67.26 % (94.11 % in urban and 60.84 % in rural) of household uses electricity as the source of lighting and 18.28 % (4.04 % in urban and 21.68 % in rural) of household uses kerosene as the source of lighting. Other types of sources are negligible in the case of urban area, but in rural area, 0.26 % of household uses biogas, 9.16 % uses solar and 7.41 % uses other sources for lighting [4].

In the modern age, people are using different types of lighting technologies as per their comfort. The trend of change in lighting technologies and their source type can be observed in Fig. 2. In 2001, kerosene was the major source of lightning, where

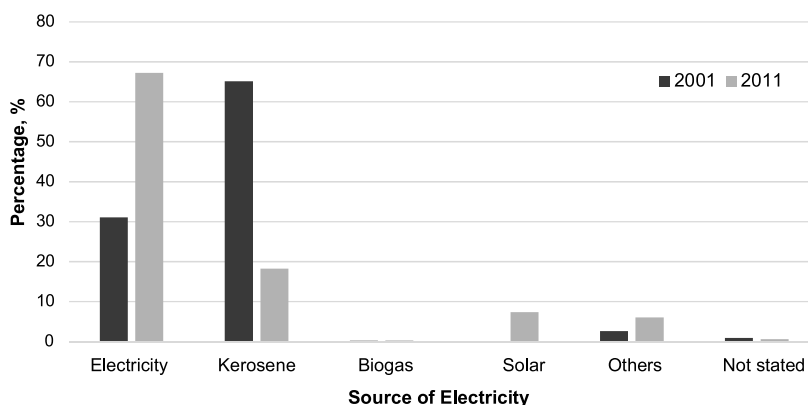


Fig. 2. Percentage of household using different sources of lighting in 2001 and 2011 AD [4]

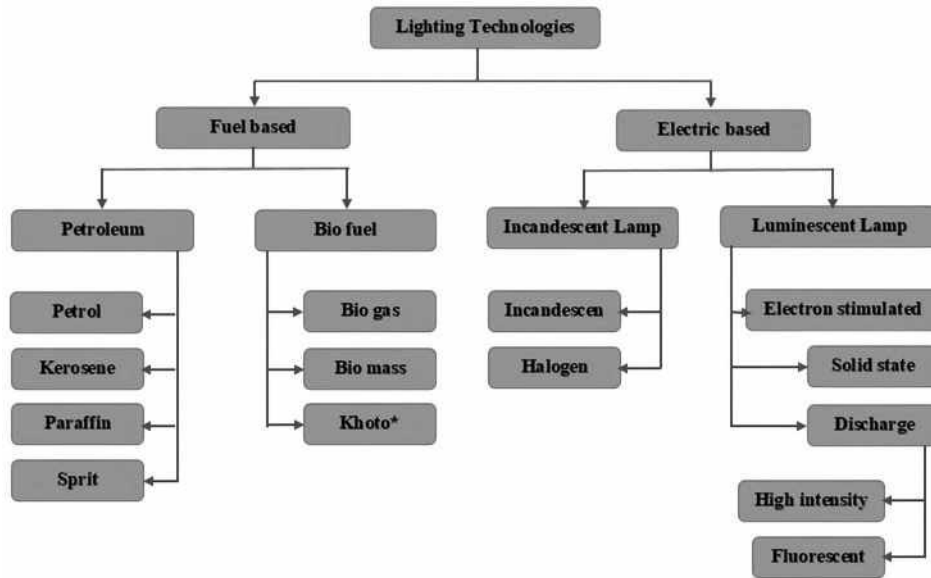


Fig. 3. Source and lighting technologies adopted in Nepal (* Khoto is the local name of turpentine extracted from pine resin)

as in 2011, electric lighting technologies covered the major proportion. In the past decade, the incandescent lamps were very popular in major cities where electricity supply was available. But in present context they are only found in some remote area due to lack of awareness, and in some hotels and museums because of their high colour rendering ability and warmth. Fluorescent lamps are one of the popular types of lighting scheme in the Nepalese market, because of its efficiency, and are found in commercialized buildings as well. The major proportion of indoor and outdoor lighting in the present context is covered with compact fluorescent lamps (CFLs) and light emitting diode (LED), whereas halogen lamps are very popular for flood lighting. Over time, different shaped and coloured lighting technologies are available in the market for specific applications. The general overview of different lighting technologies and the fuels adopted in Nepal is shown in Fig. 3. Some of the important applications of lighting noticed in Nepal are discussed below.

