TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

MSC IN ENERGY FOR SUSTAINABLE SOCIAL DEVELOPMENT

CENTRAL CAMPUS

**A Proposal on**

**Response to Urban Energy Crisis: Potential of Residential Sector**

(A Case of Kathmandu)

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**Introduction:**

Energy crisis is defined as an energy crisis is any great bottleneck (or price rise) in the supply of energy resources to an economy. In popular literature though, it often refers to one of the energy sources used at a certain time and place, particularly those that supply national electricity grids or serve as fuel for vehicles (Wikipedia). The problem of energy crisis has persisted throughout the ages and into the twenty first century as well. Nepal is also facing the energy crisis. The situation seems to worsen as the country is reeling under a severe power shortage with the winter season setting in, and fuel supplies from India sharply cut due to the embargo. There are many global initiatives that are working towards resolving the energy crisis. Regulation and restriction on carbon emissions, the promotion of greener manufacturing and construction projects, the funding of research into hybrid technologies and more sustainable technologies are some of the majors taken at a global level (Rinkesh). There are many possible solutions to the problem but are not being majorly adopted. Moving towards more renewable resources, using more energy efficient products, lighting controls, performing energy audits and having a common stand in response to energy crisis by different corners of world are some of the solutions.

There are various causes of energy crisis. Overconsumption, overpopulation, wastage of energy, improper consumption pattern, and unexplored renewable energy options etc. Overpopulation is caused by urbanization. Urbanization is growing at a speedy rate in all over the world especially in the developing countries. The pattern of energy use in the urban areas also accounts to further deteriorate the situation. As per the data collected the urban population of Nepal accounts for 17% of total population of Nepal and has the rate of urbanization of 3.62%. Kathmandu Valley has 9% of total population of Nepal and has the rate of urbanization as 4.35% (Utsav Shree Rajbhandari, Amrit Man Nakarmi, 2014). Long lines on the road for getting petroleum products, queue for getting LPG gas and load-shedding are some of the overlook of the energy crisis inside the valley. The acute energy crisis faced by the nation is destroying its economical as well as social development. Kathmandu Valley being fastest growing urban areas in the South Asia gives the hint that it will be in the irreversible state of energy crisis in near future if any actions are not been taken now.

Potential generally refers to a currently unrealized ability. The term is used in a wide variety of fields, from [physics](https://en.wikipedia.org/wiki/Physics) to the [social sciences](https://en.wikipedia.org/wiki/Social_sciences) to indicate things that are in a state where they are able to change in ways ranging from the simple release of energy by objects to the realization of abilities in people (Wikipedia, The Free Encyclopaedia, 2016). Nepal has a potential in using renewable source of energy. It has a capacity of Hydro-power and Solar-powers. But the utilization of energy varies with the different sectors such as residential, commercial, industrial, transport, agriculture etc but the share of residential sector in the consumption of energy is the highest i.e. 81.9% (Energy Sector Synopsis Report, 2010). Hence, the potential of residential sector should be explored.

Residential sector can be broadly divided into two groups that are rural and urban. The share of fuel consumption in overall residential sector has fuel-wood topping its chart i.e. 86.5% but the pattern of energy uses is different in the urban areas. According to WECS, 2010, the total energy consumption in the urban residential sector is 47.7 million GJ energy. The urban energy consumption accounts to 14.5% of the total residential energy consumption due to its different pattern of energy use. About 52% of the urban energy is used for cooking purpose followed by electric appliance (14%), Lighting (13%), heating and cooling (10%), animal feeding (8%) and agricultural processing (3%) (Energy Sector Synopsis Report, 2010). The per capita energy consumption of Nepal is only about 15 GJ, out of which 14 GJ is for consumptive and only 1 GJ for productive purposes. It is the lowest in South Asia. (Renewable Energy, Energy Mix and Energy Security in Nepal). Private households account for 43.4 % of national electricity consumption. The average daily household consumption is about 2 kWh(Nepal Energy Situation).

The depletion of non-renewable fuels and the awareness of its negative impact on the environment have led to the keen interest of energy efficiency. There can be various ways in energy efficiency that can be explored on residential level. The response of energy crisis in terms of residential sector has two folds: the reduction of energy consumption and the production of energy. These include passive solar design, high efficiency lighting and appliances, highly efficient ventilation and cooling systems, solar water heaters, insulation materials and techniques, high-reflectivity building materials and multiple glazing. Literature suggests that up to 20 % of energy savings can be achieved through different measures targeting consumer behavior (Achieving energy efficiency through behaviour change: what does it take?, 2013). Occupant behaviour, culture and consumer choice and use of technologies are also major determinants of energy use in buildings. Furthermore, the energy production from solar, wind, biogas etc should be discovered in context to Kathmandu valley in terms of cost-effectivety and feasibility. Thus, the behavioral pattern of the people on reduction of energy consumption and exploring the feasible way of producing energy from renewable sources has to be taken into account so as to see the whole scenario from bird’s eye and have a broad knowledge on how these potentials can be accessed in an appropriate manner.

