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Grid Connected Bagasse Cogeneration Potential in Nepal and its Load Flow analysis in INPS

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Abstract

This research emphasizes on the grid connected bagasse cogeneration potential in Nepal and its impact on power demand and supply of Integrated Nepalese Power System at present and future scenario. It is found that power from cogeneration that can be supplied in the grid in current crushing trend in general efficient mode is 69 MW. This amount of the electricity can be supplied in grid for 120 days of peak winter season generally start from half of the December. It is 12% of the total energy supplied to grid based on the generation, demand and supply data of Falgun 3, 2072 of Nepal Electricity Authority. If all the sugar mills are operated in full capacity than it can deliver 94 MW of electricity to grid for four month which is 16% of the total energy supplied in grid at winter season. Cogeneration at current crushing trend and full crushing trend both has a very good potential for load shading reduction. Similarly, adopting cogeneration till 2019; the load shedding can be completely reduced without evening peak in winter season.

According to the geographical location of the sugar mills, there may have four different regions in Nepalese grid based on power import points from India. After connecting cogeneration plants in respective region and making load flow analysis in Electrical Transient Analysis Program (ETAP); it is found that the voltage profile of bus and branches is greatly improved by interconnecting these plants in grid and overall transmission loss is reduced by 1.5% than before.

Keywords

Cogeneration – Integrated Nepalese Power System (INPS)– Electrical Transient and Analysis Program (ETAP)

1. Introduction

There are small challenges and bigger opportunities in Nepalese sugar sector. The filed survey with the farmers around the four bigger sugarcane factories of Nepal shows that farmer are still exciting with sugarcane cultivation but expecting easy agriculture loan, proper irrigation technology, timely price fixation, easy excess to fertilizer and modern method of cane cultivation from the government authority[1].

Due to the lowest yield of sugarcane in Nepal, Nepalese farmers are getting less earning as bordering districts farmers of India. In another side, the paying capacity of sugar mill is weak because they are losing huge amount of revenue in absence of high efficient cogeneration as compared to Indian sugar mills where it is mandatory to sell electricity to grid form cogeneration[2].

Generally, Nepalese sugar units have the facilities to meet season specific captive thermal and electrical needs by low and medium pressure boilers, mill drive turbines, cogeneration turbine generator sets. They run with the boilers with the pressure ranging from 20-25 bar which can be upgraded to boiler with pressure 67 bar/480 C and 110 bar/535 C for maximizing power generation potential and benefit through revenues from utility by the scale of surplus electricity.

One of the beauties of cogeneration in sugar industries is power evacuation in winter season when Nepal has to face very high power deficiency. NEA is purchasing very large amount of energy to meet this crisis from India. There is a very good option of Cogeneration to operate in winter where the generation of ROR hydro gets down. In another part, About 300 MW of power was imported from India during dry season by NEA. During dry season, NEA generation decreased total of up to 140 MW (Except Kulekhani storage operation), whereas IPP generation decreased up to 78 MW only resulting 218 MW production from Nepalese ROR plants. During this period, around 700 MW of power deficit was recorded at peak time. In such a energy crisis scenario very good opportunities are seen in Nepalese sugar mills as cogeneration[3].

Despite good technical potential and financial viability of cogeneration and high demand of electricity in the grid to address the longest hours of load-shedding during the winter season; the cogeneration potential has not been tapped yet. There is still a policy and regulatory reform need to create an enabling environment for cogeneration. Ministry of Energy made a break through this year by deciding for integrating incidental power from cogeneration to grid. But, there are some other technical issued, without solving them, it is not possible even to tapped incidental cogeneration in grid.

All the power house before connecting to grid should have tested in grid to see the impact of the power house in power transmission system. Basically it is done by load flow analysis. It is one of the very important task in power system. Effect of the new power house on grid like voltage, frequency, power factor, ability of grid to flow the power for whole hours of operation, supply side and demand side management etc. have to studied well. Electrical Transient Analysis Program (ETAP) is used for this purpose in this research work[4].