2.1. Indoor Lighting

Lighting is the thoughtful application of light to accomplish a specific task during the darkness by providing desirable illumination. The major requirement of lighting is aiding in in-house activities such as in home, office, industries, underground parking, shops, malls, hotels, restaurants, museums etc., and the major objectives are to provide desirable lighting and improve attractiveness of space and objects. Lighting has different provisions and purposes as per their applications, and can also be an essential component of living. Household use normal lighting to conduct their activities during night time, and the illumination design and varieties may differ as per the specific functional requirements, whereas the industries, shop and hotel use the lighting design with specific characteristics to meet their requirements. Based on the purpose, the illumination level, intensity, diffusion types and forms of lighting vary. Fig. 4 (a) shows the indoor lighting utilized in ho-



Fig. 4. Lighting system in hotel/ restaurant (a), and in museums (b) to highlight the ancient objects



Fig. 5. Lighting system used in heritage sites of Nepal

tels to provide attractive environment with desirable illuminations, and Fig. 4 (b) shows the lighting system used in museums to highlight the ancient objects.

2.2. Street and Road Lighting

Over the last decade, the street and road lighting have been blooming and is being implemented as one of the fundamental requirements in the growing cities of Nepal. In the past, most of the streets and roads were being lighted by utility based incandescent lamps, which were later replaced by fluorescent lamps. With the advancement of technologies, the previous lighting techniques are being replaced by solar-based isolated lighting system containing white light emitting diodes (WLED). The configuration of solar street light system must be designed to be robust and must be good enough to withstand the harsh environmental condition. The solar street lighting installation shall not damage aesthetic of the existing city or street plan; rather it shall add beauty to the existing roadway. The main objectives of the road and street lighting are to provide brighter light during the night and improve the road and street conditions as well as to minimize the security issues such as sexual harassment, theft, accident etc. Further, it helps to increase the active working period of the people resulting in positive contribution to the nation's economy.

2.3. Heritage Lighting

Currently, state-of-the-art lighting systems have been used to present and express the culture and his-

tory of Nepal highlighting their existence and importance, Fig.5.

Different lighting designs have been introduced on the cultural heritage site via the development of variety of concepts and materials. One of the major contributors in Nepal's economy is the tourism industry. Nepal has a wide cultural and natural diversity that attracts tourists from all over the world. Apart from international tourists, domestic tourism also contributes largely to the tourism associated economy. The major tourist attractions of Nepal are natural beauties, biodiversity, adventure activities, trekking and mountaineering in the mid-hill to high mountains, and diverse heritage area present across the country. Focused on the heritage sites, the major cities of Nepal are very rich and attracts tourist from all over the world. Unfortunately, most of the tourist attractions or tourist residing vicinities seem to be improperly and inadequately lighted. In the present context, there are no facilities to visit the heritage site at night due to the absence of illumination. Even in the important and popular heritage sites, there are no lighting mechanisms, nor are there proper illuminating systems. This has hindered the heritages' beauty and shortened the visiting duration of tourists. Fig. 5 show some of the existing lightings at the heritage site of Bhaktapur and Kathmandu, Nepal, which are not properly designed. Recently, concerned people have been working at few important sites (Tripura Sundari Temple, Patan Durbar Square site and Bhaktapur Durbar Square site) on illumination task to increase their beauty during dark, and bolster the tourist flow at night period, thus increasing the economic activities there as well.

Table 1. Types of Solar Street Lighting Adopted in Nepal [11]

Type	Lamp power, W	Min. peak PV module power, W	Min. battery capacity for Lead, Ah	Min. battery capacity for Lithium, Ah	Min. charge controller, A	Pole height, m	Right of way, m
Type 1	10	50	40	30	5	7	< 4
Type 2	20	100	60	45	10	7	4–6
Type 3	30	150	80	60	12	7	6–10
Type 4	40	200	100	75	15	8/ 9	10–14
Type 5	60	300	150	115	25	8/9	14–20
Type 6	80	400	200	150	30	10	20–30
Type 7	100	500	250	180	40	10	> 30

2.4. Automotive Lighting

Automotive lighting includes the lamps used in-front (headlights) and back-front (tail lights) of the vehicle to provide the necessary illuminations during traveling at night. The vehicle also includes some specific lighting system for a specific task such as an indication of different parameters, illumination of the interior part, decoration etc. In most of the modern vehicles, the lighting is replaced with LED technologies. Basically, two types of front lights are available in Nepalese vehicles: white and yellow (basically halogen, Xenon and/ or LED types); white for normal condition, whereas yellow for foggy environments. Similarly, red and white lamps are present in back-front; red for breaking indication and white for illuminating the upcoming status during the back-mode operation. LEDs today are mainly used for secondary functions such as dashboard lighting, turn signals and side-markers of the vehicles, but with the development in high brightness LED, they are now also being used as headlamp in automobile.

