The Journal of Economic Concerns | Vol. 13, No. 1, 2022
ISSN Print : 2091-0541 | ISSN Online : 2705-4802 | Published by NECS, NEPAL

Awareness of Household Energy Consumption and its Impact on the Environment: A case of Kathmandu Valley, Nepal

Bhintuna Vaidya[1], Keshav Raj Panthee[2], Jeeban Amgain, PhD[3]

Abstract

The purpose of this paper is to assess the situation as it currently exists and the environmental impacts of household energy consumption in Nepal's urban setting. The paper makes several recommendations for joint environmental regulation and sustainable energy consumption. The study evaluated the level of sustainable energy consumption and examined the extent and composition of household energy use in urban areas based on questionnaire survey data. The findings indicate that electricity is the primary means of lighting, and LPG is the primary means of cooking. The findings also demonstrated that only a minority of those living in the Kathmandu Valley exhibit energy conservation behaviors and are cognizant of environmental effects like climate change. The overall energy consumption in urban areas is positively influenced by both population density and income levels. It is crucial to implement appropriate measures, such as optimizing the renewable resource and enhancing energy usage efficiency through technological advancement, in order to meet the goal of emission reduction and sustainable energy consumption.

Keywords: *Energy Consumption, Environment, Kathmandu Valley, Electricity, Climate Change*

1. Introduction

Energy consumption and related carbon dioxide (CO_2) emissions are intricate issues in different countries because various factors influence energy supply, energy demand, and energy consumption on a global or local scale (Shittu, 2020). However, changes in individual behavior and management practices as part of the mitigation approach on energy consumption are often under studied (Creutzig et al., 2018; Niamir et al., 2020b). Human activities and the resulting increased emissions of greenhouse gases (GHGs) have been demonstrated to be the primary causes of global warming (Hertwich & Peters, 2009). On the global scale, as a result of consumption behavior, households are responsible for 72 percent of greenhouse gas emissions and thus, the impact of household consumption styles on the consumption of energy and carbon dioxide emissions has drawn great attention (Zhang et al., 2017). Reduced energy consumption in the residential sector is particularly important because energy demand in this sector is significantly rising (Ouyang et al., 2009; Ueno et al., 2006).

Recently, more and more researchers recognize the importance of reducing energy consumption in terms of people's energy-saving awareness and behavioral perspective (Song & Li, 2015). To reduce energy consumption, understanding the correlation between energy-saving awareness and other factors is the basis of determining the formation of individual energy-saving behaviors (Zhao et al., 2019). Existing

[1] Research Intern, Academy of Innovation for Economic Development Nepal, The British College, Kathmandu, Email: bhintunavaidya@gmail.com
[2] Research Director, Academy of Innovation for Economic Development Nepal, Email: krpanthee@gmail.com
[3] Executive Director, Academy of Innovation for Economic Development Nepal, Email: jeebanamgain@gmail.com

research has used survey data from specific cities or areas to uncover the impact of internal (demographic parameters, values, and energy knowledge) and external (social norms and policies) influence factors on energy-saving behavior. For example, Kang et al. (2012) investigated the influence of internal influencing factors (such as energy-saving awareness and knowledge) on residents' energy-saving behaviors. Energy-saving behavior is also closely related to environmental attitudes, which are related to social norms and social influences (Gadenne et al., 2011). According to Vringer et al. (2007), inability, unwillingness, and social problems were regarded as the main obstacles to individuals' energy-saving behaviors. It has been reported that even without financial incentives, group-level impacts and peer education have been reported to influence individual behavior (Carrico & Riemer, 2011).

Given the nature and scale of these ambitious low-carbon future goals, it is widely acknowledged that traditional energy-efficiency strategies will not be enough to reduce the amount of energy required, and thus changes in energy consumer behavior will be required (Stankuniene et al., 2020). Changes in behavioral patterns are being highlighted as a low-cost and quick way to assist reduce greenhouse gas (GHG) emissions (Pollitt & Shaorshadze, 2013; Poortinga et al., 2003). To combat climate change, households need to be mobilized to change their daily activities thus requiring policies that influence consumer behavior and lifestyle changes (Stankuniene et al., 2020). This much needs to be done, given the great potential and ongoing efforts to encourage energy efficiency in the residential sector. It could be likely to be attributed to the numerous challenges and market flaws that energy efficiency faces, which are exacerbated in the residential sector (Ramos et al., 2015). Households use a variety of energy sources for different purposes, and the amount of energy consumed by various household activities differs widely. As a result, households are viewed as a key target group capable of reducing energy use and mitigating a variety of sustainability challenges through energy-saving behavior.

In the context of Nepal, these kinds of research have not been prioritized regarding the energy-saving attributes and level of energy-awareness in general people. The purpose of this study is to explore the pattern of energy consumption behavior awareness and environmental impact to highlight the strengths and weaknesses of energy efficiency in the context of the urban sustainability of Kathmandu valley. Therefore, this study will help to guide and motivate people for adopting energy-saving behaviors to better understand how one may overcome the energy efficiency gap and help to improve the energy performance of urban households. This paper is relevant to policymakers, professionals, and academics working to promote energy efficiency in the urban households of developing countries.

