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Analysis of Nepal's Long Term Electricity Demand Using End Use Methodology

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Abstract
In this research comprehensive analysis of the Nepal's long term electricity demand for the year 2012 to 2030 under various scenarios is presented. This analysis was done using IAEA's model, Model for Analysis of Energy Demand (MAED) which is a bottom up model. The secondary data was obtained from government agencies and other organizations in energy sector. Starting from the base year, the future electricity demand has been projected under three scenarios comprising of possible future demographic, socio-economic and technological development of a country. The base year electricity demand is 3004 GWh which will reach to 6202 GWh in 2030 under Business as Usual Scenario (BAU). Further in Medium Growth Scenario (MG) and High Growth Scenario (HG), the electricity demand will reach 8399 GWh and 11783 GWh respectively. The percentage of share of electricity in base case for industry, agriculture, transportation, residential and service sector are respectively 38.31%, 2.42%, 0.19%, 47.39% and 11.67%. The result under high growth scenario shows that the total projected electricity demand for all the sectors in 2030 will be 11783GWh, out of which 5084GWh is industry, 4463GWh, 1991GWh, 183GWh and 62GWh are residential, service, agriculture and transport respectively. This shows how much electricity will be required to meet the projected demand in 2030.

Keywords
Electricity, demand, projection, end-use methodology, scenarios

1. Introduction

Secure, reliable, affordable, clean and equitable energy supply is fundamental to global economic growth and human development and presents huge challenges for us. Future energy supply and demand, future environmental and social contexts are subject to a knot of uncertainties that are difficult to predict, such as the global economic and geopolitical situations and new technical innovations. In a world becoming more global, where new technologies foster bring faster innovations and demand changes in our behavioral responses, the task of predicting the future becomes harder[4].

Decision making is quite tough if we don't have idea of what is likely to happen in future. So, making today's decision considering future uncertainties obviously helps to make better decisions and formulate good policies. This can be done by scenario analysis. Energy scenarios provide a framework for exploring future energy perspectives, including various combinations of technology options and their implications [6].

Continued industrialization, increase in living standards, modernization, rapid growth in the population are contributing into the increase in the demand of electricity in the country. The demand is increasing in each year whereas the generation is not increasing in the same pattern. So knowing the future energy demand pattern under various scenarios is very important for energy planning and development work.

This research deals with long term projection of electricity demand in various scenarios of Nepal's socio –economic and technological development. For this projection, the end use methodology of IAEA's simulation model, Model for Analysis of Energy Demand (MAED) has been applied. The forecast is focused on simulations of future demand based on social, economic and technological development. The demand forecast is essential to assess and plan for

supply through the use of the energy resources for a given set of demand.

2. Methodology

To analyze the future development of Nepal's electricity demand, Model for Analysis of Energy Demand (MAED) has been applied. MAED evaluates future energy demand based on a set of consistent assumptions on medium to long term socioeconomic, technological and demographic developments in a country or a region [5]. Future energy needs are linked to the production and consumption of goods and services; technology and infrastructure innovation, lifestyle changes caused by increasing personal incomes; and mobility needs. Energy demand is computed for a host of end use activities in three main 'demand sectors': household, services, and industry and transport. MAED provides a systematic framework for mapping trends and anticipating change in energy needs, particularly as these correspond to alternative scenarios for socioeconomic development.

2.1 Research Design

Constructivism approach is applied for this research. The analysis is based on quantitative approach. Literature review was done throughout the thesis period. The main methodological framework is explained in the given block diagram in Figure 1.

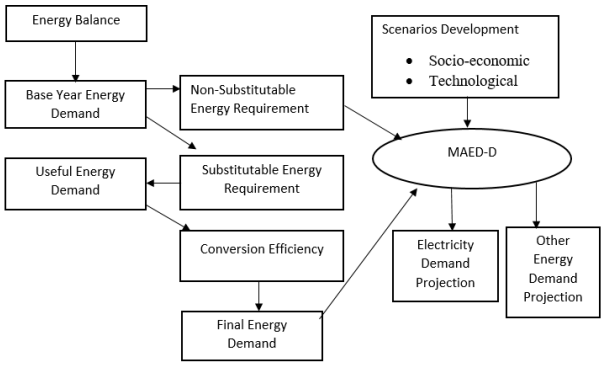

Figure 1: Methodological Framework

2.2 Research Method and Data Collection

2.2.1 Demographic Data

The demographic data is projected based on the census 2011, Nepal [7]. The nation's population in the year 2012 was 26.875 million showing population growth rate of 1.35 per annum. For subsequent years growth rate was assumed as projected in medium variant by CBS. Figure 2 describes prediction of annual population from year 2011-2030 under High variant, medium variant and low variant scenarios of Nepal by Central Bureau of Statistics.