2.5. Other

Although spending on digital approaching, different sectors have been escalating at the expenditure of traditional techniques. Today's digital advertisement is one of the major examples of lighting application. Majority of spaces in big cities and highways are displayed with some big advertisements. Similarly, with the increase of traffic flow, automated traffic lights are used in most of the busy centres, digital noticeboard are placed in-front of institutions, digital information boards are showing the contents etc. These are all some of the ma-

for applications of lighting system follow in Nepal. There are various other applications like machine vision lighting, lighting for medical and dental observation, lighting in indoor sport hall and stadium, phototherapy lighting, marine, portable torch lights and airport signalling etc. The application field is no doubt going to increase because lights are now being used in all areas and have become one of the fundamental demands in human life.

3. POLICIES AND INCENTIVES

In Nepal, there is no clear policy on lighting technologies directly, although some incentives on clean energy associated with lighting existed. A standalone solar photovoltaic street lighting system is an outdoor lighting unit used for illuminating a street or an open area. The PV powered street light utilizing LED has become a wide spread practice. Alternative Energy Promotion Centre (AEPCC) in collaboration with different municipalities has been installing Solar Power LED Street Light with specific purpose. AEPCC provide subsidy to renewable energy based technologies to secure the socio-economic development of communities by utilizing the available natural resources with best technology. It is expected to provide 40 % of subsidy in total cost of the solar based energy system in metro and sub-metro municipality, where 30 % cost will be covered by the beneficiaries and 30 % coming from credit [7]. Similarly, 70 % of project cost is subsidized in the rural municipality and 60 % in the municipality by AEPCC [7,8]. As per the data provided by AEPCC, in the fiscal years of 2016/17, 2017/18 and 2018/19, a total of 1622, 1357 and 1060 street light systems are implemented under AEPCC in different communities all over the

Table 2. Technical Specification of Solar PV Module [11]

Description	Specification
Module capacity	Capacity must be selected as per type of solar street light
Module type	Mono or Poly Crystalline or Thin Film
Operating voltage w.r.t. output power	Crystalline: 34Vmp for each 24V and 17 Vmp for each 12V module Thin Film: At least 40 % higher than system voltage
Min. module efficiency	Crystalline: 14 % Thin Film: 10 %
Junction box	IP 65 or above
Tilt angle and Direction	Towards due south around local latitude
Fasteners	Stainless Steel or Hot deep Galvanized
Design standards	IEC61215, IEC61646
Safety standard	IEC61730
Certification	RETS Certified

countries. The specified specification and types of solar street light supported by AEPC is listed in Table 1, and that of solar PV module is presented in Table 2. On the other hand, Nepal Electricity Authority (NEA) had installed 1600 street light with lamps of 30W, 40W and 60W within Kathmandu Valley at various locations. Some innovative concepts that links business and lighting just implementing, in which private company owned street lighting system with advertisement display as source of revenue. In past few years, more than 2000 lamps of 30W and 40W had been installed in such business oriented concept. Further, different NGOs and INGOs are providing small scale solar system, lantern and torch light for the rural communities untouched with national grid.

NEA had launched an energy efficient lighting project to decrease the application of incandescent lamps. In 2014, this program distributed 750,000 efficient CFL in the support of Asian Development Bank (ADB) in different part of the country [9]. NEA also conducted an awareness campaign "Bright Nepal, Prosperous Nepal", focused on the proper demand side management by displacing the inefficient incandescent lamps by LED, so that the peak demand can be clipped by a certain amount [10].

