Bhuwan Pokharel

Renewable Energy scenario and strategies adapted to minimize power cut in Nepal

Helsinki Metropolia University of Applied Sciences

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A few years back, there was a massive energy crisis in Nepal. People were facing a power cut of 12 hours a day, industries were shutting down and fundamental activities of the economy affected. Highly volatile political situations changed the energy policies. No stable strategies were adopted, and plans were doomed. People forcefully relied upon gasoline generators, solar panels, and other alternatives.

However, the political change in 2016, which followed the change of the Director of 'Nepal Electricity Authority' (NEA), the positive changes started. Huge reformation on organization was made. The result was outstanding. Power cut decreased by 80%. In current days, major urban areas are load-shedding free zones, industries have started running in full swing and positive changes in the economy have appeared. However, it did not happen overnight. The Energy Minister, Director of NEA and his team and the consumers, all have worked together to bring the situation to a hopeful point. NEA has future objectives to meet power demand and to sell hydro energy to the international market.

Keywords	renewable energy, hydroelectricity, energy revolution, investment

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1. Introduction

1.1 Background

A few years back, there was a massive energy crisis in Nepal. People faced power cut of up to 16 hours a day, many industries shut down and fundamental activities of economy were affected. Highly volatile political situations changed the energy policies. No stable strategies were adapted, and plans were doomed. People forcefully relied on gasoline generators, solar panels and other alternatives. (Nepal Energy Efficiency Programme, 2015)

However, the political change in 2016, which followed the change of the Director of 'Nepal Electricity Authority' (NEA), the positive changes started. Huge reformation on organization was made. The result was outstanding. Power cut decreased by 80%. Currently, major urban areas are load-shedding free zones, industries have started running in full swing, and positive changes in economy have appeared. However, it did not happen overnight. The Energy Minister, the Director of NEA and his team and the consumers, all have worked together to bring the situation to a hopeful point. NEA has future objectives to suffice power demand and sell hydro energy to international market too. (Sangraula, S., 2017)

Nepal has a huge potential in hydropower. Nepali rivers are of perennial nature and the abrupt gradient of the topography creates ideal conditions for the development of numerous hydroelectric projects. With approximately 1700 mm of average annual precipitation, the annual average flow from 600 perennial rivers is over 200 billion m3. The 80% of precipitation occurs during the June to September, which is also known as a monsoon season. Recent estimates show that Nepal has approximately 40,000 MW of feasible hydropower potential. However, only about 700 MW of hydropower is being generated in the present situation. (Nepal Energy Efficiency Programme, 2015)

Although granted with tremendous hydropower resources, only about 40% of Nepal's population has access to electricity through the grid and off grid system. Most of the power plants in Nepal are run-of-river type. These ROR type plants have excess energy available during the monsoon season and shortfall during the dry season. The electricity demand in Nepal is increasing by about 7-9% (approximately 80 MW at

least) per year. Nepal's new directive aims to expand the electrification within the country and export to India as well. The Hydropower Policy 2001 seeks to promote private sector investment as well. (Nepal Energy Efficiency Programme)

1.2 Methodology

This thesis presents the energy scenario from past 10 years considering associated economic factors. Data from journals, government office websites, energy related blogs, newspapers and personal interviews are used in this study.

Experiences of general consumer of energy and businessman are taken via written interviews. It clearly portrays the consumer behavior and problematic lifestyle throughout the power cut. To know the core technical and managerial strategies, interview of one of the key personnel of Government of Nepal is done. It explains the current strategies and future amendments of Nepal Electricity Authority (NEA).

The thesis discusses good practices and recommendations for energy revolution. The possible business opportunities for foreign investors is also briefly explained. The purpose of this thesis was to describe the energy scenario in Nepal and highlight the strategies to minimize the power cut. The aim of this study is to set an example for developing countries facing energy crisis like Nepal.

1.3 Ethical considerations

Three interviews were conducted during this project. All three interviewees agreed to publish their details in this study. All the statements expressed by the interviewee are solely their personal views; the author tried to remain neutral and avoided affecting their statements in anyway.

2 Energy history of Nepal

2.1 History of hydroelectricity production in Nepal

Geographically, Nepal is a mountainous country located in South Asia. It is situated between two giant emerging economies India and China. According to the World Bank, per capita income is $2400 (World Bank, 2015).

The history of hydroelectricity of Nepal goes back to 1911. The 500 KW 'Pharping Hydroelectric Plant' was the first production house built near the capital city of Kathmandu. A few decades after that, it was not a favorable era for development as the political turmoil was on the rise. During the Rana Regime (1846-1951), no attempts on energy development were made. After 1956, a few small-scale production houses were built. Trishuli, Thado Khola, Panauti, Tinau khola, Seti were the production houses which collectively produced 2 MW of electricity. (IPPAN)

Later, for additional power backup for Kathmandu, a 970 KW diesel power plant was built in Teku and Bhaktapur. In addition, primary surveys of Karnali, Kali river hydropower and Kathmandu- Hetauda- Birgunj transmission line were done. Until 1962, the total generation seems to be 2.2 MW. During the period of 1962-1965, various micro-hydro projects were carried out throughout the country to decentralize the power-politics. Several diesel plants were installed for additional supply including Panauti project (2400 KW) and Patan Diesel plant (1470 KW). Kathmandu-Birgunj transmission line was started in the same period. (IPPAN)

During the period of 1965-1970, numerous projects were started. The total power generation was increased approximately upto 20 MW. Trishuli Powerhouse (12 MW), Pokhara Hydro (2.5 MW), Hetauda Diesel (4.4 MW), Patan and Biratnagar Diesel

project (2.5 MW) were added. Gandak-Hetauda and Gandak-Bhairawa transmission lines were completed. Meanwhile, Kathmandu-Birgunj 66 KV transmission line was constructed in this period. (IPPAN)

During the period of 1975-1980, large scale plants were completed and connected to the grid. The transmission line expansion was done aggressively throughout the country. Large projects like Kulekhani, Devighat and Gandak were completed. By the end of 80s, the total power generation was 80 MW, out of which 53 MW was from hydroelectric plants, 15 MW from diesel plants and the remaining 12 MW was generated by private industries themselves. (IPPAN)

In the period of 1980-1990, major projects were completed, and micro-hydro projects were intensively carried out in rural areas. Micro-hydro projects contributed up to 2.2 MW and diesel plants share was 27.8 MW. At the end of year 1990, total production was 258 MW. Projects like Marsyangdi (69 MW) and Kulekhani II (32 MW) were completed. (IPPAN)

In 1992, along with great political changes, a revolutionary development policy in Nepal opened the floor for private sector investment. Due to the liberal policy for private investors in hydropower, additional 13 MW power was added in few years' time. But it was far less than the government expected. The year after 1997 is taken as the golden time for hydroelectricity of Nepal. (IPPAN)

The above-mentioned data is presented below graphically.