2. Literature Review

The studies based on household energy consumption and environmental effects have provided some crucial findings. Global residential energy consumption increased by 14 Percent between 2000 and 2011, with the majority of this rise occurring in developing countries, where population, urbanization, and economic expansion were the main driving factors (Liu et al., 2021). Economic growth, rising living standards, and shifting consumer views may cause household energy usage to diverge (Chun-sheng et al., 2012). As a result, conducting energy-saving and emission-reduction activities in all aspects of life is critical. Several pollutants produced by household energy use are hazardous, especially to women and children in rural places (Jin et al., 2006).

Sanquist et al. (2012) conducted a statistical analysis of the correlation between energy consumption and lifestyle characteristics and concluded that lifestyle factors account for 40 percent of energy consumption variation. Energy awareness is the perception of how much energy is consumed. Consumers need to minimize their energy use, but many are unsure how to do without the essential knowledge. On the other side, the more rational people are, the more motivated they are with adopting energy-saving strategies. The first step toward adopting energy-saving behaviors is for consumers to be aware of the issue (A Rahman et al., 2016). Despite having sufficient knowledge of how to save energy and a stated willingness to do so, many consumers fail to take significant measures toward energy conservation.

Energy conservation awareness requires a positive attitude and human behavior on the part of the residents of the household (Abdul Majid et al., 2015). It seems reasonable to presume that raising consumer awareness of their energy usage will have an impact on their consumption habits. According to a study conducted in Nigeria, the focus was on determining the elements that influence energy efficiency in pre-determined housing samples. According to the study's findings, there is a clear link between people's attitudes and behaviors when it comes to energy use in their homes (A Rahman et al., 2016).

According to a study of 612 families in Wyoming, the United States, attitudes toward environmental issues are linked to decreased energy usage, implying that environmentally conscious families are more energy conservative (Jaeger et al., 2009). To some extent, progress has been made in changing behavior, and research has shown that behavior can be changed with the appropriate measures (e.g., individual consulting, commitment strategies, social norms-based campaigns, etc.) applied at the right time (e.g., windows of opportunity where habits can be broken) (Baca-Motes et al., 2013; Burger et al., 2015; Schäfer et al., 2012). Through a study of socio-demographic characteristics, educated families are more active in increasing their energy efficiency, highlighting the relevance of education in household energy-related decisions, notably in energy investments and converting to green energy sources that indicate a higher level of education enables more insight, knowledge, and awareness of the environment, which all consequently affect personal norms and lead to behavior change (Niamir et al., 2020a).

In the context of Nepal, households consume approximately 87 percent of total final energy, as per the study, and household energy use is heterogeneous across regions, with biomass for cooking dominating the country's energy mix, resulting in lower CO_2 emissions but continuing to rise local indoor pollutant emissions in the future (Malla, 2013).

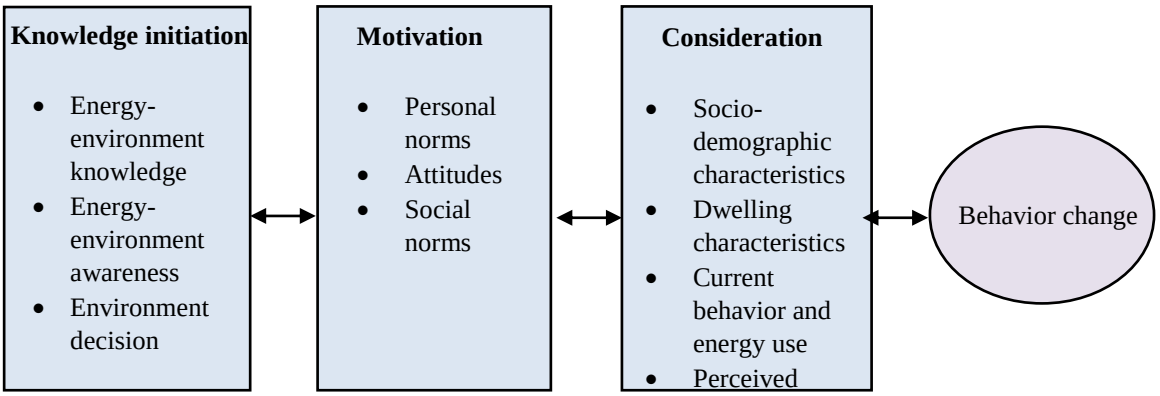
Due to increased urbanization, Kathmandu Valley is one of the fastest-growing metropolitan centers in South Asia, needing more facilities and infrastructure (Junun et al., 2017). Air pollution has become a serious environmental concern in the Kathmandu Valley in recent years. The amounts of particulate matter in the Valley are found to exceed the National Ambient Air Quality Standards (NAAQS) as recorded by Valley's permanent air quality monitoring stations (Shrestha & Rajbhandari, 2010). Energy policy has a key role to play in reducing energy use. Many countries have used various energy strategies, such as building energy codes, incentives, and energy labeling (Liu et al., 2021). Therefore, consumption behavior should be monitored, and awareness should be generated among the household residents for sustainable energy consumption.