2. Methodology

2.1 Questionnaire Development and Field Survey with Farmers:

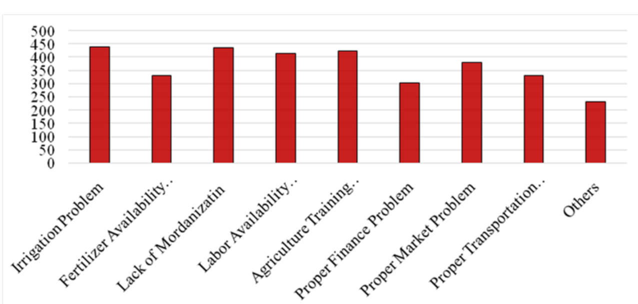

Figure 1: Cause of minimum sugar cane yield in Nepal

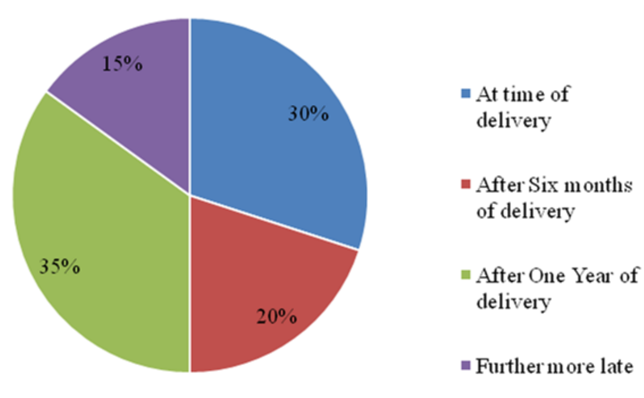

Figure 2: Payment periods for Sugarcane Farmers

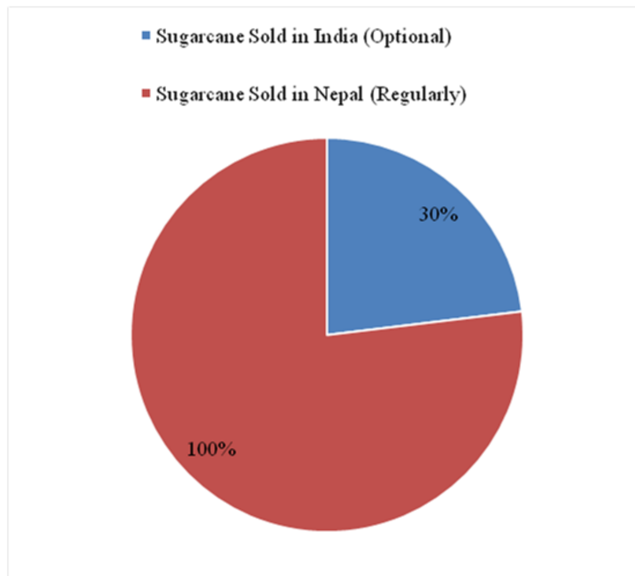

Figure 3: Percentage share of sugarcane sell in Nepal and India

Figure 1, 2, 3 are representing the report generating by the field survey with Individual farmers. The report shows that the sugarcane yield can be increased If government takes the sugarcane farming seriously.

2.2 Secondary Data Collection

- ☐ Load Shedding Table for Falgun 3, Falgun 30 and Chaitra 5 (LDC, NEA)
- ☐ Details of 132 /66/ 33 KV substations with their capacity, power houses and load flow status for Poush, Magh, Falgun and Chaitra of 2072. (System Planning department, NEA)

- ☐ Power Purchase Points in Nepal from India (LDC, NEA)
- ☐ List of Hydropower with RCOD date with in BS 2074/75 (Power Trade Department)
- ☐ List of Solar PV System committed to come with in BS 2074/75 (Power Trade Department)
- ☐ Relevant data form Year In review, NEA 2013/14 and 2014/15
- ☐ Working Formula for Cogeneration Assessment.[5]
- ☐ Power Generation Log Sheet of INPS for the whole Year of BS 2072 (LDC, NEA)
- ☐ Sugarcane crushing in by individual sugar mills in 2014.

2.3 Data Analysis

- ☐ Assessment for Cogeneration Potential for Incremental Cogeneration System (32 Bar) for current crushing mode and full crushing mode.
- ☐ Assessment for Cogeneration Potential for high efficiency (67 Bar System) and (110 Bar) for current crushing capacity and full crushing capacity.
- ☐ Study of Impact in INPS for load demand and supply by cogeneration at current crushing capacity and full crushing capacity for now and at BS 2075.

2.4 Development of INPS Model

Since, Nepalese power grid is not a single unit. There are more than ten different radial feeder from which Nepal is buying electricity from India. But based on the geographical orientation of the sugar mills and the general power supplying area from the feeders in peak time of winter, following four region is made.

Region I: Kulekhani as Slack bus
Region II: Dhalkewar as Slack bus
Region III: Kataiya as slack bus
Region IV: Tanakpur as slack bus

3. Results and Discussions

The grid connected cogeneration potential of Nepalese Sugar Mills is calculated with the help of working formula generated. Generally, 120 days from half of the December is taken as sugar crushing days. It is found that total 69 Mw of power can be integrated in grid in current crushing mode and 94 MW can be added in grid in full crushing mode.