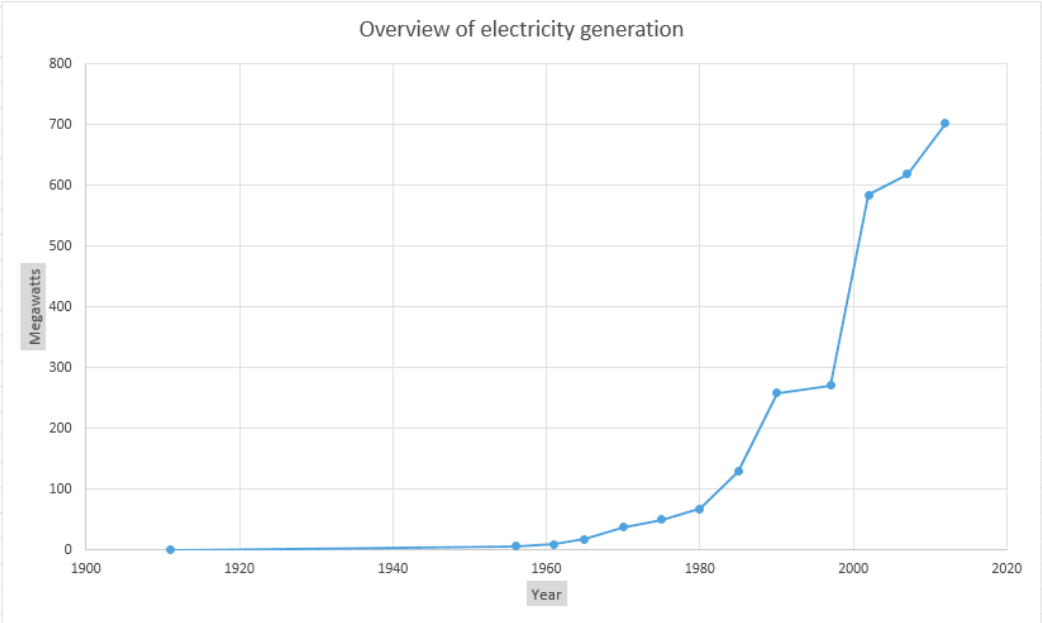


Figure 1: Electricity generation over last 100 years in Nepal [source: author]

Several large projects were started simultaneously. Installed capacity was raised to 584 MW, where Kaligandaki-A (144 MW) and Khimti (60 MW) projects were the biggest contributors. The private sectors interested in hydroelectricity were boomed and NEA target setting was aggressive. A total of 702 MW generation is estimated till date.

2.2 Types of Hydropower Plants

Hydropower plants are classified based upon their output, nature of production and type of reservoir.

2.2.1 Classification according to power output.

Hydropower plants are classified into six different groups according to their power output. (Table 1)

Type	Large	Medium	Small	Mini	Micro	Pico
Power Output	>100 MW	10- 100 MW	1- 10MW	100 kW - 1MW	5 - 100 kW	<5KW

Table 1. Classification of hydropower plants.

In the Nepalese context, large scale hydropower plants are too few. There are numerous medium plants due to production cost, optimal geographical situation and time elapsed. The project completion time has a major impact on overall production cost. Micro hydro became extremely popular in small communities in many remote destinations where national grid did not exist. Their installation, operation and maintenance were moderately easy.

2.2.2 Classification according to nature of production

ROR (Run of River)

Most of the hydropower projects in Nepal is Run-of-the-river (ROR) type. ROR hydroelectricity is recommended optimum for streams or rivers that can sustain a minimum flow or those regulated by a lake or reservoir upstream. Head pond is created by building a dam, which blocks the flow of the river. The turbines are at lower elevation. (figure 2) When the gushing water through penstock pipes hit turbines, they produce electricity. Projects with dam can address daily load demand.

ROR projects divert most of a river's flow (up to 95% of mean annual discharge) through a penstock (tunnel) towards turbines, generate electricity and then return the water back to the river river. Examples of ROR projects are Trishuli (24 MW), Modi (15 MW) and Khimti (60 MW).
(SSWM, 2012)

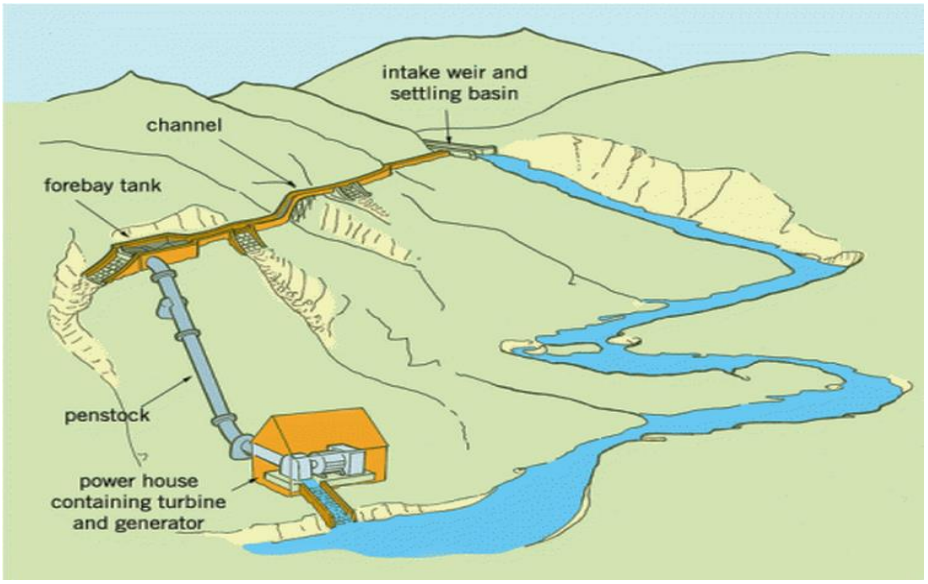


Figure 2: ROR hydroelectricity. [Source: SSWM, 2012]

PROR (Peaking Run of River)

A runoff river hydro power plant does not have effective storage. It only makes use of the discharge through the river thus, it is essentially different from operating characteristics of a storage type hydro power plant (figure 3). Most of the hydro power plants are peaking plants due to ease of load management, start-up and shutting down characteristics. This storage capacity is utilized for the dry month where the river flow rate is usually very less so that additional flow can be created with the help of stored water to increase the generation capacity. For example - Marshyangdi (69 MW), Kaligandaki (144 MW), Chilime (20 MW) are PROR type. (nepalenergyforums.net)

Figure 3: Middle Marshyangdi dam, PROR type. (Source: Trade Link International)

2.2.3 Classification according to storage

Pumped storage works like a battery, storing the electricity generated by other power sources such as solar, wind, and nuclear power for later use. It stores energy by pumping water uphill to a reservoir at higher elevation from a second reservoir at a lower elevation.

