OVERVIEW OF COGENERATION OPPORTUNITIES IN NEPALESE SUGAR SECTOR

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1. Cogeneration Basics and application opportunities:

- ☑ **Any fuel (coal, husk, bagasse or furnace oil), as an energy source, has the chemical energy which can produce any of the following:**
  - ❖ Hot Water at 70-90˚C (very low energy content)
  - ❖ Low pressure and temperature steam (Low energy content)
  - ❖ Medium pressure and temperature steam (Medium energy content)
  - ❖ High Pressure and superheated steam (High energy content)
- ☑ The industry as a user normally meets process heat energy needs by producing Hot Water, Low pressure, Low temperature steam, Medium pressure and Medium temperature steam, or High pressure and super heated steam while electrical energy needs for drives and illumination are met by grid or diesel based electricity.
- ☑ **The Industry has the choice to meet its heat energy and electrical energy, the above conventional way, or, more efficiently, and at lower overall cost, through cogeneration.**

  Here, same fuel is used first to produce high energy content steam (high pressure and superheated), which is led into a steam turbine, to produce by-product electricity, while low pressure and low temperature tail-end steam (called back pressure or extraction steam) at the turbine exit, is used to meet the process heat energy requirements. The word cogeneration thus relates to simultaneous generation of Heat (steam) and power.

- ☑ **Generating steam at higher pressure and temperature in a cogeneration system, adds just 10 to 20% on the fuel costs, but economical by-product electrical energy is produced enhancing overall energy efficiency significantly.**
  - ❖ In steam based cogeneration systems, back pressure turbines are deployed, where high pressure, often superheated steam from efficient boilers, is expanded in a turbine to generate power, and back pressure exhaust steam is utilized for process requirements.

Higher the inlet pressure and temperature, higher the power output and likewise, lower the back pressure, higher the power output.

☑ **A simple analogy illustrates the cogeneration principle well in Nepalese scenario.**

- ❖ **In run of the river situation in mountainous regions, choice is to use water as it flows, or, more productive and efficient choice exists, where the potential energy of water at heights, is tapped for by-product power generation by microheadal, small Hydro, Mini Hydro, Hydro or Large Hydro Turbine Generator sets, and downstream water is used for various societal needs. Similarly, in industrial fuel use by cogeneration, the high grade chemical energy is productively and efficiently used for by-product power generation, while tail end steam is used for process needs**.

☑ In steam based cogeneration systems, extraction back pressure turbines are deployed where steam requirements for process are at two or three pressure levels. Extraction condensing turbines are deployed, where steam requirements for process are at two or three pressure levels and, steam demands are fluctuating, necessitating condenser use to balance the steam quantity.

☑ **The key factors influencing industrial cogeneration economics include capacity utilization, process steam demand, pressure variations, Power demand pattern, turbine Inlet steam parameters, turndown ratio and efficiency of boiler and turbo generator, auxiliary power consumption, fuel and power costs prevalent, stand-alone or grid linked operations.**

☑ With Wide variety of cogeneration schemes and innovations for process industry to choose from, cogeneration offers a win-win situation, be it for a rice mill/small process industry, paper mill, sugar unit, a cement plant, or even for steam throttling avoidance, wherever steam/heat and power are simultaneously needed.

☑ **The cogeneration benefits are economy for end user, and many times, where by-product power is sold to grid, alleviation of shortfalls for utilities, and above all, avoidance of costly diesel imports, which affect economy of the nation, at large.**

2. Sugar Sector and biomass cogeneration:

☑ Overview of Nepalese Sugar Sector

Overall 29, 30,047 MT is sugarcane production, 21,99,282 MT is cane used in factories,74,7755 MT is bagasse produced, as per 2012 Central Bureau 2012 statistics.

Twelve plants with TCD capacity varying from 500-5000, aggregating to 27,400 TCD, produce sugar over a 100-120 day season.