3. Methodology

3.1 Conceptual Framework of the Study

Figure 1 illustrates the conceptual framework that represents household energy behavioral change in different stages Individual behavior change can be triggered by increased knowledge and awareness (Niamir et al., 2020a). If individuals have enough knowledge and awareness about climate, environmental, and energy issues, a feeling of guilt may develop and initiate motivational factors, which may lead to energy-related behavior change. Motivation is developed by personal and social norms (Bamberg et al., 2007; Steg & Vlek, 2009), which can lead to a feeling of responsibility to changing one's behavior. Individuals perform a formal feasibility assessment based on their income, living situations, and perceived behavioral control when their intentions for the latter are high. Individuals compare their present energy-use behaviors to alternatives, and if things can be done better, the motivation to explore an alternative increases, eventually leading to a behavior change.

Figure 1: Conceptual framework of household behavioural change



3.2 Data Collection

Primary data collection was done using a questionnaire survey. The sample size was determined (Table-1) using the following equation (Metcalfe, 2001), write as.

$$n=\frac{\frac{z^2*p(1-p)}{e^2}}{1+\frac{z^2*p(1-p)}{e^2N}}$$

Where n is the sample size, N is the total population size, p is the population proportion (50 percent), z is the z-score (1.96), and e is the margin of error (9.5 percent is taken in this study).

Table 1: Sample Size Calculation

Total households in Kathmandu Valley	Sample size (95% confidence level)
436,355	107

3.3 Description of the Case Study

The study was conducted in Kathmandu Valley. This valley is Nepal's largest and most populous urban agglomeration, encompassing considerable areas of three districts: Kathmandu, Lalitpur, and Bhaktapur, which account for 85 percent, 50 percent, and 100 percent of each district's land area, respectively. Out of the sampled 107 households, 55 households were taken from Kathmandu, 34 from Lalitpur and 18 from Bhaktapur.

Sample Distribution by age and Gender

Table 2: Sample Distribution by Age and Gender

Age	Male	Female
15-25	25	34
25--35	6	11
35-45	5	5
45-55	9	3
>= 55	5	4
Total	**50**	**57**

Out of the sampled household, 55 household were taken from Kathmandu, 34 from Lalitpur and 18 from Bhaktapur. From the Table 2, it can be seen that among them, the age group was separated into 5 groups, with a total of 57 female respondents and 50 male respondents.

A semi-structured questionnaire survey was conducted to acquire data from the householders from different age groups for the observation of their energy consumption. A questionnaire survey was conducted using Google Forms, a survey administration free web-based tool provided by Google. Similarly, the respondents were selected using convenient sampling.

4. Results

4.1 Socio-demographic Characteristics

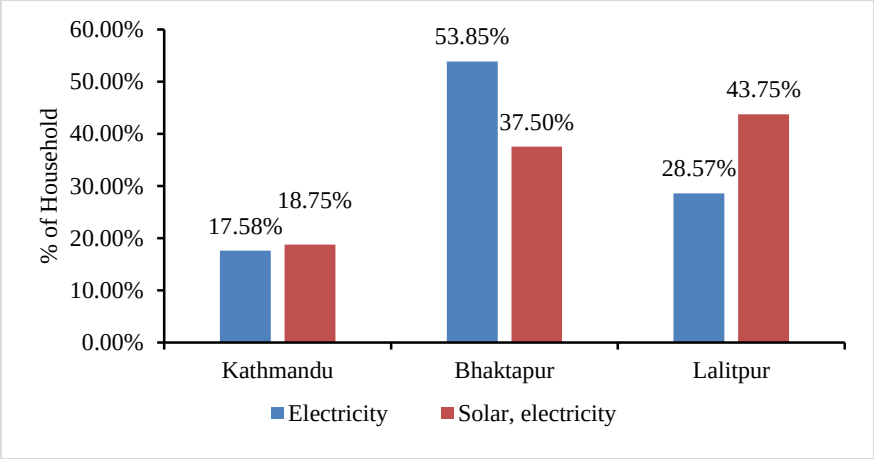
The survey presents the description of respondents' basic information which included gender, education, employment, age, and location. According to the survey, 53.2 percent were female householders while 46.8 percent of them were male householders. On an average, a family size of 2-5 residents were found in majority (71 percent).

4.2 Energy Consumption, Behavior, and Sources

Source of Lighting

The main source for lighting was found to be electricity in the Kathmandu Valley as shown in Figure 2. The pattern of electricity demand could be influenced by various factors varying from income, family size, house built up and so on (Rajbhandhari et al., 2019). Figure 3 demonstrates that Bhaktapur had the lowest solar and electrical use (37.50 percent), whereas Lalitpur had the greatest (43.75 percent). It can be seen that solar panel usage has increased in Kathmandu and Lalitpur as well, however Bhaktapur area solar lighting implementation might be enhanced to further implement sustainable lighting use.