As per the registered data provided by Renewable Energy Test Station (RETS), 5218 samples of WLED with different ratings have been tested within the last 5 years, and more than 2,568,222 lamps were approved for sale. Among these 5 years, the highest numbers of WLED were imported

in 2014 AD. The required specification of lighting sources (LEDs) is given in Table 3. Nepal Academy of Science and Technology (NAST) is also working to develop a testing and standardization section in Nepal, so that the product imported from other countries or developed within the country can be monitored and maintain the quality.

In addition, informative audio and visual materials on energy efficient lighting are disseminated through televisions, radios and newspapers. Big hotels and commercial buildings, government organization are using CFL or LED lamps, and have occupancy sensors to promote the energy efficient lighting programs. Proper training for the use of energy efficient lighting and courses at universities are delivered to speed up the energy efficient lighting initiatives.

4. SOCIO-ECONOMIC IMPACT OF THE LIGHTING SYSTEM

More than 9.3 % of Nepalese population (22.513 % rural and 3.1 % urban) are out of reach of electricity, and even the people connected with the national grid are unable to get reliable and sufficient electricity supply [12]. One of the main reason behind it is the mountainous geography of the country, where more than 60 % of the population are living in the hilly area, where it is quite difficult to transmit the electricity through the national grid [9,13]. These people are forced to use fuel-based lighting system leaving female and children in danger. The energy sources are techno-e-

Table 3. Technical Specification of Lighting Sources for Street Lighting [11]

Description	Specification
Type	Light Emitting Diode (LED)
LED light source	The capacity of light must be selected as per the type of solar street light
Luminous efficacy	≥ 100 lm/W
LED illumination	Street lamp should have illumination not less than 0.5 lx/W perpendiculars from the height of 9 m. The illumination should be uniform without dark rashes on the ground
View angle	Equal or greater than $2 * 50$ angular degree
Colour Rendering Index (CRI)	CRI of individual WLED must not be less than 60 and the correlated colour temperature must be in the range of (5000–6000) K
Lamp Rated Total Power	The capacity of light capacity must be selected as per the type of solar street light
Control Function	Must have Automatic dusk to dawn function. Also include at least two stage of dimming function. First stage-system should function at 100 % load for six hours and second stage: system should function at 50 % load for next 6 hours
Driver Circuit	Must have Driver circuit Charge Controller with not less than 85 % efficiency
Protection	The lamp must be protected against reverse polarity
Certification	Must submit IP65 or above Compliance Certificate and RETS Certified
Expected Life	Minimum 50,000 hours

conomically as well as environmentally unfeasible to human life. Improved technologies should be interfaced to reduce the cost and the emission produced from the system, which will have a significant impact on the targeted group as well as the host countries. Different techniques and pilot projects have been installed in recent years to provide access to clean energy to the targeted groups for their sustainable development pertaining to health, education, security, economic activities, etc. Solar lanterns, small-scale solar system, solar street lights, community-based distributed energy systems, and grid-connected lighting systems are some of the examples of the initiatives of the energy providing system. It is assumed that such technologies help them to light their household and residence area after dusk, and increase their effective working hours. Based on this assumption, the relief activity is focused on the product-based research and implementation of foreign products, which provide an immediate solution, but not sustainable. Similarly, such type of energy system is not techno-economically feasible for the middle-long period. Further, in an urban area the lighting system has important impacts on service mains, security issues, economic activities and promotional activities of cultural heritage and business-oriented components. The detailed impacts and role of the lighting system in socio-economic advancement of the people are explained below.

4.1. Impact of the Lighting System in Rural Nepal

A big proportion of rural Nepalese population is using the conventional source of lighting such as fossil fuel, biomass etc. which are not clean, sustainable, and techno-economically unfeasible, leaving female and children in danger [14]. Most of the developing countries including Nepal face a big challenge in education, health, security and economic activities because of those unreliable energy supply. People are forced to use conventional fuel sources to increase their active working hour per day [15]. The people now attempt to conduct their daily work activities such as cooking and other works associated with rural home, and children attempt to conduct their academic activities with the help of small kerosene lamps, solar lanterns or other proper lighting systems in the grid-connected area to provide proper lighting [15]. Fig. 1 shows the situations, where people are dependent on the fuel-based lighting technologies. Beside the difficulties to conduct the task and comfort zone for specific age group (to study for children, cooking for adult, and other basic activities for all), using conventional fuel source for lighting has various impacts on the human health, such as pneumonia, stroke, ischemic heart disease, chronic obstructive pulmonary disease (COPD), lung cancer [16]. Most of the traditional lighting lamps are responsible for

