ABSTRACT
The continual growth of Indian industries steps up towards the best coincidence with world for globalization. The economic activities in our country over last four decades have resulted in continuous rise in demand for power in spite of phenomenal growth rate achieved by the power sector. Mainly all the thermal power projects are satisfying it and the considered opinion of the experts in our country that the power shortage is here to stay in foreseeable future. The growing energy demand and the steep depletion of fossil fuels have directed the engineers and technologists to explore the possibilities of developing alternative sources of energy particularly from conventional non renewable energy source. As per the survey of present installed project capacities and proposed untapped energies we can forward for new approaches towards power in India. As per the above surveyed situation experts explore the power generation targets towards all sugar industries. So 1200 MW energy can be generated from burning the surplus bagasse for the production of steam to run the turbine generators. This method is technologically known as Co-generation. For the generation of surplus power there is continuous analysis required for the economical balance for input and output power. The system analysis and results are calibrated under one process known as Energy Audit. This reduces the wastage of power through steam & heat and non control of feed air. Tapping it at each interval can generate surplus power for Maharashtra will produce around 600MW from all running sugar factories. This paper finally focuses on developing alternative source is a lengthy process, it is important that energy conservation in the existing plants which can have beneficial effects often in the short term be stressed to help in the transitional period. The potential benefits of conservation are substation and hence it needs all round efforts. Besides it can be an effective means of combating the energy shortages in the short term and reducing the gap between supply and demand.

INTRODUCTION
Indian sugar mills, both in the private and co-operative / joint sectors, have acknowledged importance of implementing high efficiency grid connected cogen power plants for generating exportable surplus power. In fact, additional revenue stream by sale of exportable power to State Electricity Boards (or third party customers), has become the only way for achieving long term sustainability, given the fiercely competitive domestic and international sugar markets. The potential from about 575 operating sugar mills spread over 9 major States have been identified at 3,500 MW of surplus power by using bagasse as the renewable source of energy. The project involves employment of extra high-pressure boiler configurations of 67 bar / or 87 bar or 105 bar (against the conventional 32 bar or 42 bar pressure boilers used in the sugar mills).

2. POTENTIAL FOR POWER PRODUCTION
Sugar mills conventionally co generate their own requirements of steam and power during the season operation of 150-200 days by using bagasse, the residue of sugarcane generated after crushing. They, however, use a number of low-pressure inefficient boilers for the purpose and consume and waste surplus bagasse during their season operations. Over the years, due to the expansion and diversification of products in sugar mills, their energy needs, both during season and off-season, have multiplied. They often require high-cost grid power and additional fuels both during season and off-season. This invites use of high efficiency co generation plants. The potential from about 575 operating sugar mills spread over 9 major States have been identified at 3,500 MW of surplus power by using bagasse as the renewable source of energy. The project involves employment of extra high-pressure boiler configurations of 67 bar / or 87 bar or 105 bar (against the conventional 32 bar or 42 bar pressure boilers used in the sugar mills).

3. STATE WISE PRODUCTION OF SUGAR-CANE IN INDIA
The high efficiency cogeneration design not only uses the available bagasse efficiently, but also yields substantial quantities of power for exporting to the grid, over and above their enhanced energy need. Improved energy efficiency of sugar mill operations to a maximum possible extent is a pre-requisite for building high-efficiency grid-connected cogeneration power plants. Reduced captive steam and power consumptions enhance bagasse availability for extra power generation and for extending their period of operation beyond the crushing season. The potential of 3,500 MW can be easily increased to over 5,000 MW by employing new sophisticated equipment and systems for reduction of steam and power required for sugar processes. From present 50-52% steam on processing and 22 units of electricity per ton of cane crushed, it can be reduced to 42-45% steam on process and 16 units of electricity per ton of cane crushed, as well as for the manufacture of by-products.