When the electricity demand is low, water is pumped from a lower reservoir to an upper reservoir. which acts as an energy storage. During the times of high electrical demand, the water is sent back to the lower reservoir and turbine is rotated, producing electricity. (SSWM, 2012)

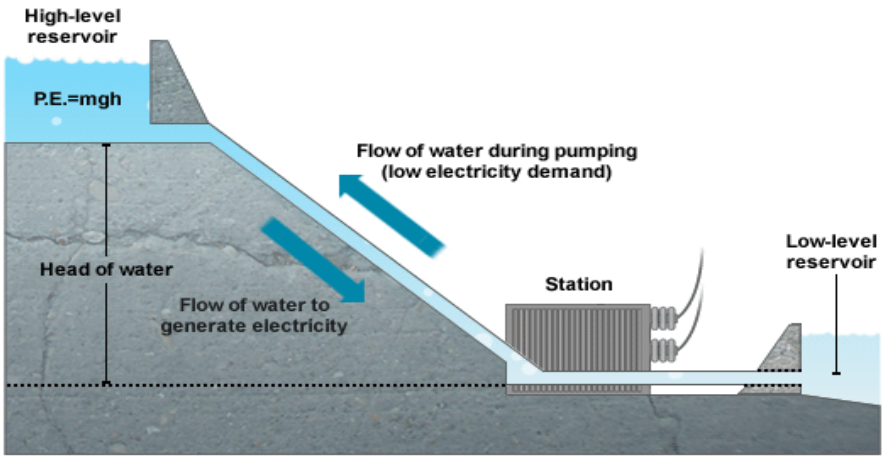


Figure 4: Different levels of reservoir [Source: SSWM, 2012]

3 Energy Crisis and Alternative Energy in Nepal

3.1 Energy crisis (2012-2016 scenario)

Electricity lacking in the country affected the daily activities, businesses, industries, telecommunications, education, hospitals and many other sectors. Tourism is one of the significant sectors with huge potential in Nepal. Its natural beauty and topographical variations attract people from all around the world, which helps to increase the flow of tourists. As a result, GDP of the country might be increased. (Nepal Energy Efficiency Programme, 2015)

The power shortage has hit Nepal to increase in import by 25 billion Nepali Rupees (NRs.), diesel by NRs. 12 billion, battery by NRs. 3 billion, inverters and generators by NRs. 5 billion and other means of energy by 5 billion. Trade deficit had soared with business associate countries due to increased power demands. No any significant source of petroleum products or the natural gas has been discovered so far in Nepal. Undoubtedly, this scenario makes the adoption of hydropower more important. (Business Age, 2011)

Energy crisis scenario made headlines in renowned global medias such as BBC and Nepalitimes, (BBC, 2011; Nepalitimes, 2014)

Every summer, forecast came with exaggerated figures of demand and supply. The power cut prediction for dry season (winter) done in inflated way that public already started panicking. Without any doubt, many consumers prepared for winter purchasing expensive backup alternatives for expanded power cut. The most common alternatives were solar panels, petrol generators and inverters.

One of the estimates indicates that about one-third of the 3 million customers installed backups in the past decade. (Sangraula, B. 2017)

Load Forecast Comparative

FY	Peak Load (MW) Previous Forecast	Peak (MW) Base Case	Peak (MW) Optimistic Case
2013/14	1303.9	1201.0	1201.0
2014/15	1426.4	1286.1	1310.6
2015/16	1542.6	1422.8	1400.5
2016/17	1653.7	1559.7	1561.5
2017/18	1837.1	1742.2	1800.6
2018/19	2018.8	1903.3	2003.5
2019/20	2208.7	2071.5	2220.3
2020/21	2361.0	2203.8	2408.6
2021/22	2523.0	2378.9	2652.6
2022/23	2695.4	2562.1	2744.7
2023/24	2888.1	2764.5	3024.9
2024/25	3109.0	2978.3	3330.1
2025/26	3345.5	3203.0	3661.6
2026/27	3597.6	3439.5	4022.0
2027/28	3866.4	3688.7	4414.5
2028/29	4168.8	3971.7	4866.7
2029/30	4493.2	4280.7	5371.2
2030/31	4841.4	4614.4	5930.4
2031/32	5216.4	4974.9	6550.3
2032/33	5621.8	5364.5	6779.9
2033/34		5785.3	7491.8

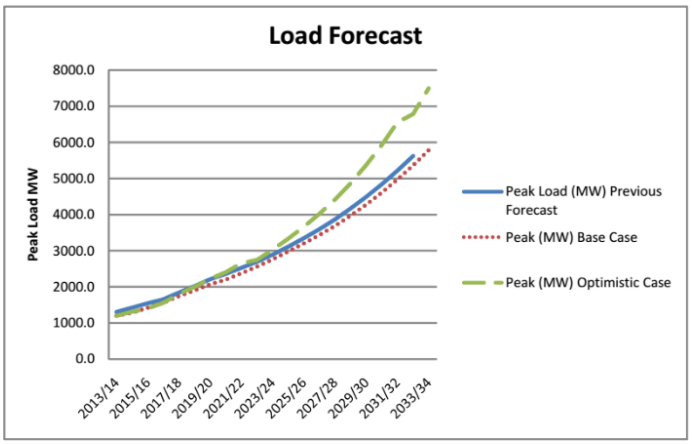


Figure 5: Load forecast tables [Source: NEA annual report, 2014]

Load forecast comparative table on fig.5 predicts the peak load of 1800 MW in the year 2017/18. But the demand was increased unexpectedly. When people were charging all their backup devices at a time, the peak load increased. About 30 percent of the energy is estimated to be lost during the charging of inverter (local name for AC-DC-AC converter) and delivering current to the load.

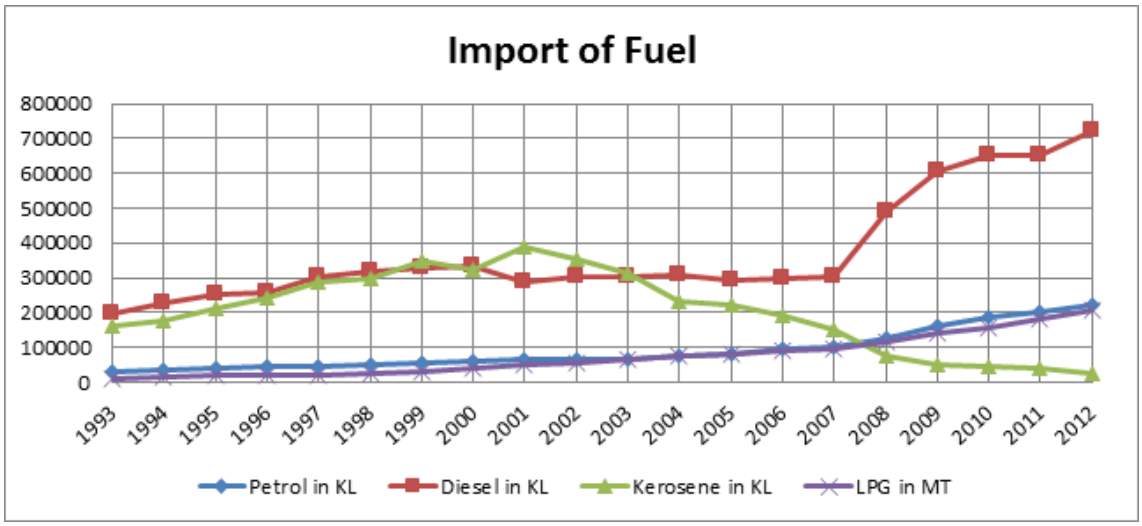


Figure 6: Fuel import data in last 20 years (Source: Nepal Oil Corporation,2015)

From the graph in fig. (6), the import of diesel seems to rise exponentially when the power cut started. This might be because of the establishment of huge diesel-powered plants by government and individual factories.