dangerous and toxic impurities in environment that are in the range of values higher than the standard of World Health Organization (WHO) guideline. It is reported that, there may be unique emissions or hazards from wicks as well from some of the lighting fuels made with lead cores and lantern mantles with radioactive thorium [17]. In the study [18], it is found that the chance of Nepalese women using kerosene to get TB was nine times greater than those using electric light. Among all age groups, female and children are in higher risk of danger, since they spend majority of their time performing in indoor activities [17]. Similarly, use traditional lighting contributes to a number of accidental events such as fire hazard for non-electric domestic appliances. It is reported that, the burns are the second most (5 % of overall disabilities) common injury in rural Nepal, where 20 % of the cases in a total of 237 burn accidents were caused from the fire hazard via traditional lamp accidents [19, 20]. These burn cases lead physical as well as financial disadvantages to the people of Nepal, since it damages the public health, houses, industries, farms etc. Sexual harassment during the night in the absence of proper lighting, cases of theft, wild animal attack, and snake bite are some major issues occurred in the rural area [13].

The government of Nepal, with the assistance of different development bodies has been working to provide electricity access, so that the people are being safe from the problems associated with the fuel-based lighting technologies. It is assumed that the under-developing strategy on lighting technology helps to improve the education, health, security, economic factors in rural communities in Nepal [21]. A study stated that, the health-related issues can be significantly reduced by replacing the fuel-based lighting system by clean renewable energy system [18]. An empirical study [22], reported the health and safety problems of 500 households associated with a fuel-based lighting system and the relief response after replacing them with the solar system. The health and injury issues of kerosene lanterns were completely eliminated with the displacement of kerosene lamp. Similarly, the implementation of renewable energy based lighting system helps to improve the education of rural area by providing the comfort as well as allowing practice of the latest methodologies of teaching via the Internet, computer, projector, printer, photocopy etc. [18]. On the other hand, the intervention of lighting

system helps to increase the economy of the rural community by increasing their daily active hours as well as by providing much-needed energy that powers local industries [23]. Further, in the presence of a proper lighting system, the rate of sexual harassment, theft, wild animal attack has been reduced significantly.

4.2. Impacts of the Lighting System in Urban Nepal

Although only 3.1 % of the urban population is unreached to the electricity supply, proper lighting plays important role in their daily life [12]. Basically, the lighting is associated with the education, safety, cultural and economic activities in urban reason. Proper lighting in the streets or squares and facilities such as restaurants, shops, hotels, monuments, etc. definitely would be liked by the tourists and should contribute to the tourism economy greatly. The total contribution of travel and tourism in gross domestic product (GDP) of Nepal was 7.8 % in 2017 with 1.02 million job creation [24]. Attractive lights at the restaurants results in increased preference to dine there, and proper lighting at monuments and heritage sites means enhanced beauty and more visitors. Similarly, proper lighting at the shops means customers have a better view of goods at the display and a better chance of buying, etc. It also helps to increase the people's activity at night increasing the efficiency and economy of people. Proper lighting at the streets or pathways and squares means increased sense of security and tendency to spend more time there, and further helps to reduce the crime significantly. Sexual harassment is one of the big risk for females, and also supposed to be disturbingly dominant in the cities around the world [25]. Figs 4 and 5 can define the positive impacts of lighting on the public lifestyle and the communities in urban Nepal.

5. CURRENT PRACTICES ON LIGHTING

As per the report [26], 43.50 % of energy was consumed by domestic, 3.11 % by non-commercial, 7.38 % by commercial, 37.53 % by industrial, 8.43 % by others and 0.05 % was exported to India in 2018. Those data show that majority of Nepalese electricity is consumed due to residential loads. As per the load data of NEA, the peak de-

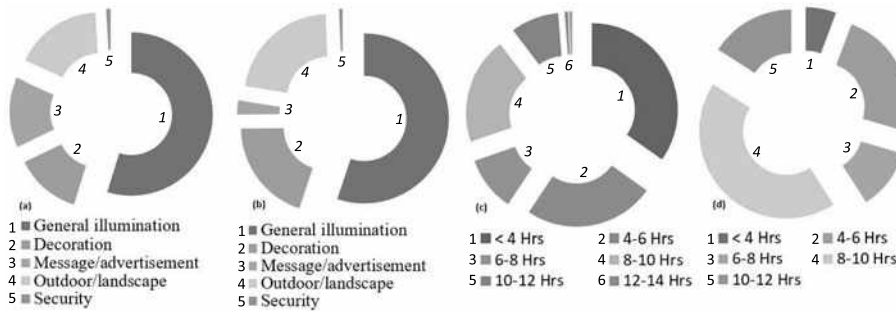


Fig. 6. Purpose of artificial lighting at workspace and residence (a, b); hours of use of artificial lighting at workspace and residence (c, d)