4. DEVELOPMENT OF POWER GENERATION FROM SUGAR INDUSTRY
Sugar industry is identified as one such non-conventional energy source because it uses renewable sugar cane crop as the raw material, which gives capital fuel (Bagasse) with appreciable calorific value. Sugar industry by and large is self sufficient in own fuel and power and it is the only industry which has not suffered any setback due to energy crisis in view of its own generation of electricity for its requirement during crushing season. Hence it is high time

<table>
<thead>
<tr>
<th>Potential of Decentralized Generation</th>
<th>Option</th>
<th>Total Potential (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar Cogeneration</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Co-generation in other industries</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Producer Gas</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
5. FIRST CO-GENERATION PLANT IN INDIA
Tamil Nadu Sugar Cooperative Limited, a government of Tamilnadu undertaking stands as the first organization in India, which has successfully organized and implemented the co-generation scheme in M.R. Krishnamurthy co-operative sugar mills Sethianthope and Cheyyar co-operative Sugar Mills, Cheyyar. The powerhouse consists of three turbo generators (TG) of generation capacity as given below: Three TG sets of 2.5 MW capacity with back pressure of turbine generating at 415 V.
With 700 BHP (522KW) turbine driver for Fiberiser and 3X350 BHP (261KW) turbine for mill drives.
In a sugar mill with electric drives for the mills and the Fiberiser, the power consumption will be 30kw/ton of cane crushed.
This means for a sugar plant with a crushing capacity of 2500TCD (Tones crushed per day). The excess power export potential works out to be 6.5 MW.

6. NEED FOR ENERGY CONSERVATION TO MAXIMIZE POWER GENERATION
It is needless to mention here that we are at the end of this “era of another cheap fossil fuels” Given our present rates of consumption, our coal reserves are sufficient for 150 years and oil reserves for 35 years. Although there is plenty of energy available from solar, Geothermal, tidal sources, to help solve the problem, technical viability of the alternate energy Source is being established rapidly where as the main difficulty is in making them commercially viable.
Since developing alternative source is a lengthy process, it is important that energy conservation in the existing plants which can have beneficial effects often in the short term be stressed to help in the transitional period, the potential benefits of conservation are substation and hence it needs all round efforts. Besides it can be an effective means of combating the energy shortages in the short term and reducing the gap between supply and demand. The present day Indian sugar industry requires a vast scale of energy saving measures, the following audit identifies some work, which needs immediate attention.

7. COGENERATION, OBJECTIVES AND ITS IMPORTANCE
In a steam turbine power plant using Rankine cycle & in a gas turbine power plant using Joule/Brayton cycle a portion of heat energy transferred to working fluid is converted in to work. However, a very large portion of heat being low grade is wasted even after using a condenser in a steam plant. The thermal efficiency is thus optimum ideally 30/ 40 %. Wasting a large amount of heat is a price that has to be paid as mechanical & then electrical energy in the form of work is a very precious & versatile commodity needed by large engineering devices.
Many systems & devices require heat called as process heat. Industries that rely heavily on process heat are chemical, pulp & paper, oil production & refinery, steel, food processing, textile & sugar industry. Process heat required in abundant quantity is normally supplied at a low pressure of 2 to 5 bar & at @ 150°C. Steam of this state was formerly produced in low pressure boilers by burning coal, oil, natural gas, biogases etc. These industries also needed electric power to run other devices like pumps, crushers, transport etc. & electrical energy was produced by running turbines on steam at a pressure of 15/25 bar produced in a separate boiler operating at that pressure. Thus steam was produced separately at required pressures. This not only added to space & expenditure both initial & running but also reduced thermal efficiency & cost & quantity of process steam. In the beginning of 20th century improvements were made as discussed below.

8. IDEAL COGENERATION PLANT
A schematic of an ideal steam turbine cogeneration plant is drawn in the following figure.
What is energy audit?
- Analysis of Internal Systems with evaluation of thermal and overall efficiencies
- Conducting energy audits for inspecting energy losses at each outlay.
- Improving various processes with proper and advance techniques

9. SUGAR INDUSTRY
It is a chain of various systems which process the sugar cane by extracting juice and converts it into sugar and its Bi. In sugar industry sugar cane is passed through crushing mill, which extracts juice in the form of liquid. Output product of crushing process is a matter, which can be used as a alternate fuel for coal or wood in combustion process. By analysis its theoretical gross calorific value (GCV) on moisture basis it is measured to be 9713 KJ per Kg (2320 Kcal/kg).