3.2 Market of alternative energy sources

Billions Nepali currency was used to import the alternate solution for energy crisis which has huge impact on national GDP of Nepal. The major import items for example were Diesel Generator, Parts and lubricators for generators, Lead Acid batteries and inverters. The import of Inverter and its components like batteries and electronic parts were increasing alarmingly and its waste caused by it led billions of rupees directly and indirectly. The efficiency of inverter is merely 50-60%, which was another cause of loss of grid power. (Energypedia, 2017)

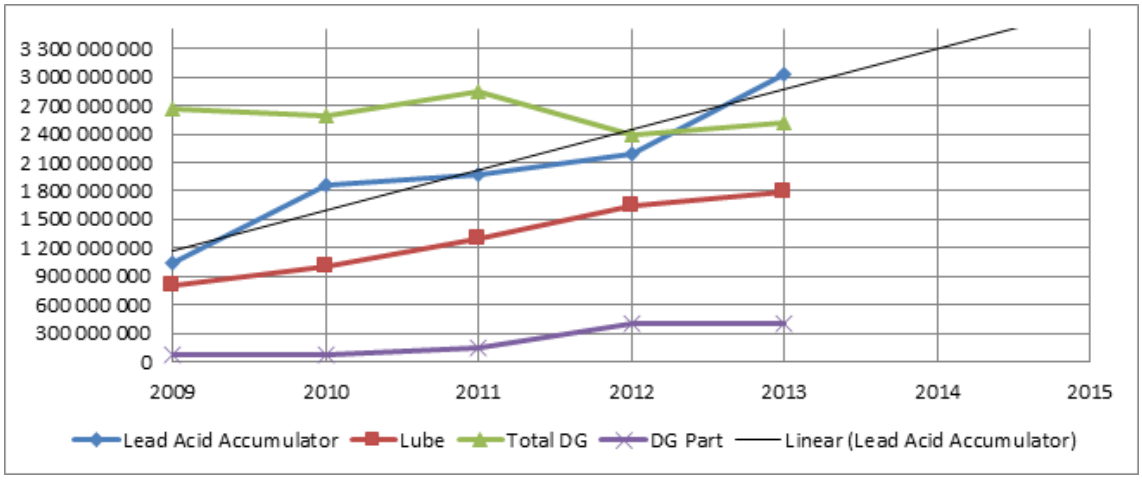


Figure 7: Import statistics of alternative energy source (Source: Energypedia,2017)

4 Change on Energy Scenario in Nepal

4.1 Political move

In September 2015, Prime Minister Pushpa Kamal Dahal, appointed Kulman Ghising as the NEA's managing director. The Prime Minister gave Mr. Ghising full jurisdiction to solve the power issue. But the main agenda of the country was the recent earthquake. The reconstruction has been the most important challenge since the great earthquake of April 2015.
Ghising, who is an electrical engineer, knew the inside story of black outs. With good demand-management competence, he took just few months to end excessive power cuts in the capital Kathmandu and 10 nearby districts. Earlier in April, he ended load shedding in Pokhara, the nation's second-largest touristic city, as well as nine more districts. (Sangraula, S., 2017)

Significant number of prominent energy journalists in Nepal stated that Ghising repossessed electricity that some industries were intaking illegally and distributed discriminatorily to consumers. Engineer Ghishing and his team have been deliberating their clear plans that all they did was managing demand and supply with maximum efficiency. Ghising claims that no one will be getting electricity that belongs to someone else. There was resistance from the opponent, as a political game. In April, the Energy Ministry, dismissed three NEA board members on charges of counteracting to solve the crisis. The media and public, both welcomed this move as they had been inefficient and incompetent. The NEA has regulated the power supply by optimizing power-plant operations. The reports stated that the power houses generated about 25 percent more power than they did last winter, which has added about 100 MW. (Sangraula, S., 2017)

Ghising is pitching an ambitious plan to turn NEA (Nepal Electricity Authority) from a loss-making monopoly to a profit-making entity. NEA has around 10 000 employees. The entity suffered a loss of 12 billion rupees ($110 million) on 2015, and its cumulative loss was calculated to be 37 billion rupees. (Sangraula, S., 2017)

4.2 The Process of change

To answer this question in more specific and authorized way, the author interviewed one of the board members of NEA (Nepal Electricity Authority) Mr. Chet Raj Joshi. The questions were sent in a written form and his answers are presented below. His answers clearly explain the energy production and consumption scenario of Nepal, reformation of NEA, strategies adapted to lower the power cut and future planning.

4.2.1 **Interview 1**

Mr. Chet Raj Joshi is a senior electrical engineer and one of the key policy makers in NEA. He is also leading the 'smart-meter reading' project which is one of the crucial upcoming projects of the organization. The key points are summarized below:

Mr. Joshi referenced the recent report published by NEA to summarize energy scenario of Nepal. 36.8 % of energy is produced from hydroelectricity, 28.4 % is from IPP (individual power producers) and 34.7% is purchased from India. He shows significant amount of revenue generated from domestic users, since 93.9 % of consumers are domestic.