**Need of research:**

Residential sector is one of the major contributors in the energy consumption amongst all sectors. It consumes the highest level of energy i.e. 81.9% of the total energy% (Energy Sector Synopsis Report, 2010). Furthermore, 97 percent of new buildings are residential houses in the Kathmandu Valley (Thapa, 2015). This reveals that the energy consumption is going to be towering even more in the future to come. But what worsens the situation is that Nepal, even for its daily survival, is completely dependent on India and other countries. However, the level of frustration that can be witnessed in the urban areas is not evident in rural areas because people there maintain a stock of food and are self-dependent on fuel, ie, fuel wood (Adhikari, 2015). So the crisis is in a worse state in urban area. Despite this fact, there is a limited amount of research carried out to seek what could be the response of urban energy crisis from the residential sector level.

Different research has been carried out for exploring the potential of the residential sector in reducing the energy consumption as well as producing the energy from residential level but not in respect to cost-effective aspect as well as feasibility aspect. By using passive design strategies, use of available resources and technology, and renewable energy in the housing units of Kathmandu, it was discovered that a total reduction of 78% in the HVAC and 35% in the lighting is possible (Subedi, 2010). Also, Literature suggests that up to 20 % of energy savings can be achieved through different measures targeting consumer behavior. (Achieving energy efficiency through behaviour change: what does it take?, 2013)

Nevertheless, the prevailing studies only addresses the potentials of residential sector as in overall but very less concern is shown for study of the potential of residential sector in curtailing the energy demand in terms of cost-effectiveness and producing energy which are feasible. The current research addresses the gap and hence this validates the need of the research.

**Importance of the research:**

In 2011, about 23% of global final energy consumption was used in the residential sector. Total residential energy consumption increased 35%. As a result of increases in final energy consumption and changes to the energy mix, global residential carbon dioxide (CO2) emissions2 increased between 1995 and2011 by 27% to reach approximately 5 gigatonnes of CO2 (GtCO2). (Energy Efficiency Indicators: Essentials for Policy Making, 2014). This research will thus help to be inclined towards the use of renewable energy and thus bridging the amount of pollution on the environment.

Energy efficiency policies such as building codes or standards have not been effective in the residential sector, which is actually increasing its energy use and also creating pollution. This research will address the pattern of energy use in residence, the probable cost-effective and feasible ways to shift to renewable energy and the reduction of energy consumption by changing behavioral pattern and these issues requires specific policy instruments and strategies. Therefore, this research will enable the policy makers to formulate the policies which can strengthen the energy efficiency.

This research can help the nation overcome the dependency it has on the southern neighbor for fulfillment of its fuel demands. Controlling the energy demand with changing consumption behavioral pattern, energy auditing, proper implementation of building codes and policies can give a relief and also the energy production at local level for fulfilling the energy requirement can help foster energy efficiency and hence thereby enabling the nation stand on its own. This research will help realize the potential of residential sector in promoting the overall social and economic development.

**Problem Statement:**

Increasing energy demand and inability of fulfilling the demand with equivalent energy supply is the problem which has the top priority. Kathmandu valley has the rate of urbanization of 4.35% (Central Bureau of Statistics (CBS) 2012, 2012) and this can conclude that the energy demand is going to take a heap in the very short span of time. In 2008, the energy demand increased by about 10.76% and will continue to increase in the future by approximately about ten times of the current demand (Shrestha, 2010). The energy dependency on the non-renewable resources is evident. Residence of urban areas uses LPG gas, wood and kerosene as their major energy for cooking. And, for other purposes like heating, lighting, they use electricity as their major energy.

In the context of Nepal, dependency on fulfilling the energy requirement on its neighbor’s countries is the second major problem. 2.5 million People living in the Capital are going through the problems due to the shortage of fuel and cooking gas and the load shedding. On top of that, the black marketing of fuels has supplemented the burden of the people. There are various problems faced by people of residential sector in real life in context of Kathmandu Valley due to the energy crisis. Due to the current energy crisis, we face the problem of load-shedding throughout the year with the peak of 14 hours per day. Furthermore, On the other hand, dependability of our nation on our Southern neighbors elevates the scenario which demands the study of feasible and practical solutions in the near future. The education of students getting hampered, shortage of LPG gas for cooking, hindrance in internet surfing, power overload in peak hours etc are some of the problems that the occupants of residential sector face on daily basis.

These are the general problems faced by the people. Also, there is a research gap which is adding to the problems and not out breaking any solutions to these prevailing problems. There is a limited amount of research been carried out and the prevailing studies only focuses on general solutions irrespective of cost and feasibility factor. There is a gap in research which has to diverse the study on the cost and feasibility aspect so that the people can welcome the solutions and incorporate into their practical life.

