Understanding Energy Crisis in Nepal

Assessment of the Country's Energy Demand and Supply in 2016

Ramhari Poudyal*
College of Engineering
Swansea University
Swansea, UK

Shree Krishna Khadka
Center for Energy Studies
Institute of Engineering
Tribhuvan University, Nepal

Pavel Loskot
College of Engineering
Swansea University
Swansea, UK

***Abstract*— The world is facing an enormous challenge to provide sufficient quantity of clean energy to its burgeoning population. Energy is a fundamental asset for enabling socio–economic development and poverty eradication in any country. Nepal has been suffering from the chaotic energy crisis for about a decade now despite having a potential for generating 43,000 MW of hydro-electricity, 2,100 MW of solar power, and 3,000 MW of wind power. A normal life of its citizens is being crippled with long hours of load shedding and never ending queues in front of the gas stations reflecting the state of the energy-hungry country. This paper gives a perspective on the energy crisis in Nepal in order to point out how serious the problem is and also presents some ways how to obtain an immediate relieve through the use of green energy commodities. In addition, the strategic advantages to potential investors are explored that encourage investments into national priority projects facilitated by the progressive policies of the Government of Nepal.**

Keywords*— *energy crisis; energy demand; green energy; renewable energy

I. INTRODUCTION

Energy is one of the basic needs to sustain the society development. In today's world, the electricity is a backbone of all industrialized countries [1]. The United Nations Sustainable Development Goals (SDGs) [2], scheduled to be achieved over the next 15 years, aim to end the poverty, protect the planet, and ensure the prosperity for all. Of the 17 SDGs, Goal #7 aims to ensure access to affordable, reliable, sustainable and clean energy for all people. Presently 1.2 billion people in the world are without access to modern electricity, while 2.9 billion people have to cook using inefficient and polluting fuels such as firewood or kerosene. Majority of these people are concentrated in about a dozen countries in Africa and Asia. The energy security in least developed countries (LDCs) is a major challenge that needs to be addressed urgently. At the same time, it is important to be aware that energy is the dominant contributor to a climate change, accounting for about 60% of the total greenhouse gas (GHG) emissions [3].

A volatile nature of the international energy markets has aggravated the energy crisis in Nepal which is 100% dependent on imports of petroleum products and coal while the consumption of petroleum products in Nepal is increasing at an alarming rate of 10% annually [4]. Nevertheless, Nepal has a very low per capita energy consumption of 128 KWh compared to the world average being 3104 KWh [5]. Most rural people of Nepal are still dependent on firewood which causes the death of over 7,500 people annually due to indoor air pollution [6]. In addition, the corresponding depletion of forests in Nepal prompted environmental scientists to search for better solutions to the energy security problems [7].

Generally, developing a electricity power system is extremely capital intensive, and hence, it requires substantial financial capital as well as adequate technical expertise contributed both from the private and public sectors. In Nepal, the electricity imported from India accounted for 27% of the total energy supply in 2014/15 while growing steadily year after year [8]. The never-ending power shortages also gravely affect the Nepal's industrial sector. On the other hand and importantly, a large unfulfilled domestic demand for energy represents a great opportunity for potential investors, with or without export prospects. In addition, the Government of Nepal (GoN) has been very proactive recently in formulating the long-term economic visions with the aim of removing Nepal out of the LDC status by 2022 to a Middle Income Country by 2030 [9]. The vision 2030 will require the transformation of subsistence-based farming into a large-scale commercial agriculture, and also a massive upgrading of the currently dismal industrial base. The GoN has made a crucial step towards the country industrialization by adopting Special Economic Zone Act which offers attractive facilities and privileges to the export-oriented industries. However, all these initiatives will create huge additional demands for the electricity. It is therefore critical that Nepal starts implementing its energy policies and effectively manage the deficits of its electricity supplies. Fortunately, the availability of huge sources of renewable energy (RE) promises a better energy future for Nepal [10].