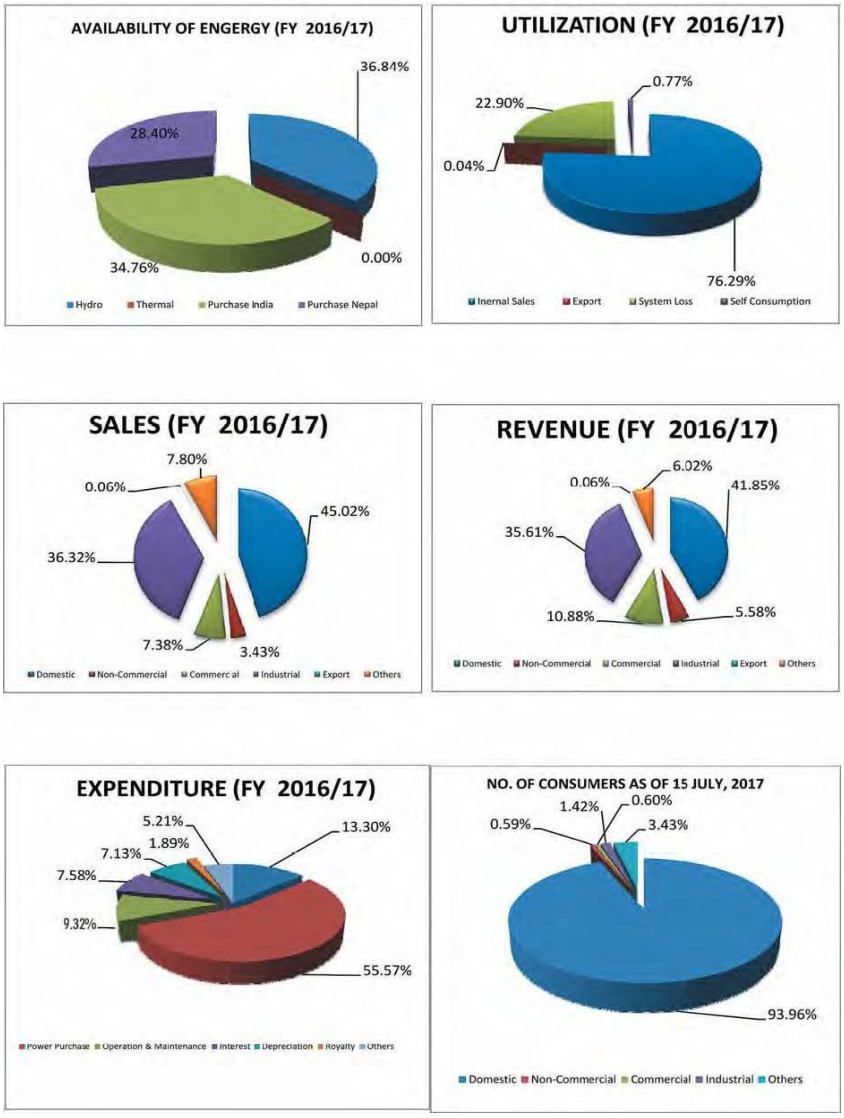


Figure 8: Energy schematics (source: NEA annual report 2017/18, page 151)

Mr. Joshi pointed out the key facts about power revolution in Nepal in various aspects. One of them was organizational reformation. The honest board of directors and changed political scenario adapted aggressive work policy.

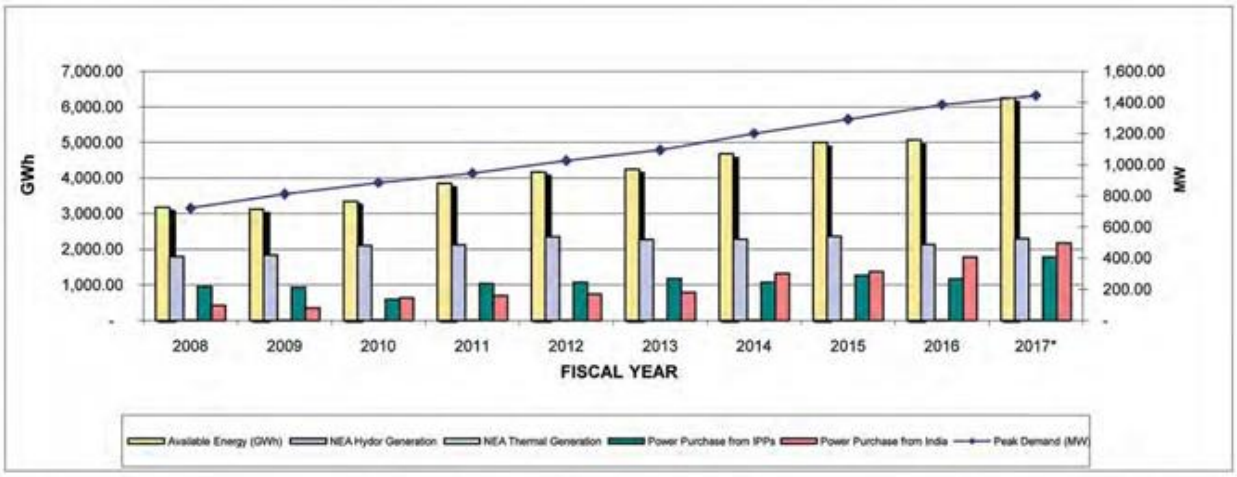
The new strategy consists of replacement of employees, removal of dedicated line, intensified meter reading and various technical upgrades. The previous board of directors were defamed as corrupted in the public. After the change, significant amount of irregularities and corruption cases were out in the media. Many crucial department heads as well as the junior technicians were brought under the punishment. The new team aggressively went after the peak load management, which surprisingly decreased the power cut hours. Mr. Joshi mentions other technical reformations as well.

Reduced electricity stealing, proper maintenance scheduling and upgrading of transformers and switching units supported the power management. He mentions about the huge media campaign for consumers about power awareness. It helped in removal of individual backups saving up to 200 MW in overall system.

Mr. Joshi explained about NEA's short term and long-term plans for power management in Nepal. The short-term plan includes importing of energy efficient units, replacement of old transformers and jumpers and completion of undergoing hydro-projects in time. Expanding international transmission lines, energy banking concept with India, Power Purchase Agreement (PPA) rate variation according to hydroelectricity plant type and smart metering system in households are included as long-term planning of NEA.

Mr. Joshi summarizes the power revolution just as a matter of peak load management. He focuses on honest management team, resource and will power of stakeholders.

The transcript of the full interview is presented in Appendix 1.



Particulars	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*
Peak Demand (MW)	721.73	812.50	885.28	946.10	1,026.65	1,094.62	1,200.98	1,291.10	1,385.30	1,444.10
NEA Hydor Generation	1,793.14	1,839.53	2,108.65	2,122.08	2,357.43	2,273.11	2,288.23	2,366.88	2,133.14	2,305.17
NEA Thermal Generation	9.17	9.06	13.01	3.40	1.56	18.85	9.65	1.24	0.08	0.28
NEA Generation Total (GWh)	**1,802.31**	**1,848.59**	**2,121.66**	**2,125.48**	**2,358.99**	**2,291.96**	**2,297.88**	**2,368.12**	**2,133.22**	**2,305.45**
Power Purchase from India	425.22	356.46	638.68	694.05	746.07	790.14	1,318.75	1,369.89	1,777.68	2,175.04
Power Purchase from IPPs	958.42	925.74	591.43	1,038.84	1,073.57	1,175.98	1,070.47	1,268.93	1,166.24	1,777.24
Power Purchase Total (GWh)	**1,383.64**	**1,282.20**	**1,230.11**	**1,732.89**	**1,819.64**	**1,966.12**	**2,389.21**	**2,638.82**	**2,943.92**	**3,952.28**
Available Energy (GWh)	**3,185.95**	**3,130.79**	**3,351.77**	**3,858.37**	**4,178.63**	**4,258.08**	**4,687.09**	**5,005.70**	**5,077.14**	**6,257.73**

Note :- Peak demand is for all areas covered by integrated system including supply to India
* Provisional figures

Figure 9: Total energy available and peak demand (source: NEA annual report 2017/18, page 152)

Total energy available and peak demand chart (figure 9) shows that demand and production has been unbalancing since 2008. It has continued up to mid of 2016. The total energy available is the sum of NEA hydropower and thermal power generation, power purchased from IPPs (individual power producers) and purchased from India. The average energy available (by August 2017) was 6250 GWh.