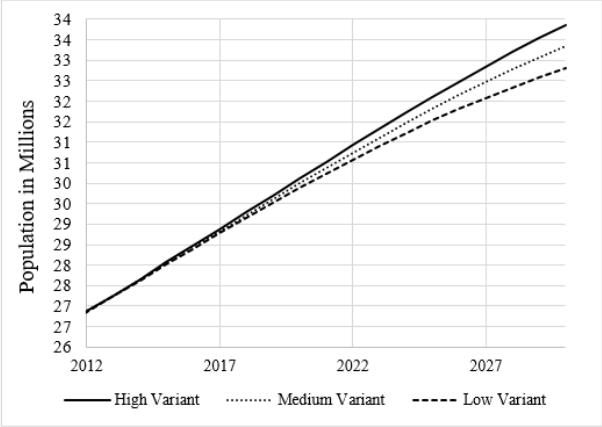

Figure 2: Projection of Population throughout the year 2012 to 2030

2.2.2 Economic Data

Economic data is based on Asian Development Bank Report, Asian Development Outlook 2016 Update. The average GDP growth rate is 4.8% [1] which is taken as Business as Usual Rate (BAU). Further GDP growth rate of 7% is assumed on medium growth scenario as per sustainable development goals 2016-2030 by National Planning Commission [3]. In high growth scenario, GDP growth rate of 9.2% is taken according to graduation from least developed country by 2022 [2].

2.2.3 Energy Balance in Year 2012

Preparing energy balance for the base is primary and most critical task for developing energy model. Energy balance summarizes the quantitative behavior of an energy system for a given time period. The energy balance for the base year 2012 has been developed using secondary data from Nepal Oil Corporation,

Nepal Electricity Authority, Alternative Energy Promotion Center, Economic Survey published by National Planning Commission and Energy Datasheet 2011/12 published by WECS.

2.3 Energy Demand Calculations

The energy demand is calculated by the model MAED as a function of a scenario of possible development. This scenario covers two types of scenario elements, one is related to the socio-economic system and describes the fundamental characteristics of the social and economic evolution of the country and the second is related to the technological factors, which should be taken into account in the calculation of energy demand, for example the efficiency of each alternative energy form and its penetration into its potential markets.

2.4 Scenarios Description

2.4.1 Business as Usual Scenario

Economy: GDP growth rate of 4.8% (Average annual GDP growth rate of past 10 years) Demography: Medium Variant population growth rate as projected by CBS with decrease in population growth rate from 1.45% to 1.01% Lifestyle: Medium increase in dwelling number, car ownership, mobility and electric equipment. Technology: Low efficiency improvement and low use of solar for heating purpose.

2.4.2 Medium Growth Scenario

Economy: GDP growth rate of 7% (Sustainable Development Goals) Demography: Medium Variant population growth rate as projected by CBS with decrease in population growth rate from 1.45% to 1.01% Lifestyle: High increase in dwelling number, car ownership, mobility and electric equipment. Technology: Medium efficiency improvement and use of solar for heating purpose.

2.4.3 High Growth Scenario

Economy: GDP growth rate of 9.2% (Graduation from least developed country by 2022) Demography: Medium Variant population growth rate as projected by CBS with decrease in population growth rate from 1.45% to 1.01% Lifestyle: High increase in dwelling number, car ownership, mobility and electric equipment. Technology: High efficiency improvement and use of solar for heating purpose.

3. Results and Discussion

3.1 Sector-wise Electricity Demand

3.1.1 Industry Sector

The industrial sector electricity demand under various scenarios is shown in fig 3. As shown in graph, the electricity demand will increase in subsequent years under each scenario.

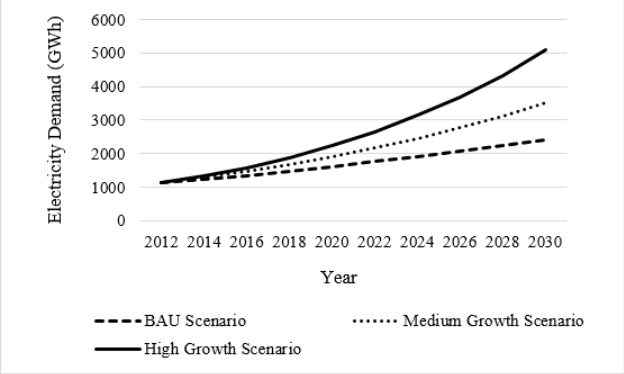

Figure 3: Industrial Sector Electricity Demand

subsubsectionAgriculture Sector Fig 4 shows the agriculture sector energy demand under business as usual scenario, medium growth scenario and high growth scenario. The electricity demand will reach to 87GWh, 127 GWh and 183 GWh respectively under BAU, MG and HG scenario in 2030.