☑ TYPICAL OPERATIONAL FEATURES INCLUDE:

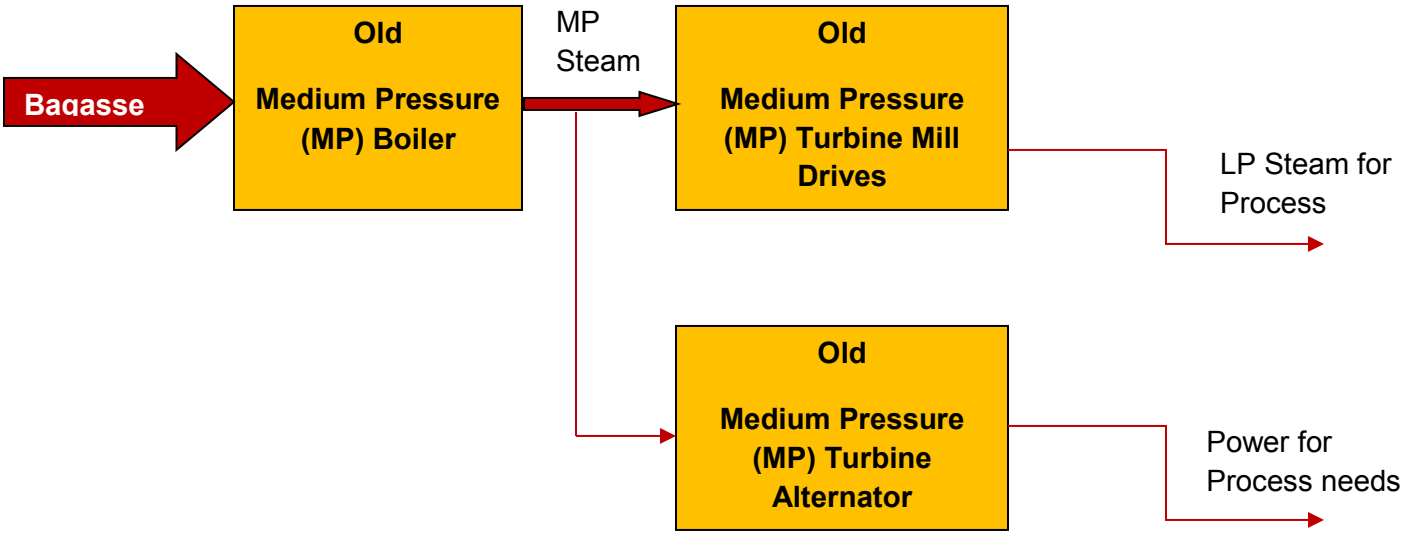
Bagasse % per Ton of Cane:	34-35
Bagasse GCV:	Around 2270 kCal/KG
Sugar % per Ton of cane:	9-9.5
Water % in Bagasse :	50
Boiler Steam Parameters:	Typically 32 Bar 380 deg C
Boiler Evaporation Ratio:	2-2.5
Steam Rate of turbines :	9 to11 T/MW
Cogen. Power Produced:	To meet captive needs @ 22-25kWh/Ton cane crushed.
Mill system:	5 Mill system steam turbine drives
Juice concentration:	Double Effect Vapor compression and 5 effect evaporation.