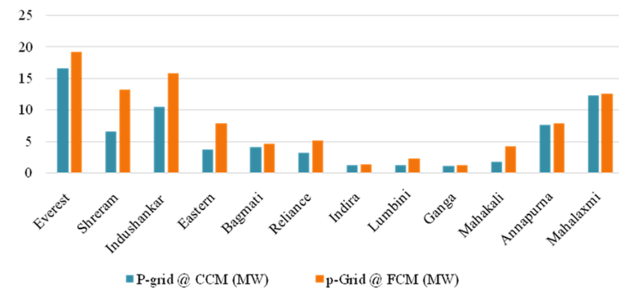

Figure 4: Potential Power to Grid at Current Crushing and Full Capacity Crushing of Sugar Mills

For the analysis, the power generation, supply and demand of Falgun3, 2072 is taken as the reference date; collected form load dispatch center, NEA.

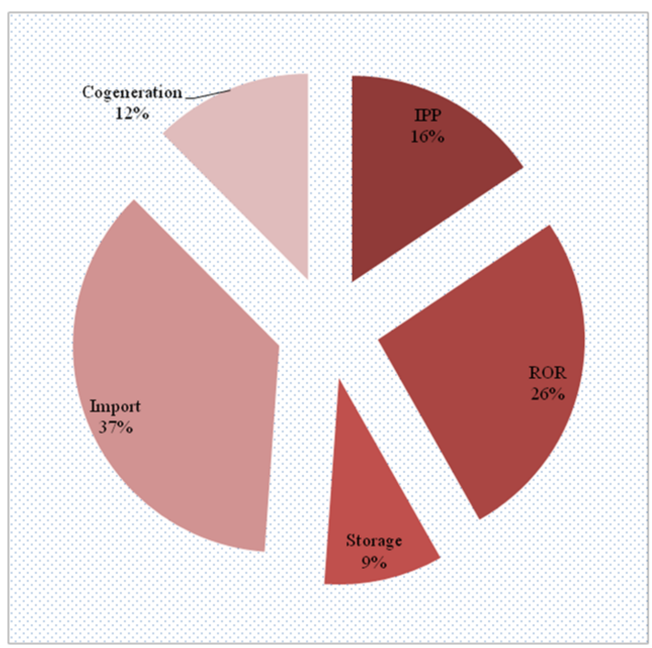

Figure 5: Total MWh Injection in INPS with Cogeneration in General efficient Mode with current TCD

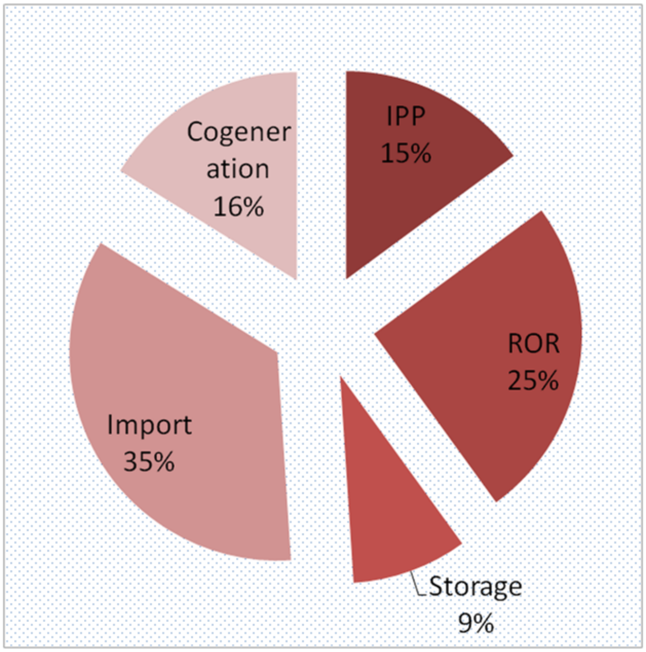

Figure 6: Total MWH Injection in INPS with Cogeneration in efficient Mode with Full Capacity Crushing Mode