4.2.2 **Interview 2**:

To understand the power cut situations and its effect on people, the author interviewed Mr. Baburam Pandey, who is a principal of a high school in Kathmandu. This interview portrays the views of a middle-class working person living with a family. He represents a general consumer in capital city. The questions were sent in a written form and the answer was obtained in same format as well. The main points of his experience are summarized below.

Mr. Baburam Pandey remembered the load shedding times as a nightmare. His family couldn't use electric oven, refrigerator, washing machine and other household appliances on time. It made his lifestyle complicated and disruption in normal schedule. He mentioned about the hiked price of solar systems, Inverters (localized name for AC-DC-AC converter) and gas. He and his wife, along with two school going children couldn't focus in studies. They were forced to have a candle light dinner made on a coal-stove polluting the whole apartment. They spent the extra money every month on candles, woods and kerosene.

Mr. Pandey also mentioned about changed behavior of using electricity and knew how minimal use of it can make difference on energy saving. He expressed the satisfaction on new working model of NEA.

The transcript of the full interview is presented in Appendix 2.

4.2.3 **Interview 3**:

After knowing the views of a common family man, the author decided to know the views about power cut from a startup owner in Kathmandu. Mr. Bhushan Pokharel owns an IT company named Metro Vibes Pvt. Ltd. He represents a young entrepreneur from Kathmandu. The major points of his experience are mentioned below.

Mr. Pokharel mentioned that he started his small IT company when the power cut was in high time. The frequent power cuts affected his schedule and his co-workers were frustrated. Some of the tasks were lost in mid-way as power fluctuation occurred randomly. He spent around 2000 Euros for power backup system. But still he had to pay high electricity bills because of the more current used to charge the batteries.

Mr. Pokharel reveals that he stopped using extra backup system as the grid supply became continuous. He also mentions that everyone has become more conscious about power saving. He expressed gratitude to government body who made this power reformation happen. He thinks a system is good, when right people are in the right places.

The transcript of full interview is presented in Appendix 3.

5 Business opportunities

5.1 Private investment policy

As to the private investment policy in the hydropower sector, Nepal has ratified the national water resources strategy. This will help to provide the standard measure of sustainable use of resources along with the protection of environment. The resource strategy has the target of generating up to 2035 MW hydroelectricity by 2020. Integrated Nepal Power System (INPS) targets to provide electricity for 50 % of households, in which micro and small hydro plants will contribute by 12% and 3% will be from other alternative energy sources. The government has also set the target of generating 4000 MW by 2027 which expects to provide 75% of the households with integrated system, 20% by isolated (off grid) systems and 5% with alternative energy sources. (Energypedia, 2017)

Hydropower Development Policy 2001 sets the vision to meet the national consumption and export the energy as well. The Government of Nepal prioritizes the low-cost hydroelectricity generation which mainly targets the rural electrification. The secondary target is said to be export of energy, which ultimately supports the development goals. (MOFA, 2016)

5.2 Investment risks and challenges

Slow and hectic government processes: Plenty of time is already consumed on possibility survey and related homework. And again, when the application is on the table, officials tend to add numerous clauses and amendments, which might even not be supported by legislation. There have been examples of taking a whole year to make one decision. In the whole process, several ministries work together in parallel. Thus, the coordination between ministries itself has been a tedious process due to lack of political instability. Many times, private investors have withdrawn their applications in mid-way. Monitoring bodies are fully aware with these irregularities but does not seem to implement effectively so far. (Shrestha, S., 2016)

Social and political challenge: These two adjoining topics are the main challenges seen in recent times. Each political party has individual interest. Thus, according to their benefit, they misinform people about the hydropower project goals and create dispute. This forced-controversy makes the construction process more hectic. Most of the times, parties themselves appear on the scene to make bargains in the name of problem solving. (Sharma, R. 2016)

Skilled labor and capability: Experts anticipate that Nepal can build 2-3 hydropower plants at once ranging 100 MW by its own. But beyond this capacity and number, it needs the foreign technical and monetary aid. Thousands of skilled manpower have been working abroad, but due to job security and political situations, they doubt coming to Nepal and work on local projects. (Country profile, Nepal, Hydropower.org)

Natural challenges: Geologists claim that land structure of Nepal is in young age. Due to this, erosion and rate of sediment flow is significant. Nepal lies in one of the active earthquake faults. This makes tunneling process challenging and expensive. Local deforestation and global warming have resulted glaciers unstable. The summer rain pattern has been slightly changed, which mostly depend on monsoon. Most of Nepal's river origin from glaciers or mountains. Due to the mountainous land structure, construction of access roads to project site and delivery of heavy equipment is another big challenge. It raises the overall construction capital. (Sharma, R.,2016)

Financial challenge: Large projects mean a substantial sum of money. In recent times, it takes 1.5 - 2.5 Million euros per Megawatt. Nepal has targeted to produce 10 000 MW in 10 years. To meet his target, foreign investment is most. For appropriate foreign investment, the first step of government is to make feel that Nepal is safe for investment and guarantee of profit return. (Sharma, R., 2016)

5.3 Foreign investment, risks and benefits

Many times, investors have withdrawn their projects due to for example, tedious legislation hindrance, local obstruction and political undermining. Those who continue still face the increased budget on project. Some of the companies are facing problems on taking back their profit outside Nepal. Government often accuse them for taxation fraud and ambiguous aim. For example, TeliaSonera from Sweden invested a huge amount of money on telecommunication in Nepal. But recently, it sold most of the shares to a third company and claimed to secure its profit. The government has been

accusing TeliaSonera for profit tax fraud and misinformation. However, the politicians are divided in this case, whether it should be charged or not. (Sharma, R. 2016)

There are still other challenges than those mentioned above. Foreign investors want to remove the double taxation system. Till date, a company must pay taxes on both countries. The next problem is Nepal does not have credit-rating so far. It has not deployed 'sovereign bond'. This means a company faces the problem on receiving periodic interest payments and to repay the face value on the maturity date. Government bonds are usually denominated in the country's own currency. (Shrestha, 2007)

Nepal has fixed exchange rates with the Indian currency. Foreign companies often complain about this issue. Another problem is that the Nepal Electricity Authority (NEA) does not accept Power Purchase Agreement (PPA) on Dollars. NEA suspects of monetary balance due to foreign exchange risk. (Thapa, S, 2017)

5.4 Possibilities and positive scenario

In the present scenario, India, China, America and Norway are the key investors on Hydropower in Nepal. India and China are more attracted towards increasing their investment as they can directly use other collaborative resources. They have an advantage of being physical neighbors. Nepal and India share more than 1500 Km of border which includes several cities nearby. The rapid industrial growth in India is creating more demand. Thus, India can be the largest consumer of Nepal's energy if the production suffixes. The cross-border transmission line with India of 1000 MW capacity has recently been completed. (International Hydropower Association, 2016)

Nepal has a possibility to sell energy to another neighboring country Bangladesh, where energy scarcity is huge. the Prime minister of Bangladesh, Ms. Sheikh Hasina, has recently requested India for a transmission line expansion to Nepal. According to the Ministry of Foreign Affairs, Nepal encourages foreign investment as joint venture operation with Nepali investors or as 100% foreign-owned enterprises. Nepali tax slabs are one of the lowest and its position is fairly good in ease of doing business. (MOFA, 2016)

Nepal has lower tax rates comparing to India and China. The Nepal government has announced to make the capital flight easier for both national and international

companies. Almost all the Initial Public Offering (IPO)s have been oversubscribed in Nepal by more than 100 times for last 5 years. Nepal has a huge amount of poorly-employed but skilled manpower. In terms of salary, the best manpower can be hired with a salary of almost half the amount paid in India or China. Nepal produces around 10 thousand qualified engineers and IT graduates per year. These candidates can be tapped by early movers.