It includes a study of
A] Analysis of present bagasse
Stoichiometric air required for the combustion of 1 kg of bagasse is Using combustion equations stoichiometric mass of air required:

i) Combustion of carbon

\[ C + O_2 \rightarrow CO_2 \]
Relative atomic weight of carbon is 12 kg
Relative molecular mass of O is 32 kg.
12g of C + 32 Kg of O = 44 kg of CO2
Now O2 required for burning of 1 kg of Carbon is, 32/12 = 2.67 kg of O2 /Kg of Carbon.
As per ultimate analysis of Bagasse carbon percentage is 23.4% , therefore,
O2 required, 32/12 X 0.234 = 0. 613 Kg of O2 /Kg of bagasse.

ii) Combustion of Hydrogen

\[ 2H_2 + O_2 \rightarrow 2H_2O \]
Relative molecular mass of hydrogen is 2 kg
Relative molecular mass of O is 32 kg.
2Kg of H2 = 32 Kg of O2 = 36 kg of H2O
As per analysis H2% is 2.8% per kg of bagasse.
Now O2 required for burning of 1 kg of bagasse is, 32 / 04 X 0.028 = 0.224 kg of O2 /Kg of carbon.
Total O2 required /kg of bagasse = 0.613+0.224 = 0.837 Kg of O2 /Kg of bagasse.

Less O2 present in the fuel = 0.837 – 0.201
Total O2 required for 1 kg of bagasse is, = 0.636 Kg of O2 / Kg of bagasse.

Now O2 present per kg of air is 23%, So as per requirement total air required for 1 kg of bagasse is, Stoichiometric air required per kg of bagasse = 0.636/ 0.23

2.76 Kg / kg of bagasse. ---- (Air/fuel)
(Air contains O2 23% by mass)

10. CASE STUDY –
Survodaya Sugar Karkhana
AIR CONSUMPTION AUDITING FEED AIR (SAMPLE ANALYSIS)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Specifications</th>
</tr>
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<tbody>
<tr>
<td>01</td>
<td>Capacity of boiler</td>
<td>35 ton/day</td>
</tr>
<tr>
<td>02</td>
<td>Steam pressure</td>
<td>45 bar</td>
</tr>
<tr>
<td>03</td>
<td>Steam temperature</td>
<td>419 +/-10 °C</td>
</tr>
<tr>
<td>04</td>
<td>Furnace temperature</td>
<td>1400 °C</td>
</tr>
<tr>
<td>05</td>
<td>Super heater heating Surface</td>
<td>1444 m²</td>
</tr>
<tr>
<td>06</td>
<td>Eco. Heating surface</td>
<td>382 m²</td>
</tr>
</tbody>
</table>

Complete combustion is possible by complete fulfillment of air requirement through blowers. As per the requirement of combustion in boiler air is supplied with bagasse inside the combustion chamber. Factory mfg. have fulfilled the design conditions during the erection of factory. Now we are contributing on to save the excess air supply. Presently at part load air consumption is maximum which takes more heat while it goes out from combustion chamber. So if we will control it by automation it improves the boiler efficiency.

Actual analysis is carried out for identification of optimum air supply.

Excess air:

a) Increase in CO2 level
b) Increase in O2 level

Excess heat loss from flue gases.

Less air:
Increase in co due to absence of O2 in combustion
Increase in Nox level.
Increase in carbon deposits.
So the analysis is carried out for automation of regular supply of air by designing Specifications:

Blower no.1
Air supply capacity : 18000 kg/hr
Type of blower : rotary
Application : Secondary air
Blower no. 2
Air supply capacity: 62,200 kg/hr
Type of blower : rotary
Application : forced draught

Observations of supplied air for Boiler I
Total capacity of air to be supplied from both the blowers is 80,200 kg/hr.
For full load steam produced from boiler: 34Ton/hr
Total air supplied for combustion, Theoretical air/fuel ratio: 1: 2.76kg of air
Amount of bagasse kg/hr: 17 kg/hr
Amount of theoretical air to be supplied: = 17 x 2.77 = 47
Excess air is up to 33% of theoretical air: 47 @ 33% =63000kg/hr.
Considering 0.8 % of mechanical efficiency air supplied = 73,200kg/hr