% Steam consumption per Ton cane crushed: 50

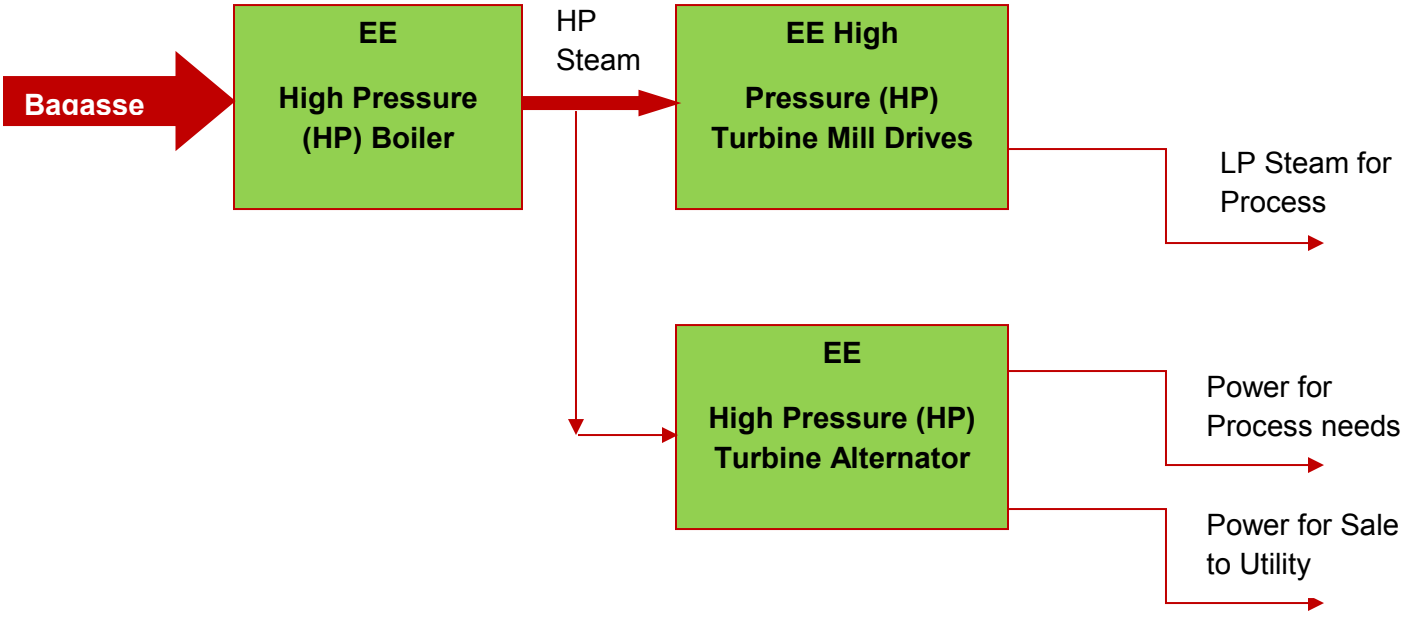
Specific Electricity consumption:	22 kWh to 30 kWh/Ton Cane Crushed.
Notional Price of Bagasse:	NRs 1000/Ton
NEA Electricity cost:	NRs 230/kVA; NRs 4.20 to 8.50 per kWh (ToD)
Share of Cogen power in total power used:	Over 90 %

☑ **In Business as usual case, sugar units are content to meet season specific captive thermal and electrical needs by low/medium pressure boilers, mill drive turbines, cogen turbine generator sets of small capacities, instead of availing technical potential of much higher scale.**

Typical Prevalent Configuration:



Upgraded Co-generation Configuration:



☑ **Illustrative Cogen Potential indicators in Sugar Plants**

Steam parameters (Bar / °C)	Steam Production (T/T Bagasse)	Power Generation (kW /T bagasse)	Steam Rate (T/MW)	Bagasse Required (Ton / MWh)
21/340	2.50	227.3	11	4.5
32/380	**2.43**	**286**	**8.50**	**3.5**
42/400	2.40	313	7.67	3.2
45/440	2.33	328	7.10	3.0
67/480	2.27	378	6	2.6
87/510	2.24	401	5.59	2.5
110/535	2.21	427	5.18	2.3

3. A first Order estimate of sectoral Cogeneration potential through Upgradation and cost benefits:

- ☑ **By Economy of scale, the units with less than 5000 TCD capacity could opt for steam parameters up to 67 Bar 480 Deg C and those units with and higher than 5000 TCD capacity could opt for steam parameters up to 110 Bar 535 Deg C for maximizing power generation potential and benefit through revenues from utility by sale of surplus electricity, after meeting captive needs, through a judiciously structured Upgradation, R & M plan.**
- ☑ **The Upgradation, R & M needs may include, Energy Efficient Boiler, TG set, auxiliaries, fuel and ash handling system, water treatment plant, Distributed Control systems, overhead crane, civil works, ventilation, electrical evacuation, black-start DG set and other necessary upgrades such as mill drive replacements/modernization, etc.**
- ☑ **The capex for cogen plant is envisaged to be of the order of NRs 120 million/MW, made up of around NRs 90 Million/MW for cogen upgrades and NRs 30 million/MW for process drives and other upgrades.**
- ☑ **With upgrades, the Auxiliary consumption could be of the order of 15 %.**
- ☑ **With three broad options considered, namely- Upgradation to 87 Bar steam based co-generation system for one unit, Upgradation to 67 Bar steam based cogeneration system**

for five units and Upgradation to 45 Bar steam based co-generation system for six units, with the same level of bagasse consumption, the potential gross generation will be of the order of 93 MW, of which, after accounting for 28.85 MW towards process needs,14.06 MW towards auxiliary consumption, about 50.8 MW of surplus power could be available for release to utility, especially convergent with the power shortfall season of winter.