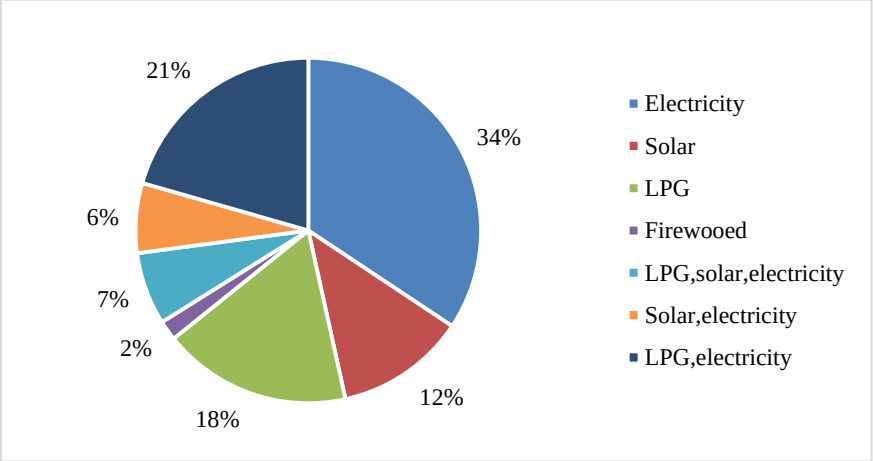
Figure 2: Use of Energy Lighting



Source of Energy for Heating Water

It can be demonstrated that the most common energy source used to heat water is electricity (Figure 3). In contrast to firewood, which is used the least because most Nepalese households have access to electricity, solar energy and LPG usage are higher in the valley.

Figure 3: Source of energy for heating water

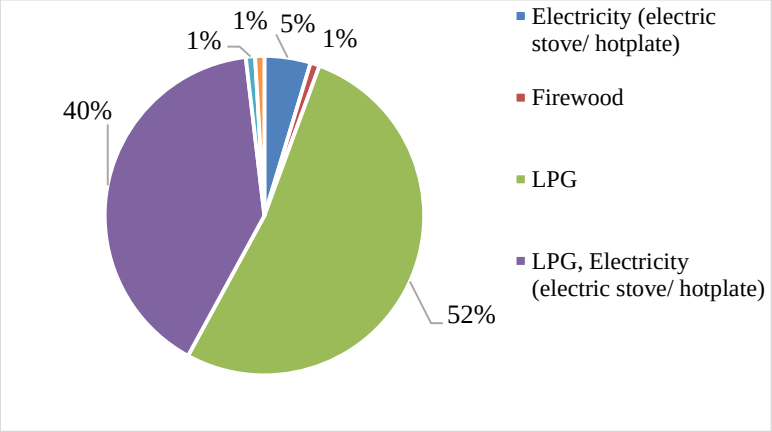


Source of Energy for Cooking

The main source for cooking was found to be LPG source according to the survey which is shown in Fig. 4. Regarding electricity, per-unit costs in Nepal are higher than in many other South Asian countries (Sigdel, 2007), which discourages households from adopting it for cooking uses. Some have noted that electricity is actually a cheaper cooking fuel than LPG (Paudel et al., 2020), but that its supply is unreliable and that households perceive it to be higher in cost. Female household members are mostly responsible for cooking-energy usage in developing countries. They play an important role in collecting and choosing fuels at low-income levels. Education among household members also has a positive link

with the household's willingness to choose clean and efficient energy fuels (Paudel et al., 2020). With more education among household members, there are better employment opportunities, improved economic statuses of families and awareness about clean-cooking fuel that assist them in upgrading to cleaner and healthier methods of energy usage.

Figure 4: Source of Energy for Cooking



4.3 Energy Consumption Behaviors

As shown in Table 3, a list of energy-saving behaviors was given in the survey to gauge respondents' agreement with these sustainable practices and whether they have adopted them into daily life or not. While most of the respondents only use often, it can be noted that the majority of them have already been putting these sustainable steps into practice. Although the majority of respondents have adopted these practices, there are still many household members who need to be aware of these practices in order for everyone to implement them in the future for the sustainable energy environment.