6 Conclusion

Energy is the backbone of development for any country. A country like Nepal where other alternatives are much too far, hydroelectricity is the only best option. Around 600 large and small rivers gushing down all the year with optimal discharge is nature's gift for the development of clean energy. Despite of having a huge potential of hydroelectricity, Nepal has not been able to extract it adequately. Political instability, dishonest leadership, lack of vision and corruption are the major problems in countries like Nepal. However, since 2016, reformation in the organization and support of government has made exemplary changes in the energy situation.

This thesis presented some utmost facts about the strategies adapted to minimize power cuts in Nepal. It also explains some key issues for the development of hydropower more efficiently. It was concluded that without the cooperation of political support as well as organizational reformation, there are rare possibilities of relieving future energy crisis. The cooperation between the government and the private as well as foreign investors will help Nepal to export energy in the future.

The development of hydropower not only meets the gap between demand and supply but also produces more jobs, helps to reduce the import of petroleum products, enables numerous industries to start which will lead the country towards the prosperity of economic growth.

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Appendix 1

Mr. Chet Raj Joshi
Member, Board of Directors
Nepal Electricity Authority (NEA),
Kathmandu, Nepal.

Date of the interview: 20.08.2017

Q1: What is the energy production and consumption scenario of Nepal?
Ans: Well, the exact and recent figures need some time to be calculated and analyzed. I want to present an overview on our energy and utilization scenario. This is obtained from the NEA annual report, 2016.

Q2: What are the key points to support the claim of 'end of load-shedding' by Nepal Electricity Authority (NEA)?
Ans: Since the drastic managerial change in NEA, it took few months to figure out from where to start the task. There was huge pile of problems. Not only the political games, there were problems in consumer behavior too. But, we first started reforming our organizational structure and responsibilities. The most populated city Kathmandu, which is also a capital city of country has been declared load-shedding free zone. When power management was successful in Kathmandu valley, we started working on other districts too.

Q3: What strategies were adapted to reform the administrative mechanism?
Ans: The ministry for Energy handled the managerial aspects. Mr. Kulman Ghising was appointed on September 2016 as a new director. He is a very determined and experienced person in the field of energy. He has been associated with NEA for 20 years. The board of directors appointed under his recommendations set up the new strategies. Few of them can be listed as follows-

a) Replacement of employees

Some employees were somehow linked with business houses for the personal interest. We tried to identify key personnel for irregularities and replaced with young and talented ones.

b) Removal of dedicated line

Even high-level officers were influenced with big industries. They provided the dedicated-lines to certain industries only. Dedicated lines (feeders) provide electricity all the hours without disturbance, which led to distribution of power and unbalance in schedule management. We have now removed almost of the so called 'dedicated lines' from personal entities.

Recent data shows, it has saved around 40 MW of energy.

c) Intensified meter reading

We don't have smart metering system yet. Thus, our employees have to go house to house and read the value of consumed power throughout the month. In some of the areas, we found our technicians did not read the value correctly and mentioned less numbers to the system which made the power consumption more and statistical revenue lesser. In some cases, only the single-phase reading was done, even if the 3-phase system was installed. Now we have intensified the meter reading and set up internal enquiries if needed.

Q4: What major technical reformations and upgrading were done?

Ans: Many people perceive that increase in power is directly linked with increased production. But the fact is, we just did the peak load management. There were no such big projects which would start production immediately. There are many hydro projects undergoing, but it takes a couple of years to extract their production. From the 2016 data, our maximum demand on Peak Hour was about 1400 MW. In normal hours, it is 700 MW. You know, Nepal hasn't been industrialized so much. Thus, the demand figures are not that huge.

Importing from India: Nepal faces energy crisis mostly on winter times. Because our productions houses are mostly ROR (run of river) types. When the flow of water is low, we can't operate our turbines on full capacity. Dams do not hold surplus water for longer times. Thus, we have been importing from India in those situations. We import electricity from 4 major transmission lines in Nepal. The max. importing capacity of our existing transmission line is about 800 MW. The newly built cross-border transmission line of 220 KVA on Dhalkebar, Dhanusha District has made easier for power import and export.

Removal of Individual Backup: When the Peak Load was managed in urban areas, people got electricity on almost of times. This made less use of their backup systems (batteries, inverters, etc.). As a result, overall electricity consumption on device charging was less. Individual amount seems less, but it has now saved almost 200 MW in overall system.

Reduced electricity-stealing: In some areas where police and government access is low, people used direct hooking on transmission wire and used electricity without the billing-meter. Electricity-stealing was common on rural area. But NEA has mobilized special task groups on those areas and greatly reduced the no. of hookers. 30 MW of power in average has saved so far.

Maintenance scheduling: Usually, the production house maintenance was done in winter time, because of low discharge of river. Longer the maintenance time, longer was the power cut. But, since 2016, we have scheduled the maintenance of turbines in alternate ways so that production houses will be disturbed at least.

Upgrading transformers and switching units: One of the key reasons for power cut was the low capacity transformers. The step-down transformers (which are kept in local area) couldn't handle increased load. Which often gave trouble and people had to face power cut unless the new one was replaced. We have started upgrading transformers nationwide. High capacity transformers seem to be durable and needed less maintenance. Some of the switching units were facing 'tripping problem'. They had old switches, jumpers and related equipment. The upgrading and maintenance of switching stations has begun.

Annual energy consumption factor: Due to the regular power supply, the overall annual energy consumption factor has decreased. We can conclude that annual energy demand hasn't much hiked as anticipated in previous years. Our efforts have added 400 MW energy during peak hours. The national demand rises to 1,350 MW in peak hours. The NEA has almost met the deficit of about 400 MW by importing 330 MW of power importing from India and our hydropower plants producing 400 MW of electricity.

Q5: What are the short-term plans of NEA?

Ans: Most districts of the country including urban areas are now load shedding free. But the whole population is not getting continuous supply. Thus, we have much more to do. NEA has few points for short term planning.

Importing Energy Efficient units: NEA is importing adequate amount of energy efficient LEDs, fans and street lights. We have coined the term 'smart fan' for low capacity fans. Public can buy those fans and LED lights from NEA in subsidized rates.