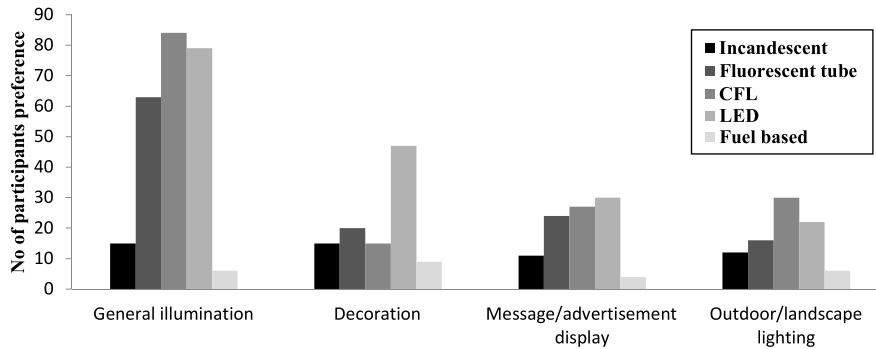


Fig. 7. Types of luminaries being used for various purposes

mand of electricity in Nepal occurred at evening hours and lighting has a major impact [26]. A study showed that about 60 % energy used in Kathmandu can be saved by using LED lamps [27]. Thus, the energy efficient lighting is considered to be preferred to maintain the demand and supply ratio. A team including the authors conducted a survey on necessity of lighting education by developing the questionnaires for different five groups: employers, university graduates, students, teachers and consumers [28]. The survey includes 250 samples (20 employers, 30 graduates, 98 students, 57 teachers and 45 consumers) from different groups. From the survey it was found that all types of participant use artificial lighting either at workspace or home for general illumination along with some other purposes depending upon their need. The digit for application of artificial lighting for workplace and residence are presented in Fig. 6 (a, b), showing the proportions of various habits of artificial lighting. The use proportion of lighting for general purpose is more than 50 % in both of the cases, and that for security and message/advertisement is very less. Similarly, the hours of use of artificial lighting at workplace and residence are depicted in Fig. 6 (c, d), presenting most of the participants are using lighting for more than 8 hours at residence, while that was less than 6 hours at workplace for general purpose lighting.

In current scenario, various types of luminaries are used in the Nepal’s market and users have their

own preferences as per the cost, purpose of use and efficiency. CFL is more dominant in the Nepal compared to incandescent lamp, fluorescent tube lamp, LED lamps or others. Fig. 7 presents the different types of luminaries being used for various purposes by the participants. For general purpose LED lamps, CFLs and fluorescent tube lamps are used in equal proportions throughout Nepal. For decoration and display, LED lamps are being used significantly high now days compared to other lamps, and for outdoor or landscape lighting CFL and LED lamps are being preferred. The major challenges in adoption of efficient lighting are found to be lack of knowledge and awareness, lack of skilled manpower, high initial cost and low quality of available product within the market. As shown in Fig. 8(a), the participants claimed that the lack of knowledge and high initial cost of efficient technologies are the main challenges in the adoption of efficient lighting technologies. During the survey, most of the participants were found to be familiar with efficient lighting technologies, where 72 % of the graduates and 97 % of teachers stated that they were aware of energy efficient lighting management. Fig. 8(b) shows that 63 % of the participants in the survey prefer LED lamps among all the luminaries available, whereas, Fig. 8(c) presents the reasons of preference of luminaries by the different participants; 25 % of participants prefer high efficiency luminaries, 28 % prefer luminaries with longer life and 21 % participants prefer luminaries of least cost.