Excess air supplied = 73,600 – 63000 = 10,600 kg/hr
Analysis of air consumption (Boiler I + II)

Heat carried away by flue gases with excess air = Mg X Cp X Δtg
Wt. of flue gases with recommended 30% excess air

\[ \text{CO}_2 = 0.85 \text{ Kg/Kg bagasse} \]
\[ \text{N}_2 = 3.58 \times 0.77 = 2.76 \]
\[ \text{O}_2 = 2.76 \times 0.3 \times 0.23 = 0.190 \]
Total = 3.80 kg kg of bagasse

Heat carried away by flue gases = 3.80 x 232.6 KJ

= 883.8 KJ / kg

Cal. value of bagasse = 9713 KJ / kg

Less Heat taken away by flue gases = 883.8 

Less Heat taken away by moisture = 2266.36 KJ

by subtracting, available heat for production of steam per kg of bagasse = \(6562.84\) KJ / kg of bagasse.

Hence, Steam produced = \(6562.84 / 2665.3\)

=2.46kg of steam / kg of bagasse

Wt. of flue gases when 50% excess air is supplied:

\[ \text{CO}_2 = 0.85\text{ Kg/Kg of bagasse (unchanged)} \]
\[ \text{N}_2 = 4.14 \times 0.77 = 3.18 \]
\[ \text{O}_2 = 2.76 \times 0.5 \times 0.23 = 0.317 \]
Total = 4.34 kg kg of bagasse

Heat carried away by flue gases = 4.34 x 232.6

= 1009.4 KJ / kg

Wt. of flue gases when 75% excess air is supplied:

\[ \text{CO}_2 = 0.85\text{ Kg / Kg of bagasse (unchanged)} \]
\[ \text{N}_2 = 4.83 \times 0.77 = 3.71 \]
\[ \text{O}_2 = 2.76 \times 0.75 \times 0.23 = 0.476 \]
Total = 5.036 kg kg of bagasse

Heat carried away by flue gases = 5.036 x 232.6

= 1174.37 KJ / kg

From above, it appears that, since at all the time ie. when inadequate or stoichiometric or excess air is supplied all H will be always burn to H2O, then the efficiency of combustion becomes a function of the % of CO, CO & O in the flue gases. It is true that very often % of CO in flue gases is taken as measure of combustion efficiency. The presence of CO will indicate inadequate supply of air. The presence of O2 in the flue gases indicates excess air. Percentage of CO2 will then indicate the correct amount of excess air to be supplied. It is therefore feared that extra excess air is being supplied which carries lot of heat (about 387.36 KJ/ kg of bagasse) and wastes to atmosphere.

11. CONCLUSION

The present study is honestly tried elaborate effort to examine the performance of a sugar industry regarding its overall efficiency, cogeneration; combustion is the main process chain for the heat conversation from bagasse. In our study utilization measure is the input feed air. The final comparison proves that extra air abstracts more heat from combustion and exhausts it to atmosphere. Finally it is analyzed that around 40 to 50% extra feed air removes 10 to 13% of energy from boilers and influences on boiler efficiency. So for co generation plant this addition will be beneficial for enhancement in electricity generation through completing energy audit. This papers concludes with analysis of generation side is compared and forwarded for each boiler plant and it will provide scope for the conservation of 387.36 KJ/ kg from bagasse combustion. So around 350 Tones of bagasse/per Day produces 3 MW power through conventional sugar industry boilers but if we can reaudit our extra feed air supply which can recovers 10% of waste heat as 90KJ/kg of bagasse. This concludes that 10% of total electricity generation can be enriched by correction in extra air as a ultimate measure in the efficiency improvement of power plant. It is suggested that all the sugar factories can be examine with or without cogeneration for their betterment.

Finally all power plant erectors should take corrective action in conventional power plants and convert more amount of heat from waste to best.

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