Table 3: Use of Energy Saving Behaviours

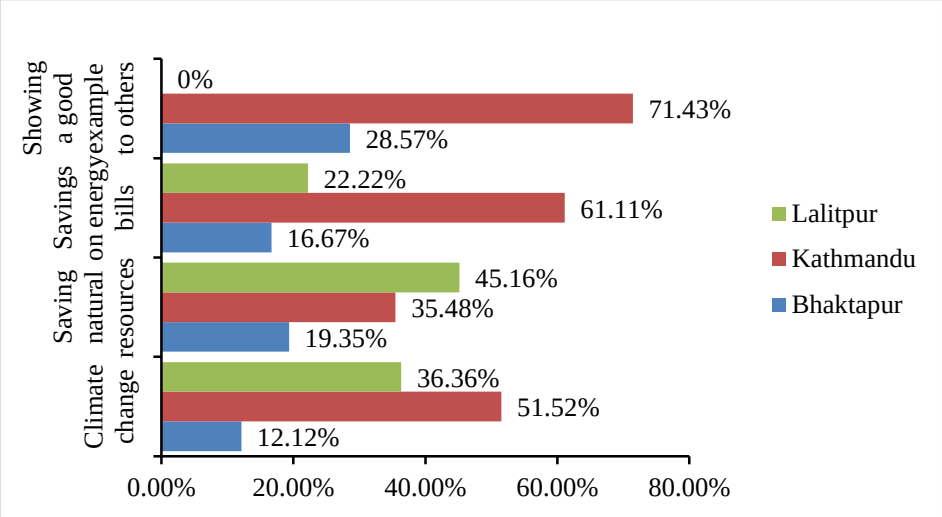
Use of energy saving behaviors	**Percentage of respondents**			
	Always	**Never**	**Often**	**Rarely**
Turning appliances off when not using	57.94	1.87	29.91	10.28
Using energy saving light bulbs	37.38	4.67	53.27	4.67
Reduce heating in unoccupied rooms	70.09	6.54	16.82	6.54
Switching off lights in unused rooms	57.01	0.93	33.64	8.41
Wait for a full load before using washing machine	94.39	2.80	1.87	0.93
Taking shorter showers	15.89	21.50	31.78	30.84
Replacing old appliances with energy efficient ones	18.69	4.67	40.19	36.45
Use warm clothing or blankets instead of an electric heater	43.93	9.35	36.45	10.28
Close windows and doors when a heater is on	38.32	21.50	27.10	13.08
Install a solar water instead of an electric heater	39.25	24.30	20.56	15.89
Average	47.29	9.81	29.16	13.74

As shown in Table 4, similar questions were designed to respondents regarding their willingness to adopt energy-related changes in their daily lives. Most of them, it has been revealed, have already made lifestyle adjustments like switching to energy-efficient light bulbs, and they may even be considering how to adjust these changes appropriately. The majority of respondents (39.25) indicated that they "Would possibly consider" demonstrating the respondents' willingness to put these sustainable ideas into action.

Table 4: Consideration on Energy Related Changes

How likely you would consider the following energy related changes.	Percentage of respondents				
	Already done	Never	Unlikely to do	Would actively consider	Would possibly consider
Installing energy-saving light bulbs	36.45	-	4.67	25.23	33.64
Buying an energy-efficient refrigerator	14.95	4.67	7.48	32.71	40.19
Changing to more efficient water heating system	14.95	3.74	4.67	36.45	40.19
Install solar photovoltaic	12.15	5.61	9.35	29.91	42.99
Average	19.63	4.67	6.54	31.07	39.25

Figure 5: Motivational Factors to Reduce Energy Consumption



From Figure 5, it can be observed that majority of respondents from Kathmandu (71.43 percent) and Bhaktapur (28.57) have selected “Showing good example to others” whereas respondents from Lalitpur (45.16 percent) have selected “Saving natural resources”. It is clear from the survey results that respondents are fully aware of environmental challenges like climate change, which must be addressed now as well as in the future. Additionally, another source of motivation for respondents is economic, such as saving on energy bills. Therefore, these motivating factors can thus be connected to the social, economic, and environmental aspects.

Figure 6: Energy Source Choice (Renewables or Fossil Fuels) Has an Impact on the Environment