- ☑ An Investment of the order of NRs 11160 Million @ NRs 120 Million per MW is envisaged, while utility sale proceeds against 121920000 kWh, over 2400 Hr season @ NRs 8.20/kWh as revenues would amount to NRS 999.74 Million/season, leading to a simple payback period of 11.16 years.
- ☑ Unit specific Investment Grade Energy Audits could bring out insights/specifics and best fit technical proposals with user end cost benefits on one hand and supply side cost-benefits such as cost of avoided capacity and cost of avoided energy generation vis-a-vis costs of capacity addition and long run marginal cost of energy supply on the other.

4. INTERVENTIONS DESIRABLE:

- ☑ Given the ever increasing demand supply gap situation, there is a felt need for fructifying the cogeneration potential, which may call for proactive interventions such as:
- ☑ Assessment and preparation of unit level proposals (IGEA reports) for cogeneration Upgradation schemes, addressing technical as well as cost benefits, incorporating captive needs and revenue opportunities of electricity sale to utility.
- ☑ Assessment of utility side Demand side Management benefits, in respect of avoided costs of generation/procurement, of capacity and energy.
- ☑ In case of likely un-viability of cogeneration upgrades for sale of electricity to utility in business as usual scenario with technical and financial risks perceived from user end, stakeholders from relevant Government ministries, Financial Institutions could consider coming up with suitable incentive schemes, towards cogeneration market transformation from feasibility to reality.
- ☑ Incentivizing cogeneration upgrades in sugar sector could possibly be considered as part of biomass energy promotion programs as well as waste to wealth programs.

5. SUGAR SECTOR COGENERATION FEATURES : REGIONAL SCENARIO

- ☑ All India potential, 7000 MW (650 sugar mills)
- ☑ Achievements as of September 30, 2012, 2250 MW (200 projects)
- ☑ Under construction, 750 MW (50 projects)
- ☑ Total, 3000 MW (250 projects), 43% penetration
- ☑ Private sector leading in States like UP, Tamil Nadu, Karnataka & Andhra Pradesh
- ☑ Co-operatives leading in Maharashtra & Tamil Nadu
- ☑ Own investment & BOOT models established
- ☑ Conducive CERC / SERC orders, CDM, REC & power trade, the key drivers
- ☑ Results due largely to promotional measures, mainly by MNRE

- **Fiscal Incentives Prevalent in India :**

Central Financial Assistance (CFA) and Fiscal Incentives provided by the Central government for biomass and bagasse-based co-generation projects are as follows:

	Special Category States (NE Region, Sikkim, J&K, HP & Uttaranchal)	Other States
Project Type	Capital Subsidy	Capital Subsidy
Biomass Power projects	Rs. 25 lakh X(CMW [1])^0.646	Rs. 20 lakh X (C MW [1])^0.646
Bagasse Co-generation by Private sugar mills	Rs.18 lakh X (CMW [1])^0.646	Rs. 15 lakh X (CMW [1])^0.646
Bagasse Co-generation projects by cooperative/ public sector sugar mills		
40 bar & above	Rs. 40 lakh per MW *	Rs. 40 lakh per MW *
60 bar & above	Rs. 50 lakh per MW *	Rs. 50 lakh per MW *
80 bar & above	Rs. 60 lakh per MW *	Rs. 60 lakh per MW *

[1] Capacity in MW

* Per MW of surplus power (maximum support Rs.8.0 crore per project)

For new sugar mills, which are yet to start production and existing sugar mills employing backpressure route/seasonal/incidental cogeneration, which exports surplus power to the grid, subsidies shall be one-half of the level mentioned above.

- Power generated in a sugar mill (-) power used for captive purpose i.e. net power fed to the grid during season by a sugar mill.