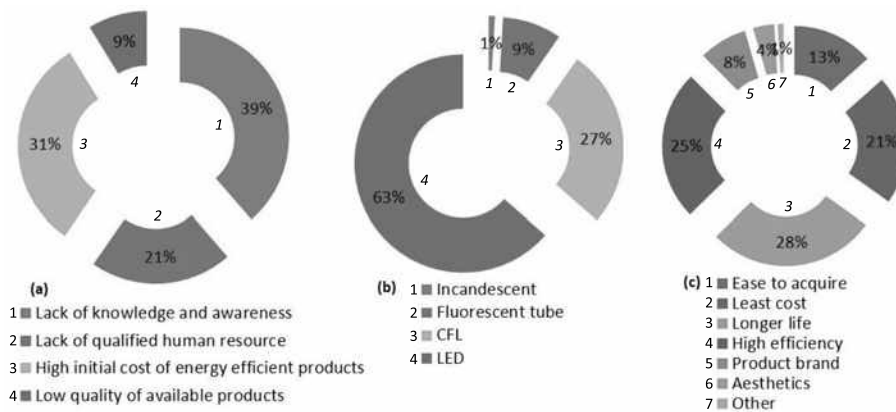


Fig. 8. Challenges of adaptation of energy efficient lighting (a), preference of luminaries for lighting (b), and reasons for preference of luminaries for lighting (c)

6. CONCLUSION

The demand of electrical power is increasing day to day and the supply requirement in most of the developing country cannot be met due to the high capital cost of generation and transmission. Lighting is one of the major loads for residential sector and contributes for the peak demand in the evening hours for most of the developing countries like Nepal. The use of energy efficient lighting would help to decrease the electrical power demand and would thus help to minimize the difference between demand and supply of electrical power. Lighting in most of the residential as well as commercial buildings use incandescent lamps, or florescent tube lamps which are less efficient compared to the today available CFLs and LEDs. Despite of several initiatives form the government, the use of inefficient lamp has not stopped. The quality of LED lamps available, high initial cost of efficient product and the lack of awareness in users are the major drawbacks.

Energy efficient lighting is concerned with the use of luminaries which consumes less energy and which has high efficiency compared to other luminaries available. These lighting maintains the lighting quality with less power consumption. Hence, the people and government are moving toward the efficient and clean lighting technologies from traditional one. The implementation of efficient and clean lighting technologies helps the people to improve their living standards.

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Status of Lighting Technologies in Nepal

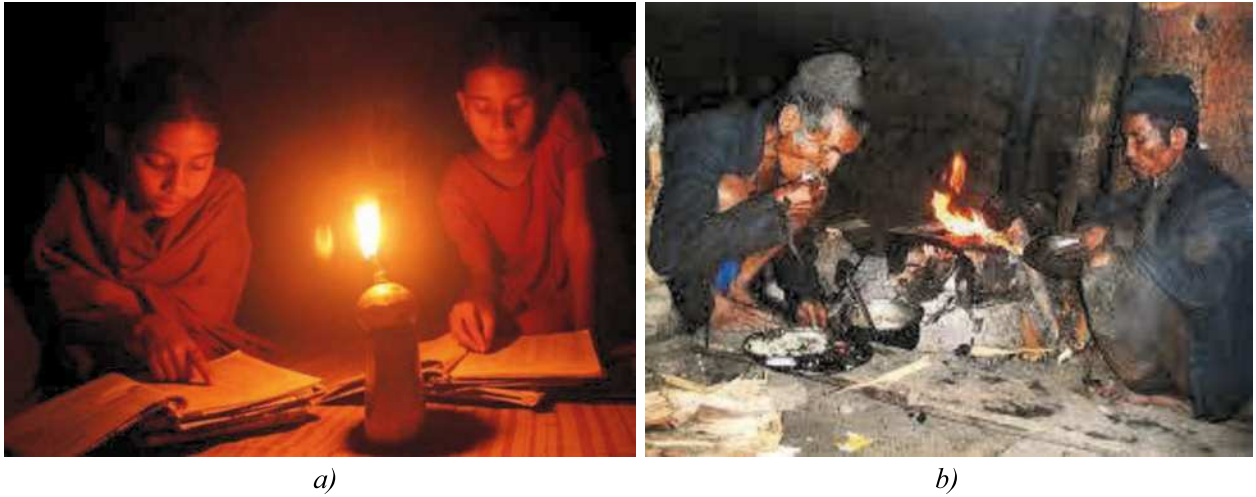


Fig.1. People using fuel-based lighting for study, cooking and other activities [5,6]



Fig. 5. Lighting system used in heritage sites of Nepal