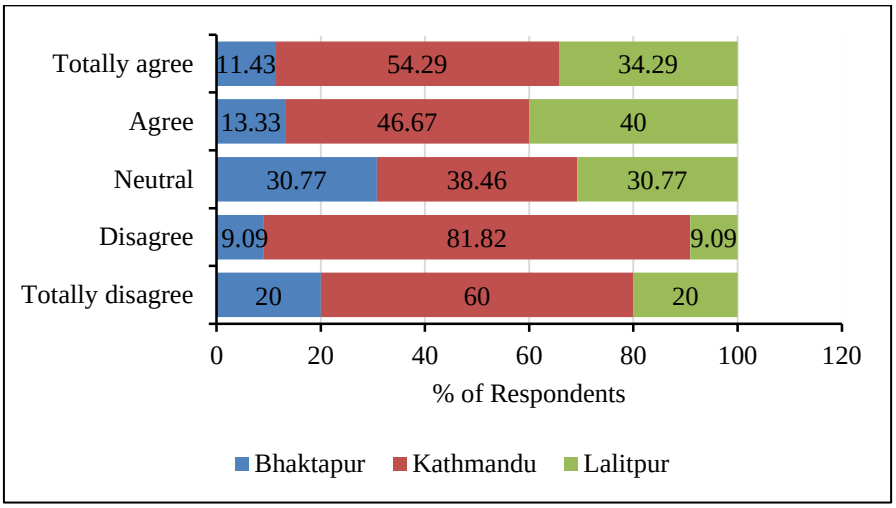
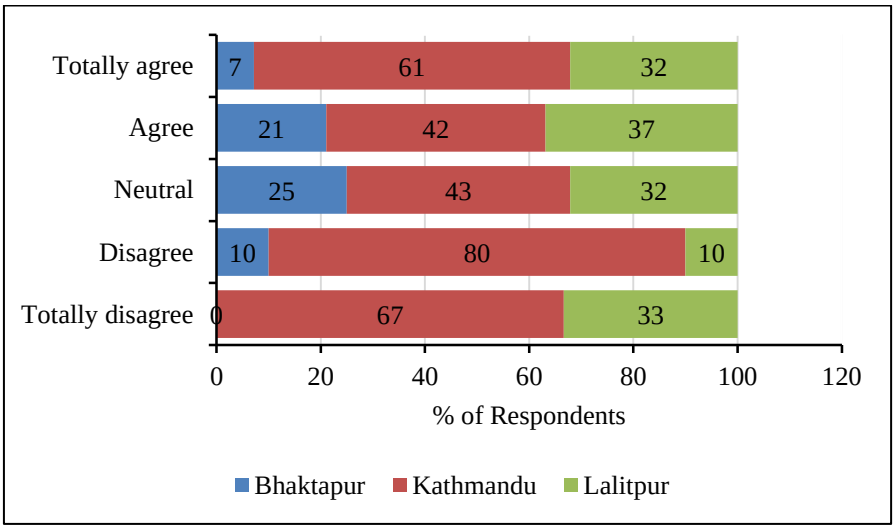
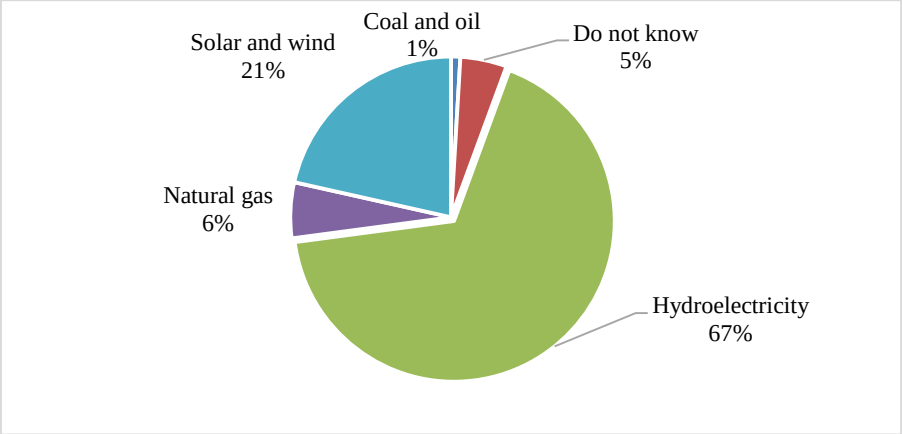


Figure 7: Avoiding Fossil Fuels Use Will Help Solve Wider Environmental Issues



From the above Figure 6 and Figure 7, it can be observed that respondents from Lalitpur are more inclined towards the agreement whereas respondents from Bhaktapur have neutral perspective. Similarly, most of the respondents from Kathmandu have shown the disagreement. It is clear that a dispersed viewpoint should be considered in order to inform and educate people about the potential environmental effects of their regular, everyday energy-related behaviors.

Figure 8: Priority for Future Energy Demand



From the Figure 8, it can be observed that majority of the respondents has prioritized hydroelectricity (67 percent) followed by solar and wind (21 percent). The highest hydroelectricity potential is in Nepal, hence the demand for a sustainable energy environment can be directly correlated with energy use. Different technology and additional research may improve and encourage better energy usage across the spectrum in Nepal's domestic sector.

5. Conclusion

This study depicts that only a small portion of the population in the Kathmandu Valley engages in behaviors that are associated with energy conservation. Similarly, the results show that LPG was the main fuel for cooking, and electricity was the main source of lighting. Additionally, it is evident that household energy use, population, and income are all interconnected. As population and income increase, urban centers such as Kathmandu Valley use more electricity and other energy resources. Additionally, increasingly people in rural areas are moving into towns and cities as urbanization progresses rapidly, which will increase the demand for energy consumption. In contrast to posing additional challenges for consumers, the rising cost of energy makes it challenging to preserve environmental equilibrium.

Future efforts should focus on the development of solar, hydro, and alternative energy resources, as well as the processing and conversion of bio-fuels, in order to reduce emissions to the desired level. In order to have a positive impact on environmental consequences in the urban context, awareness campaigns concerning energy-saving behavior and sustainable energy usage should be conducted and incorporated into the educational curriculum as well. Therefore, this study will help individuals to get idea about how to bridge the energy efficiency gap and contribute to improving the energy efficiency of urban households by educating and motivating them to adopt energy-saving practices. Hence, this paper could be relevant to those working in government, business, and academia to improve energy consumption in urban households in developing nations.