The current rate of energy consumption in Nepal is unsustainable together with poor harnessing of the indigenous RE sources, and increasing dependency on the imported fossil fuels. In order to revert these adverse trends, it is essential to understand financial implications in adopting the RE. We will review the current energy stratum of Nepal and explore immediate prospects of utilizing the RE to overcome the current energy crisis.

II. ENERGY SPECTRUM OF NEPAL

Nepal is blessed with theoretically huge hydropower potential of 83,000 MW, out of which about half (43,000 MW) is considered to be techno-economically usable. The water resources in Nepal (225 billion m^3/km^2/year, 4 times the world average) are regarded as one of the

*Corresponding author: 847043@swan.ac.uk, +44 1792 602619

prime opportunities for future economic development [8]. Despite having a century long history of the electricity generation, 6.6 million people in Nepal are today without the electricity, and those who have it are experiencing 12-14 hours of load shedding during dry seasons [11].

Worryingly, Nepal still relies heavily on the traditional energy resources even though the country has no significant deposits of fossil fuels. The total energy consumption in Nepal in year 2014/15 was 11,232 toe [9]. Depending on the fuel type, traditional fuels represent 78% of the total energy consumption followed by the petro-products (see Fig. 1) whereas the use of modern RE resources is still too low [12].

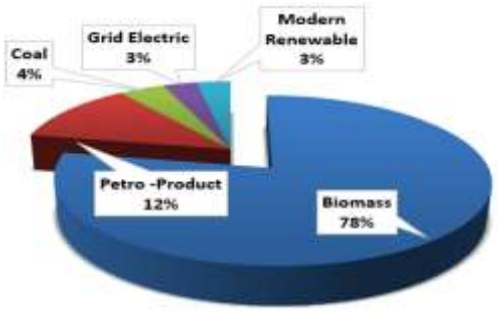

Fig. 1. The energy review of Nepal in 2015 [12].

III. Energy Crisis and its Adverse Impacts

Nepal is currently facing a severe electricity crisis. There is currently a huge discrepancy between the electricity demand and supply which leads to frequent load shedding for general public as well as for the industrial consumers (see Table I).

TABLE I. Impacts of Load Shedding [10]

SN	Sector Impact	Impact
1	Education	90.6%
2	Water Supply	56.1%
3	Loss of Work Capacity & Income	31.7%
4	Food Storage	29.8%
5	Social Activities	27.0%
6	Health Hazards	19.4%
7	Others	7.2%

The Nepal Electricity Authority (NEA) has been able to only reach 829 MW of the installed capacity (cf. Fig. 2) and currently imports 345 MW of electricity from India, since the domestic production falls short of demand. The peak demand for electricity is at least 1,423 MW which is predicted to reach 3,200 MW 10 years from now [8]. The transmission and distribution (T&D) losses recorded last year were 31.48%, whereas the world average is only 8.16% [5]. In addition, even though there is no exact measure of the electricity theft in Nepal, it is estimated that 10% of the losses occur due to illegal stealing of the electricity. In total, more than 200 MW of electricity is lost annually in Nepal which amounts to US$75.47 million.

There is a tremendous hydropower potential in Nepal, however, its exploitation is facing many challenges. Until today, only about 2% of this potential is being utilized, so 36.55 million toe yearly of non-diminishing hydropower still goes unused to change the energy and economic situation of Nepal and the neighboring countries.

The primary energy demand of Nepal is growing at the staggering rate of 2.73% annually along with the electricity demand of 8.8% [8] which will reach 17 million GJ in year 2040 [13] (see Fig. 2).

Fig. 2. The trends of the electricity supply and demand in Nepal [14].

The supply-demand energy gap in Nepal is consistently widening over a decade, so the country is facing heavy energy shortages. The GoN declared the state of energy crisis in the country in early 2008. Moreover, load shedding together with the fuel crisis have infuriated many people and forced many shops and households to start using their own electricity generators to mitigate the problem. The use of fossil fuels as an alternative to electricity by the industries and even shops running backup generators have created the environmental pollution, both indoor and outdoor.