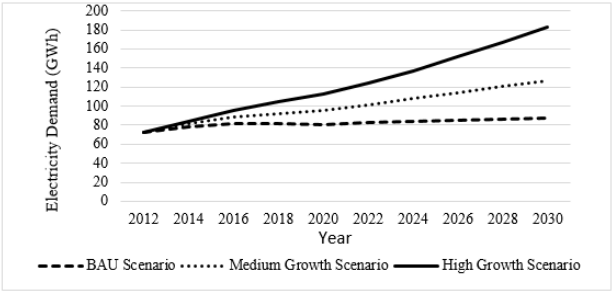

Figure 4: Agriculture Sector Electricity Demand

subsubsectionTransportation Sector Figure 5 shows that the electricity consumption will hover around the base

case result up to 2018 and after that it shows the sharp increase in electricity demand. This is due to increase in penetration level of electricity in transportation sector in future years.

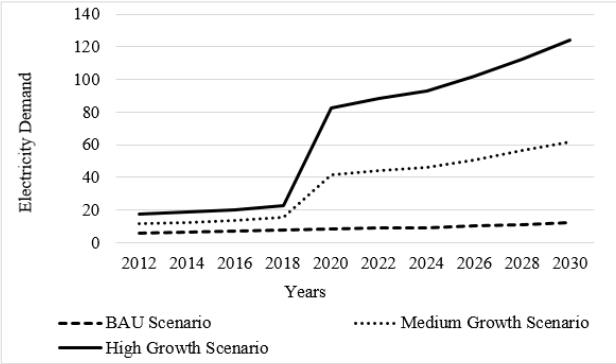

Figure 5: Transportation Sector Electricity Demand

3.1.2 Residential Sector

The residential sector will also witness a significant increase in its electricity demand as shown in Fig 6. Due to increase in use of electricity in both urban and rural households, the electricity demand is soared in subsequent years.

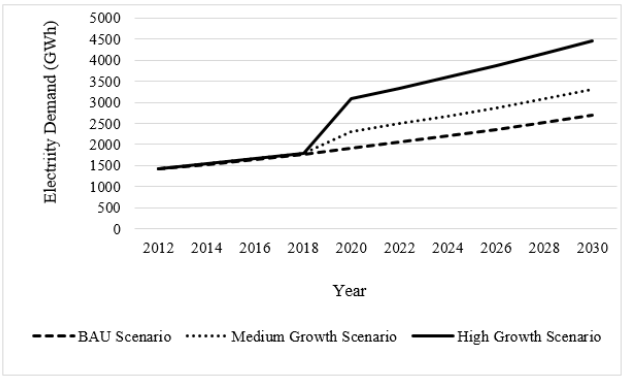

Figure 6: residential Sector Electricity Demand

3.1.3 Service Sector

Electricity consumption in service sector was 351 GWh in base year 2012. The figure 7 shows that the electricity consumed in service sector will keep increasing from base year till 2030. Due to increase in tourism and hospitality industries, the demand pattern keep on increasing.

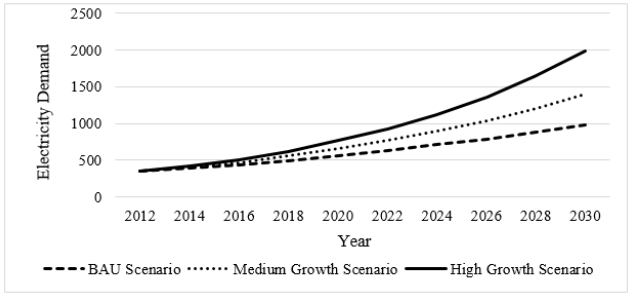

Figure 7: service Sector Electricity Demand

4. Conclusion

Using the end-use approach the future long term electricity demand of Nepal has been projected according to various scenarios representing the possible future socio-economic and technological development trends of the country. It has been found that the final electricity demand will grow up annually at an average rates of 4.1%, 6% and 8% (starting from 3004 GWh in the base year) for the BAU, MG and HG scenario respectively.

The growth of electricity is continuously higher with increasing tendency throughout the study period as a result of more automation in industry and more electric equipment in household and service sector.

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