References

A Rahman, K., Leman, A., Yusof, M. Z. M., & Salleh, M. M. N. (2016). Consumer awareness in energy efficiency for residential houses in peninsular Malaysia. *MATEC Web of Conferences, 78*, 01010. https://doi.org/10.1051/matecconf/20167801010.

Abdul Majid, N., Salehudin, M., Abdul Rahim, Z., & Othman, R. (2015). Indoor environmental regulation hrough preference and behaviour of inhabitants in houses. *Procedia - Social and Behavioral Sciences, 170*, 527–536. https://doi.org/10.1016/j.sbspro.2015.01.054.

Baca-Motes, K., Brown, A., Gneezy, A., Keenan, E. A., & Nelson, L. D. (2013). Commitment and behavior change: evidence from the field. *Journal of Consumer Research*, *39*(5), 1070–1084. https://doi.org/10.1086/667226.

Bamberg, S., Hunecke, M., & Blöbaum, A. (2007). Social context, personal norms and the use of public transportation: Two field studies. *Journal of Environmental Psychology, 27*(3), 190–203. https://doi.org/10.1016/j.jenvp.2007.04.001.

Burger, P., Bezençon, V., Bornemann, B., Brosch, T., Carabias-Hütter, V., Farsi, M., Hille, S. L., Moser, C., Ramseier, C., Samuel, R., Sander, D., Schmidt, S., Sohre, A., & Volland, B. (2015). Advances in understanding energy consumption behavior and the governance of its change – outline of an integrated framework. *Frontiers in Energy Research*, 3. https://doi.org/10.3389/fenrg.2015.00029.

Carrico, A. R., & Riemer, M. (2011). Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education. *Journal of Environmental Psychology, 31*(1), 1–13. https://doi.org/10.1016/j.jenvp.2010.11.004.

Chun-sheng, Z., Shu-wen, N., & Xin, Z. (2012). Effects of household energy consumption on environment and its influence factors in rural and urban areas. *Energy Procedia, 14*, 805–811. https://doi.org/10.1016/j.egypro.2011.12.1015.

Creutzig, F., Roy, J., Lamb, W., Azevedo, I., Bruine de Bruin, W., Dalkmann, H., Edelenbosch, O., Geels, F., Grubler, A., Hepburn, C., Hertwich, E., Khosla, R., Mattauch, L., Minx, J., Ramakrishnan, A., Rao, N., Steinberger, J., Tavoni, M., Ürge-Vorsatz, D., & Weber, E. (2018). Towards demand-side solutions for mitigating climate change. *Nature Climate Change, 8*, 268–271. https://doi.org/10.1038/s41558-018-0121-1.

Gadenne, D., Sharma, B., Kerr, D., & Smith, T. (2011). The influence of consumers' environmental beliefs and attitudes on energy saving behaviours. *Energy Policy, 39*(12), 7684–7694. https://doi.org/10.1016/j.enpol.2011.09.002.

Hertwich, E., & Peters, G. (2009). Carbon footprint of nations: A global, trade-linked analysis. *Environmental Science & Technology, 43*, 6414–6420. https://doi.org/10.1021/es803496a.

Jaeger, M., Luitjens, S. B., Mihajlović, V., Snijde, F., Tsoneva, T., Weda, H., & Weffers, A. (2009). *Raising awareness on energy consumption of household devices.*

Jin, Y., Ma, X., Chen, X., Cheng, Y., Baris, E., & Ezzati, M. (2006). Exposure to indoor air pollution from household energy use in rural China: The interactions of technology, behavior, and knowledge in health risk management. *Social Science & Medicine, 62*(12), 3161–3176.

Junun, S., Ridwan, K., & Hizbaron, D. (2017). Urban Energy Scenario: The case of kathmandu valley. *Journal of Engineering and Technological Sciences, 49*, 210–224. https://doi.org/10.5614/.

Kang, N. N., Cho, S. H., & Kim, J. T. (2012). The energy-saving effects of apartment residents' awareness and behavior. *Energy and Buildings, 46*, 112–122. https://doi.org/10.1016/.

Liu, M., Huang, X., Chen, Z., Zhang, L., Qin, Y., Liu, L., Zhang, S., Zhang, M., Lv, X., & Zhang, Y. (2021). The transmission mechanism of household lifestyle to energy consumption from the input-output subsystem perspective: China as an example. *Ecological Indicators*, *122*, 107234. https://doi.org/10.1016/j.ecolind.2020.107234.

Malla, S. (2013). Household energy consumption patterns and its environmental implications: Assessment of energy access and poverty in Nepal. *Energy Policy*, *61*, 990–1002. https://doi.org/10.1016/j.enpol.2013.06.023.