☑ **CFA for Bagasse Cogeneration Project in cooperative/ public sector sugar mills implemented by IPPs/State Government Undertakings or State Government Joint Venture Company / Special Purpose Vehicle (Urja Ankur Trust) through BOOT/BOLT model:**

PROJECT TYPE	MINIMUM CONFIGURATION	CAPITAL SUBSIDY
Single coop. mill through BOOT/BOLT Model	60 bar & above	Rs. 40 L/MW of surplus power *
	80 bar & above	Rs. 50 L/MW of surplus power*

* Power generated in a sugar mill (-) power used for captive purpose i.e. Net power fed to the grid during season by a sugar mill.

☑ **Central Finance Assistance for Bagasse Cogeneration Project in existing cooperative sector sugar mills employing boiler modifications:**

PROJECT TYPE	MINIMUM CONFIGURATION	CAPITAL SUBSIDY
Existing Cooperative Sugar Mill	40 bar & above	Rs. 20 L/MW of surplus power *
	60 bar & above	Rs. 25 L/MW of surplus power *
	80 bar & above	Rs. 30 L/MW of surplus power*

* Power generated in a sugar mill (-) power used for captive purpose i.e. Net power fed to the grid during season by a sugar mill. CFA will be provided to the sugar mills who have not received CFA earlier from MNRE under any of its scheme.

☑ **Fiscal Incentives for Biomass Power Generation**

Item	Description
Accelerated Depreciation	80% depreciation in the first year can be claimed for the following equipment required for co-generation systems: 1. Back pressure, pass-out, controlled extraction, extraction–cum-condensing turbine for co-generation with pressure boilers 2. Vapour absorption refrigeration systems 3. Organic rankine cycle power systems 4. Low inlet pressures small steam turbines
Income Tax Holiday	Ten years tax holidays.
Customs Duty	Concessional customs and excise duty exemption for machinery and components for initial setting up of projects.
General Sales Tax	Exemption is available in certain States

☑ **Prevalent Biomass Cogeneration Tariff across Indian States:**

State	Tariff fixed by Commissions	RP0 %
Andhra Pradesh	Rs. 4.28/kWh, (2010-11) (BM) Rs. 3.48/kWh (Cogen)	Min. 3.75%
Chattishgarh	Rs. 3.93/Unit (2010-11) (BM)	5%
Gujarat	Rs. 4.40/unit (with accelerated depreciation)(BM) Rs. 4.55/unit (with accelerated depreciation) for 1st 10 yrs (Cogen)	10%
Haryana	Rs. 4.00/unit (BM) Rs. 3.74/unit (Cogen) 3% escalation (base year 2007-08)	1%
Karnataka	Rs. 3.66 per unit (PPA signing date) Rs. 4.13 (10th year) (BM) Rs. 3.59/unit (PPA signing date) Rs. 4.14/unit (10th Year) (Cogen)	Min.10%
Kerala	Rs. 2.80/unit (BM) escalated at 5% for five years (2000-01)	3%
Maharashtra	Rs. 4.98 (2010-11) (BM) Rs. 4.79/unit (Comm yr.) (Cogen)	6%
Madhya Pradesh	Rs. 3.33 to 5.14 /unit paise for 20 yrs. With escl of 3- 8paise	0.8%
Punjab	Rs. 5.05 /unit, (2010-11) (BM) Rs. 4.57/unit (2010-11) (Cogen) escalated at 5%-cogen, & 5%-BM	Min. 3%
Rajasthan	Rs. 4.72 / unit-water cooled (2010-11) Rs. 5.17-air cooled(2010-11)-(BM)	1.75%
Tamil Nadu	Rs. 4.50-4.74/unit(2010-11) – (BM) Rs. 4.37-4.49/unit (2010-11)- (Cogen) (Escalation 2%)	Min. 13%
Uttaranchal	Rs. 3.06/unit. (2010-11) - BM Rs. 3.12/unit (2010-11)- (Cogen) (new projects)	9%
U.P.	Rs. 4.29 / unit, for existing and 4.38 for new with escalated at 4 paise/year, base year (2006)	4%
West Bengal	Rs. 4.36/unit fixed for 10 years-BIOMASS	4%
Bihar	Rs. 4.17/unit (2010-11)–BIOMASS Rs. 4.25/unit (2010-11) – existing (Cogen) Rs. 4.46/unit (2010-11) – new (Cogen)	1.5%
Orissa	Rs. 4.09/unit	