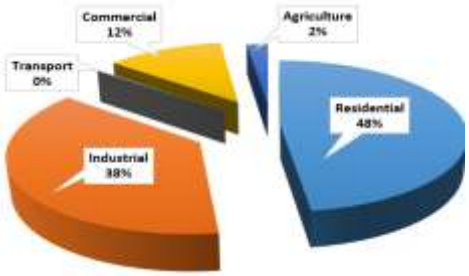

Fig. 3. The electricity consumption in different economic sectors [12].

The industry consumers (see Fig. 3) are severely affected by the lack of supply. Even the services oriented industries had to cut their office hours to adapt to the electricity market dynamics. The manufacturing units are compelled to use diesel or fossil fuel plants to operate which is pushing up the total cost of finished products by a whopping 25 to 40%. In other cases, the industries have been shut down, and restructured to focus on more basic products. Hence, the energy sector has large adverse effects on the developments in Nepal.

IV. Energy Prices in Nepal

In fiscal year 2012/13, the petro-oil accounted for 19.2% of total imports. Nepal has imported $1,222.3 million of petroleum products from India alone. The

consumption rises between 17 to 29% per annum according to the government records [4]. Soaring energy prices and the geopolitical turmoil (Blockade by India) of the recent years have reminded Nepal of the essential role the affordable energy plays in the economic growth and the human development as well as of the vulnerability of the global energy systems to supply disruptions. Thus, safeguarding the energy supplies is once again on top of the Nepal's policy agenda.

TABLE II. THE ENERGY COST HIKES IN NEPAL [4]

Year	Petrol	Diesel	Kerosene	Aviation Fuel	LPG
	Rs/Liter	Rs/Liter	Rs/Liter	USD/KL	Rs/Cyl
2000	40	23	13	360	465
2001	46	26.5	17	360	550
2002	52	26.5	17	360	650
2003	54	31	24	360	700
2004	56	35	28	609.27	750
2005	67	46	39	660.12	900
2006	67.25	53.15	47.65	931.83	900
2007	80	56.25	51.2	1180	1100
2008	80.5	68.5	68.5	945	1325
2009	77.5	58	58	750	1125
2010	88	68.5	68.5	945	1325
2011	105	76	76	1215	1325
2012	123	99	99	1250	1470
2013	130	103	103	1300	1470
% Rise	**225**	**347.82**	**792.30**	**361.11**	**216.13**

The investment into a hydro power is behemoth and accounts for up to US$2 million per 1 MW as indicated by a detailed analysis of the projects until their completion [13]. A high cost of energy (CoE) services in developing countries necessitating the subsidies is largely a result of poor governance of state-owned utilities. This then causes corruption, inefficiency, overstaffing, and puts a fiscal burden on the state.

The electricity price in Nepal represents one of the costliest tariffs in South Asia, although it has remained the same for more than a decade (20% increase in August 2012 and again in 2016). Rabindra Nepal et al. (2011) argue that electricity prices in Nepal are too low to cover all costs and they are not based on economic principles but on valued interests and political motives. The electricity is then supplied to customers at highly subsidized rates which distorts the demand [15]. It is one reason why the NEA suffers from huge financial losses and is unable to invest into costly hydropower projects.

V. RE POTENTIAL AND PIPILINED HYDRO-PROJETS IN NEPAL

We can identify trends affecting the energy sector to understand the reforms that are under way while emphasizing the changing roles of state, private and civil sectors [16]. Our intention is to analyze the key issues that result from ongoing and planned changes in order to propose how developing countries and their cooperation partners can best respond to the energy crisis.

Harnessing the RE sources support sustainable practices around the globe. These resources are available locally and are often part of the local economy in a community and its life-style. In such conditions, Nepal should think seriously how to choose the right RE mix [17]. Since Nepal has plenty of other RE resources, it can invest in solar, wind, small hydro and biomass sources to cope with the present energy crisis (see Table III), and consider multiple larger hydropower projects for the long term solutions.