**Research Purpose:**

Main Objective:

* To find the potential of residential sector of Kathmandu valley in curtailing the energy demand in terms of the feasibility and cost-effectiveness.

Specific Objectives:

* To find the response of the occupants of residential sector towards energy crisis and whether the people are aware about the energy efficiency.
* To find the contribution made from the locals and the experts (Architects) level in energy efficiency.
* To find the possible policies that can be formulated and implemented for the effective response of energy crisis.

**Validity of research:**

In spite of the large potential of energy efficiency in the residential sector is there, much remains yet to be achieved. Though the energy consumption pattern in residential sector are been studied previously, the cost-effective and feasibility aspect in the context of Kathmandu is yet to be discovered. So, this research is validated.

**Conceptual Framework and Methodology:**

Rapid enrollment of people in search of a better job, better education and a better life in Kathmandu Valley has been a prime cause of energy crisis in the valley itself. Burgeoning population demands more energy but the dependency for energy on non-renewable sources is not dependable as it is sure to be exhausted in few decades. Further, the reliance for energy demand on neighboring countries can prove to be a terrible choice. The need of fossil fuels is completely fulfilled by importing it from neighboring country and this fact is alarming because we are all aware of the blockade which has made the people suffer to the worst. The worst part is that there is no sign of relief.

There are various disciplines that are available for carrying out the research. Positivist, post-positivist, Constructivist and Critical Theory are some of them which are majorly used. Positivism relies on the holistic observation of all the subjects. It is a philosophical theory originating from the natural sciences in which informative data is obtained from observation by sensory experience and is interpreted by the researcher via generalized reasons and logic. (Wikipedia, 2015). It is value free and is governed by cause and effect notion. It believes that the truth can be known and that is true regardless of context such as time or place. The post-positivist on the other hand is a descendant of positivism which rejects the theory of absolute truth and that says universe is not deterministic. According to post-positivist, reality is not an absolute truth and thus is open for falsification and revision. Unlike positivist paradigm, it suggests that the reality depends on both scientific reasoning and common sense reasoning. In Post-positivist paradigm, only a plausible population of subject is taken due to practical constraints in resources and time and interpolates the data to generalize. Positivist believes that the objectivity can be achieved perfectly whereas the post-positivist believes that objectivity cannot be perfectly achieved but can be approached. In my context as well, my research seeks the reality in terms of measuring the energy consumption by the residential sector of Kathmandu Valley and seek what are its potentials in curtailing the energy demand. These constraints can be measured and can be quantified; hence, Post-Positivist Paradigm is suitable for my research.

On the other hand, Constructivism pronounces that there are no universal laws or absolute truths, reality is constructed. Because research is bound by the context all people’s values are important to the process because this informs the research. It facilitates understanding of how and why and enables the researcher to acquire food knowledge on social processes. It allows the complete understanding of the contextual factors. In my research, I will also be dealing with the variables such as preferences, reliability, dependence, choice etc. which requires a contextual understanding. Thus, I will also be adopting constructivism paradigm.

Though mixed approach of model including both post-positivism and constructivism paradigm will be used, there are certain short comings that I have to deal with. Since post-positivist paradigm is related to approaching the truth, so to increase the level of confidence, the sample has to taken very carefully so that it represents the whole population and the data’s can be generalized after interpretation. Likewise, in constructivism paradigm, the data can be complex and challenging and thus, the credibility and validity of the data will be ensured by triangulation, reviewing and analyzing variables from more than one perpective.

The variables of the research to be carried out are interconnected to each other. Since the variables are of real world and inter dependent or inter-related to one another, co-relational survey suits the best. The relation between energy, people and buildings is prioritized in order to see the relevant outcomes which can respond to the problem of energy crisis that we are facing. Different variants such as types of energy (Solar, Wind, Biogas), behavioral pattern of people, affordability of alternate energy use, feasibility of alternate energy use, reliance, family size, size of the dwelling etc are identified which are interconnected and there is a relation of these aspects. Furthermore, cross-sectional strategy will be adopted. Cross-sectional study is a research tool used to capture information based on data gathered for a specific point in time. This is a descriptive cross-sectional study and is done without manipulating the study environment. The population chosen will be studied under the natural environment and the study will be made at specific point of time without considering past or future influencing factors.

**Conclusion:**

The excessive use of non-renewable energy for daily activities is a sign that the whole world will soon face energy crisis which will be an irreversible process since they will deplete in few decades. The situation of Nepal is even worst in the present context as it is suffering from energy crisis because of the embargo of fuels by its southern neighbor. Therefore, an alternative has to be explored which demands a shift towards approaching and accessing renewable energy for fulfilling energy demand. In spite of the large potential to foster in energy efficiency in the residential sector, much remains to be achieved. Thus, this research will help exploring the potential of residential sector in responding energy crisis with the focus on the aspects cost-effectives and feasibility thereby providing the basis for overall social and economic development.

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