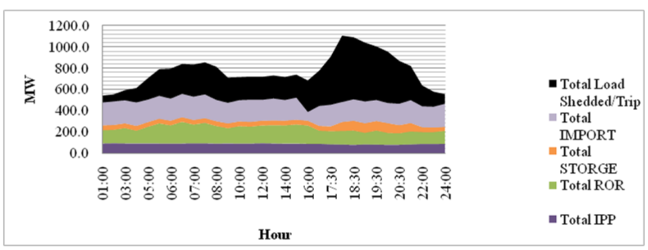

Figure 7: Demand, Supply and Load shedding Chart of Falgun 3, 2072

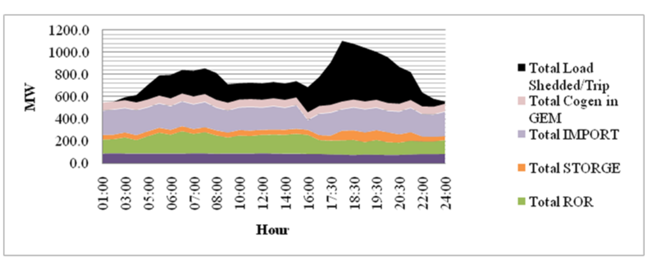

Figure 8: Demand and Supply Curve with cogeneration at CCM of Falgun 3, 2072

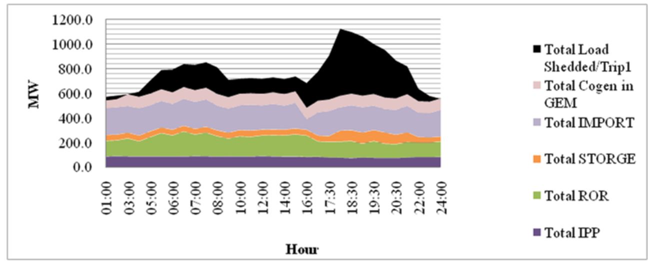

Figure 9: Demand and supply curve with Cogeneration at FCC of Falgun 3, 2072

Figure 2 and figure 3 shows that 12% of the total energy injected in grid can be supplied by cogeneration in current crushing trend and 16% of the total energy can be injected in grid at full capacity crushing. Similarly, the load shedding pattern with out cogeneration is shown in figure 4. It can be reduced by cogeneration at CCM is a great extent. By adopting cogeneration at FCM, the load shedding gets almost limited to peak hours of the day. Figure 7 is made for contribution of cogeneration at future scenario. The demand the supply curve is made for Chaitra 5, 2075 considering 10% growth in system demand per year.

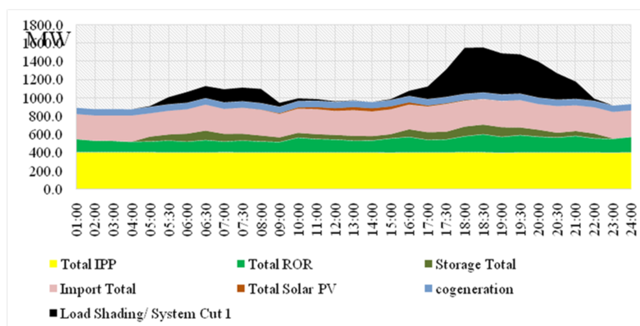

Figure 10: Projected demand and supply for Chaitra 5, 2075 with 10% Demand Growth

It is mandatory to have the load flow analysis of the new power plant in system grid before synchronizing. Since, Nepalese grid is not a single unit. It takes electricity from India from various 10 points. According to geographical region of the sugar mills, four different regions were made and the load flow was carried out. For this purpose ETAP software is used. By adopting cogeneration, the voltage profile of most branches and buses are greatly improved with overall transmission loss reduction by 1.5%.

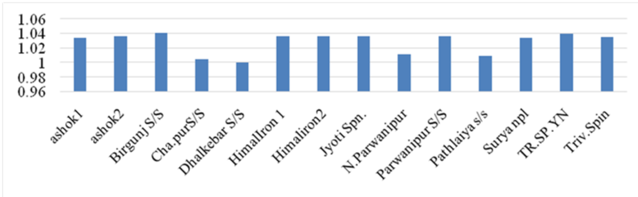

Figure 11: Voltage profile of Region II before Cogeneration

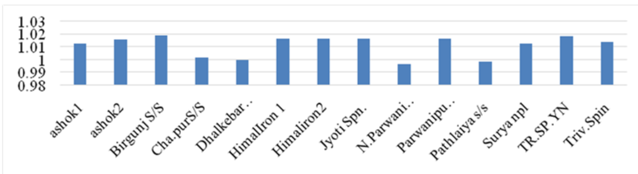

Figure 12: Voltage Profile after Cogeneration in Region II

4. Conclusion

Integrating cogeneration in grid has a very positive effect in demand side management in INPS in winter season in current and future scenario. The load flow analysis shows that all the power generated by cogeneration plans can easily take by grid with better voltage profile generation in buses and branches with effectively reducing system loss. Grid connection of cogeneration provides the sugar industries to collect a huge revenue in a year. Around NRs.40 Crore gross revenue collection is possible by Everest Sugar Mill itself if it sells in current crushing capacity. If it sells in full crushing capacity the total gross revenue will be NRs. 47.5 Crore. Similarly the financial health of the other industries will also gets improved. Farmers, Mill owners, NEA and state all are going to be benefited by adopting cogeneration. So, the cogeneration energy should be harnessed soon.

5. Future Works

Detail financial analysis of cogeneration integration in INPS is an important task. Region selected in INPS of this analysis may vary according to power availability in the grid. Effect in INPS with cogeneration plants with varying the length of these region is a remaining task of the research work. The load flow analysis is done with existing capacitor back. The effect of cogeneration plants can be seen without putting the existing bank in the nearby region of the plant.

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