Despite the tremendous energy resources, only about 75% of total population has access to the electricity among which 58% is connected to a national grid while 9% in rural areas rely mainly on small, relatively reliable off–grid systems [9]. However, the grid connections in both rural and urban areas do not guarantee electricity supply due to the recurring shortages.

TABLE III. THE RE POTENTIAL OF NEPAL [15]

Technologies	Estimated Potential	Basis
Mini/Micro Hydro	>100 MW	Possible in 55 Districts of Nepal
Domestic Biogas	1.1 million plants	At existing livestock population
Solar Energy	2100 MW	4.5 KWh/m^2/day radiation if 2% area is taken as being acceptable
Improved Cooking Stoves	>2.5 million	Assuming 75% eligible of the total households by the 2011 census
Improved Water Mill	25,000 – 30,000 MW	-
Wind	3000 MW	Assuming 10% of area with more than 300W/m^2
Bio – Fuel	100000 tons	Assuming 10% of area with more than 300W/m^2

Nowadays, the RE is a high priority for the GoN which has a target to increase a share of renewables from less than 1% to 10% of the total energy supply, and to increase the access to electricity from alternative energy sources from current 10% to 30% within the next 20 years. Complementing these goals, the GoN's plan to invest US$1,076 million into the RE by year 2020 which includes the support for hydropower, solar PV, wind turbines and biogas technologies [18].

In Nepal, the history of hydropower development is sluggish. Most projects are delayed against their promised schedule as shown in Table IV. The main reasons are political corruption and financial inabilities [16]. Most donor funded projects tend to incur not only the time overruns, but also the cost overruns. Moreover, there are issues with inadequate planning and investments into the generation, transmission, and distribution infrastructure. The delays in project implementation are also caused by a lack of adequate legal and regulatory frameworks to resolve land acquisitions. The right of way and forest clearance processes also hamper development of hydro resources which contribute to a severe underdevelopment of the energy infrastructure in Nepal [20]. Other reasons are prolonged procurement processes and the ghost

contractors leaving the work to be done by inexperienced and technically weak local contractors, low project readiness at the time of approval and a weak project management capacity of NEA [20].

TABLE IV. THE TIME OVERRUNS IN HYDROPOWER AND TRANSMISSION LINE PROJECTS IN NEPAL

Project	Time overrun
Kulekhani I (60 MW)	21 Months
Marsyangdi (69 MW)	7 Months
Kali Gandaki – A (144 MW)	18 months
Chilime (22 MW)	60 months
Kulekhani III (14 MW)	54 months
Raughat (32 MW)	72 months
Upper Trisuli I (216 MW)	38 months
Upper Tamakoshi (456 MW)	12 months
Trisuli 3A (60 MW)	26 months
Chameliya (30 MW)	60 months
Middle Marsyangdi (70 MW)	48 Months
220 KV Khimti – Dhalkebar	> 10 years
400 KV Dhalkebar – Muzzaffarpur	6 months

Most hydropower projects are a Run of River (ROR) type which depends on the monsoon and flow of the river. During dry season, these projects only produce below half of their capacity. Therefore, Nepal needs to develop more storage for hydro power which is, however, very costly and time consuming. The deferred investment in the electricity infrastructure has already caused severe power cuts forcing the industrial and commercial entities to operate expensive generators. The import of petroleum products exceeds the total exports and is the main reason for the country's large trade deficit. Ignoring the cost-based tariff adjustments in the past 3 years, the financial health of NEA has deteriorated, so it is now unable to invest in the infrastructure to meet the rising electricity demands.

VI. DISCUSSION

The GoN has endorsed "Work Plan on National Energy Crisis Alleviation and Energy Development Decade" in February 2016, which provides a roadmap for policy reforms and initiative to spur private sector investment. To meet such aspiration, Nepal has to add 6000+ MW corresponding to US$10 billion of investments. Other investment opportunities lie in the upgrade and expansion of distribution systems (approximately US$2 billion) and transmission systems (approximately US$4.45 billion) [18]. The Power Trade Agreement with India has opened up a large market for exporting the electricity. Foreign investment is especially encouraged in the recently enacted Foreign Investment Policy-2015 and is governed by the Foreign Investment and Technology Transfer Act (FITTA-1994).