Reducing technical loss: Due to our old and faulty connections, there has been a significant amount of technical loss. We are replacing and maintaining the low power transformers, jumpers, switching systems, etc.

Public awareness: In this short period of time, public supported NEA to lower the power cut by not using heavy loads on peak hours. But still we need to aware them more about energy efficient behavior and economic ways. It helps a lot on reducing peak load.

Q6: What are the long-term plans?
Ans: There are many small and big scale hydropower plant constructions going on. But many companies are luring on their targets. We should urge them to speed up the construction and complete within the targeted date.

Selling energy: We are planning to build international transmission lines for export and import of power. There have been possibilities to sell the power to Bangladesh. It is just 27 Km away via India. Recently, Prime Minister of Bangladesh also expressed willingness to buy energy from Nepal if India allowed to share its border. But still, political movement and foreign policy are key issues here.

Energy Banking concept: India has peak demand on summer time and Nepal has on winter time. There is a possibility of surplus energy in Nepal in summer because of high current in rivers. Thus, we are thinking of an agreement with India lending our surplus energy in summer and bringing back in winter. This process is a kind of 'energy banking'.

PPA rate variation: Till date, there has been a same tariff rate for all kind of production houses, like Run of River (ROR), storage type, etc. Since, their production cost and

nature vary, we are planning to differentiate the per unit rate according to production types. This might be encouraging for companies.

Smart metering system: As I mentioned earlier, we have been facing problems due to manual meter reading. It's a loss in many ways to read the meter manually and issue the bill. We are planning for online metering, saving our manpower and technical loss. But it needs a lot of homework and system development.

Q7: In your opinion, how Nepal can be an example to third world nations facing extreme power cuts and energy crisis?

Ans: No miracle has happened in Nepal. It is just a matter of Peak Load management, in technical terms. No government can proceed its plan and meet its development goal unless the employees are honest and corruption free. We have just removed our dysfunctional parts (including old machines and employees). The proper management of resource is the key formula to success. Yes, our 'power revolution' can be an example to other countries if they have similar situation same problems as ours. There is no secret formula for this step, it is just the resource management within the system.

Appendix 2

Interview with Mr. Pandey

Mr. Baburam Pandey

Principal, Nepal Army High School

Budhanilkantha, Kathmandu.

Date of Interview: 10.04.2017

Q1: How do you remember power cut situations a year back?

Ans: Honestly, I don't want to remember the power cut situations. Watching TV, using washing machine and using fans on hot temperature were just dreams. We were compelled to stay in the dark. Using inverter (localized name for AC-DC-AC converter) and emergency-lights were the only option for us. But it did not even last for long. Inverter and solar prices were hiked.

Q2: What major problems you faced due to power cut? What were its effect on your daily life and family?

Ans: I am a teacher on high school. I have two kids going school and a wife, working on a private office. The load shedding time was increasing day by day. I remember it was once up to 18 hours a day. I couldn't use iron in the morning, we couldn't use water pumps, no washing machine, no fan, etc. Daily life was suffered a lot. Kids couldn't concentrate on their homework. The inverter we installed did not work properly when we used rice cooker and fan at once. We had to wait until the power resumed. There was no power in mornings and evenings. Thus, sometimes I had to return home in the mid-day to use water pumps, washing machine and recharge the inverter. We used to wake up around 3 AM in the morning to use washing machine. As a teacher, I could easily see side effects of power cut on students. Many of them silently complained that they do not own proper backup systems at home, due to which, homework and extra activities given were not completed on time.

Q3: How much money you used to invest monthly on alternative sources (like Solar, Inverter, gasoline, generator sets, etc.)?

Ans: We had a small solar panel (may be 20 watts) on the roof and an inverter (I don't know its power) in the room. Our local technician called its was the 'hybrid system'. The total cost for the system was 60 000 Nepali Rupees (around 550 Euros). But it seemed that panel on the roof was doing nothing to the battery. Because the electricity bill was same in all the months. (around 3 Euros). Later realized that the inverter used much

more power to charge the battery. Besides these systems in home, we bought 'portable mobile charger' (10 euros), extra gas-cylinder for water heating (25 Euros) every 3 months and even few packets of candle (1-2 euros).

Q5: How your energy consumption behavior has changed before and after Energy reformations?

Ans: The first thing is - I stopped buying 'power cut schedule' print outs, as they are no longer published. Children do school homework in bright CFL lights, me and my wife watch TV after dinner and we can use washing machine when we want. But since, NEA has appealed the public about energy awareness, we don't use rice cooker, washing machine and water pump at the same time in peak hours. We remember to switch off the unnecessary lights every time. We don't put on the balcony lights for the whole night. I have replaced the corridor and bathroom lights with low power LED lamps. The inverter is no longer used. Our electricity bills have decreased by 10-15 % than previous years.

Q6: Why do you think this power cut has reduced dramatically?

Ans: I think it's due to new committee formed in NEA and change in Energy Ministry. There were lot of corrupted officers who intentionally did the power cuts. People even rumor about the bribery done by inverter businessmen. Inverter and battery companies had spent huge amount of money in Nepal.

Appendix 3

Interview with Mr. Pokharel

Mr. Bhushan Pokharel

CEO, Metro Vibes Pvt. Ltd.

Date of Interview: 10.04.2017

Q1: How do you remember power cut situations a year back? What major problems you faced due to power cut? What was the effect on your business and overall productivity?

Ans: I started my IT company 2 years ago. It does the web designing, hosting and software development. I rented a flat with 3 rooms including front desk office and working places. I had 7 computers and other peripherals. The frequent power cuts affected our computers. Some of the tasks were lost in mid-way. Our programmers were frustrated. We had to manage working schedule according to the power cut schedule. Then I bought the inverter system for computers. It used a sine-wave power inverter and a tubular battery. It made little easier to work and manage schedule.

Q2: How much money you used to invest monthly on alternative sources (like Solar, Inverter, gasoline, generator sets, etc.)?

Ans: I did not use generator sets, as they consume gasoline and made noises when running. I chose inverter system which cost was 200000 NRs (approx. 1700 Euros). But then the electricity bill was bit more than usual. Because inverter drew more current for charging the set of batteries.

Q3: How your energy consumption behavior has changed before and after Energy reformations?

Ans: Now the grid supply is continuous. My inverter hasn't been in use since 6-7 months. Electricity bills seems to be normal. I don't turn on all the computers and projectors if they are not in use. I have replaced the old bulbs with LED lights. I have printers with power saver functions. We all have been more conscious on power saving after NEA issued the awareness campaigns. We have to help them so that energy would be saved, and we get the flawless supplies.

Q4: Why do you think this power cut has reduced dramatically?

Ans: It's all due to good leadership in NEA. Everybody knows, the officials were corrupted. New hydro production houses were pending. Even engineers presented the fake statistics, and everybody started believing that. I don't understand all the politics, but the new team has utilized our resources well. Maybe, it's due to right people in the right place.