Metcalfe, C. (2001). Biostatistics: A foundation for analysis in the health sciences. 7th edn. Wayne W. Daniel, Wiley, 1999. No. of. pages: xiv+755+appendices. Price: £28.95. ISBN 0-471-16386-4. *Statistics in Medicine*, *20*(2), 324–326. https://doi.org/10.

Niamir, L., Ivanova, O., Filatova, T., Voinov, A., & Bressers, H. (2020a). Demand-side solutions for climate mitigation: Bottom-up drivers of household energy behavior change in the Netherlands and Spain. *Energy Research & Social Science*, *62*, 101356. https://doi.org/10.1016/.

Niamir, L., Kiesewetter, G., Wagner, F., Schöpp, W., Filatova, T., Voinov, A., & Bressers, H. (2020b). Assessing the macroeconomic impacts of individual behavioral changes on carbon emissions. *Climatic Change*, *158*(2), 141–160. https://doi.org/10.1007/s10584-019-02566-8.

Ouyang, J., Gao, L., Yan, Y., Hokao, K., & Ge, J. (2009). Effects of improved consumer behavior on energy conservation in the urban residential sector of Hangzhou, China. *Journal of Asian Architecture and Building Engineering - J ASIAN ARCHIT BUILD ENG*, *8*, 243–249. https://doi.org/10.3130/jaabe.8.243.

Paudel, D., Jeuland, M., & Lohani, S. (2020). Cooking-energy transition in Nepal: Trend review. *Clean Energy*, *5*. https://doi.org/10.1093/ce/zkaa022.

Pollitt, M., & Shaorshadze, I. (2013). *The role of behavioural economics in energy and climate policy* (pp. 523–546) [Chapters]. Edward Elgar publishing. https://econpapers.repec.org.

Poortinga, W., Steg, L., Vlek, C., & Wiersma, G. (2003). Household preferences for energy-saving measures: A conjoint analysis. *Journal of Economic Psychology*, *24*(1), 49–64. https://doi.org/10.1016/S0167-4870(02)00154-X.

Rajbhandhari, U. S., Poudel, L., & Bhattarai, N. (2019). Demand characteristics of electricity in residential sector of Kathmandu valley. *Journal of the Institute of Engineering*, *15*(3), 275–284. https://doi.org/10.3126/jie.v15i3.32196.

Ramos, A., Gago, A., Labandeira, X., & Linares, P. (2015). The role of information for energy efficiency in the residential sector. *Energy Economics*, *52*, S17–S29. https://doi.org/10.1016/j.eneco.

Sanquist, T., Orr, H., Bin, S., & Bittner, A. (2012). Lifestyle factors in U.S. residential electricity consumption. Energy Policy - *ENERG POLICY*, *42*. https://doi.org/10.1016/j.enpol.2011.11.092.

Schäfer, M., Jaeger-Erben, M., & Bamberg, S. (2012). Life events as windows of opportunity for changing towards sustainable consumption patterns? *Journal of Consumer Policy*, *35*, 65–84. https://doi.org/10.1007/s10603-011-9181-6.

Shittu, O. (2020). Emerging sustainability concerns and policy implications of urban household consumption: A systematic literature review. *Journal of Cleaner Production*, *246*, 119034. https://doi.org/10.1016/j.jclepro.2019.119034.

Shrestha, R., & Rajbhandari, S. (2010). Energy and environmental implications of carbon emission reduction targets: Case of Kathmandu valley, Nepal. *Energy Policy*, *38*, 4818–4827. https://doi.org/10.1016/j.enpol.2009.11.088.

Sigdel, B. (2007). Growing energy demand in India: Nepal's hydro-power export potentialities. *Socio-Economic Development Panorama, 1*(1), 91–105.

Song, Q., & Li, J. (2015). Greenhouse gas emissions from the usage of typical e-products by households: A case study of China. *Climatic Change, 132*(4), 615–629. https://doi.org/10.1007/s10584-015-1449-4.

Stankuniene, G., Streimikiene, D., & Kyriakopoulos, G. (2020). Systematic literature review on behavioral barriers of climate change mitigation in households. *Sustainability, 12*, 7369. https://doi.org/10.3390/su12187369.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29*(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004.

Ueno, T., Sano, F., Saeki, O., & Tsuji, K. (2006). Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data. *Applied Energy, 83*, 166–183. https://doi.org/10.1016/j.apenergy.2005.02.002.

Vringer, K., Aalbers, T., & Blok, K. (2007). Household energy requirement and value patterns. *Energy Policy, 35*(1), 553–566. https://doi.org/10.1016/j.enpol.2005.12.025.

Zhang, Y.-J., Bian, X.-J., Tan, W., & Song, J. (2017). The indirect energy consumption and CO2 emission caused by household consumption in China: An analysis based on the input–output method. *Journal of Cleaner Production, 163*, 69–83. https://doi.org/10.1016/j.jclepro.

Zhao, S., Song, Q., & Wang, C. (2019). Characterizing the energy-saving behaviors, attitudes and awareness of University students in Macau. *Sustainability, 11*, 6341. https://doi.org/10.3390/su11226341.