The RE projects in Nepal need business processes and technology to be able to sell their electricity. The GoN must be lenient to support such investments, for example, into the modern energy infrastructure. In order to improve the industrial energy efficiency, the government can develop relevant policies including collection of appropriate data. In addition, international sharing of the energy policies and coordination with the industry are critical for conserving the energy. The energy sector suffers from widespread inefficiencies including the transmission and distribution losses that exceed 30%. The losses are caused by poor maintenance, and the energy theft. However, Nepal has the resources to meet not only its growing energy demands, but it can also play a leading role to supply sustainable energy to the whole SAARC region. It should be noted that the two neighboring countries of Nepal, India and China, now account for about half of the global energy demand, and their appetite continues to grow. However, the challenge is to make all solutions commercially, economically and politically viable.

REFERENCES

[1] World Bank (WB), "Annual Report, End Extrement Poverty - Promote Shared Prosperity," WB, USA, 2013.

[2] United Nations, "The Sustainable Development Goals Report 2016," United Nations, New York, 2016.

[3] International Energy Agencey, IEA, "Energy and Climated Chage, World Energy Outlook Special Briefing for COP21," IEA, Paris, France, 2015.

[4] Nepal Oil Corporation, NOC, "Selling Price Archive," 2016.

[5] The World Bank, WB, "World Data Bank, World Development Indicators," 2016. [Online].

[6] Center for Rural Technlogy, Nepal (CRT/N), "Annual Report: Towards Action for Development," CRT/N, Nepal, 2015.

[7] Climate Investment Fund, CIF, "Scaling-up Renewable Energy in Low Income Countries," CIF, Mongolia, 2015.

[8] Nepal Electricity Authority, NEA, "Nepal Electricity Authority, A Year in Review 2015-16," NEA, Kathmandu, Nepal, 2016.

[9] Ministry of Finance (MoF), Governmetn of Nepal (GoN), "Final Economic Survey," MoF, Kathmandu, Nepal, 2016.

[10] J. N. Shrestha, *Application of Clean Energy in Nepal: Prospects and Problems,* Nepal Solar Energy Society (NSES), 2014.

[11] Central Intelligence Agency, CIA, "The World FactBook," CIA, Washington D.C. USA, 2014.

[12] Water and Enegy Commission Secretariat, WECS , "Energy Sector Synopsis Report," WECS, Kathmandu, Nepal, 2012.

[13] C. G. Heaps, *Long-range Energy Alternatives Planning (LEAP) System,* Stockholm Environment Institute, Somerville, USA, 2012.

[14] A. M. Nakarmi, "Current Energy Consumption Trends & Future Energy Scenarios of Nepal," in *IPPAN - Seminar*, Hotel Yak & Yeti, Kathmandu, 2016.

[15] Alternative Enegy Promotion Center, AEPC, "Annual Report," AEPC, Kathmandu, Nepal, 2015.

[16] P. Ljung, Energy Sector Reform: Srategies for Growth, Equity and Sustainability, SidaStudies, 2007.

[17] N. R. Karki, "Rural Energy Security: Utilizing Renewable Energy Sources: Challanges and Opportunites," in *TENCON 2010 – 2010 IEEE Region 10 Conference*, Fukuoka, Japan, 2010.

[18] GoN, Office of Investment Board, "Nepal Investment Guide 2016," Investment Board Nepal, Kathmandu, 2016.

[19] T. J. Rabindra Nepal, *Reforming Small Power Systems under Political Volatility: A Case of Nepal,* UK: CWPE 1133 & EPRG 1114, 2011.

[20] Ministry of Finacne, MoF, Government of Nepal, GoN, "Nepal Portfolio Performance Review (NPPR), Implementation for Results," MoF, Kathmandu, Nepal, 2015.