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| **Sector: Energy** | |
| **Sub-Sector/Technology Option:** Cogeneration | |
| **Technology Application:** Cogeneration of bagasse at GUYSUCO's sugar estates. | |
| **Introduction**<br>Cogeneration is the simultaneous production of electricity and heat or steam using the same primary fuel source. This process of cogeneration is also known as combined heat and power (CHP). There are several forms of CHP which utilize a wide range of technologies through an integrated system that recovers the waste heat or steam and generate electricity instead of direct release into the environment. These systems are highly energy efficient where approximately 80% of the fuel source is converted to useful energy, depending on age of the CHP plants (IPCC, 2007). CHP systems allow for on-site generation and utilization of energy and are sited near to the end users, thus, reducing network losses.<br><br>The Guyana Sugar Cooperation (GUYSUCO) traditionally utilizes in-house bagasse[39] as its energy source to produce steam for factory operations, as well as, electricity to its surrounding facilities (factory and housing) at each of its seven operational sugar estates. According to the GEA, an estimated 3.52% total electricity generation in 2012 was from bagasse-based cogeneration. The remainder of 96.28% for the same year was generated using petroleum-based products with the resultant electrical energy-generating sector accounting for approximately 33% consumption of total petroleum based products imported in 2012.Of the total electricity generation in 2014, 91.8% was from fossil fuels, 8.0% from bagasse-based cogeneration and the remaining 0.2% from solar photovoltaics and wind powered sources. The electricity generating sector accounted for approximately 36% consumption of total petroleum based products imported in 2014.<br><br>Improving the supply efficiency in the electricity sector through cogeneration using bagasse offers an important near-term opportunity and allows for incremental increases in the generation of electricity using renewable sources. | |
| **Technology Characteristics** | |
| Features | The CHP system consists mainly of four (4) elements:<br>▪ Turbine or engine<br>▪ Electric generator<br>▪ Heat recovery system<br>▪ Control system<br>CHP plant size range from 1 kilowatt electric to over 500 megawatt electric. The equipment and proportion of heat and power are site specific for large plants and CHP plants should be selected to match these requirements. As a result of sizing to meet the heat demand, the excess electricity generated is usually supplied to the grid. The efficiency gains of such a system vary and depend on the technology, fuel/energy source and the heat power generation system displaced. |
| Capital Investment Cost | An estimated investment cost to produce electricity to supply the national grid using bagasse was presented in the Guyana Skeldon |

[39] Bagasse is the waste generated after the juice is extracted during the processing of sugar cane.

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| | Bagasse Cogeneration Project Design Document and submitted to the Clean Development Mechanism. The total investment cost for the bagasse cogeneration plant at that time was an estimated USD 32.2M and is presented here as a guide in the absence of current figures. |
| Operating Cost | The operating cost depends on the size of the cogeneration plant. |
| Maturity | The technology is mature in terms of development and application and is well proven with many commercial installations worldwide. Additionally, it has been in operation at limited scale in Guyana for a number of years. |
| **Country Specific Applicability** | |
| Status of technology in country | CHP technology is limited in operation in Guyana. These systems are concentrated at each of the sugar estates to generate power to service GUYSUCO's factory operations as well as its surrounding facilities (including housing). These CHP systems operate at low efficiencies and on a small scale. The installed boilers and turbines generate, as well as, use low pressure steam to meet the sugar plants internal energy demand.<br><br>The Guyana Bagasse Cogeneration Project was the first cogeneration facility to produce bagasse-based electricity at the Skeldon Sugar Estate for internal use, as well as, selling the excess electricity to the national grid to service the Berbice Region. The Bagasse Cogeneration Plant has an installed capacity of 2x15MW bagasse-based steam turbine with additional 10MW diesel generators for peaking proposes and use during off-crop periods. Less fuel is consumed to produce electricity by using the diesel generators to supplement the power to grid during the off-crop periods, instead of using heavy fuel oil to run the factory boilers.<br><br>It was estimated that at least 85% of the 77GWh or 10MW of surplus electricity will be supplied to the national grid annually from the Skeldon cogeneration facility. The remaining 15% (11.55GWh) will be generated using fuel oil during off-crop periods. Additionally, about 58.8 GWh of electricity is produced annually for use internally.<br><br>Recognizing the high dependence of petroleum-based imports for electricity generation in the power sector, expanding the remaining six (6) sugar estates to generate excess electricity to supply the national grid has significant potential in the country to reduce costs and enhance energy security.<br><br>Apart from Skeldon the other six operating sugar units are installed with 50Hz operational equipment. The national grid operates at 60Hz. The Enmore sugar plant is located close to Georgetown where the major electrical load (from National grid 80MW) is in use. There are no technical / feasibilities studies |

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| | towards co-generation enhancement in this particular Enmore plant for additional power generation. |
| Market potential | The market potential is significant for enhancement and or improvement of the technology for incremental addition to supply the national grid providing that the supporting policy framework is in place. As a long term option, installation of new cogeneration based sugar plant of 3500 TCD with 5 MW or more with the capacity to export to the national grid near Enmore is an ideal option. Similar capacity plants are working well in Ethiopia and India. |
| Scale of application and time horizon | Short – medium term |
| Institutional and Organisational requirements | Skeldon Energy Inc. (SEI) was established in April 2015 and is jointly owned by Guyana Power & Light Company and the National Industrial and Commercial Investment Ltd. (NICIL). SEI replaces GUYSUCO as the power producer and is now party to the power purchase agreement for the production and sale of electricity to GPL. |
| Operation and maintenance | Significant training and capacity building will be required to ensure availability of local expertise for the operation and maintenance of the systems. |
| Scale/size of beneficiary group | The national economy in general will benefit through direct cost savings as a result of reduced imports of petroleum products for electricity generation. The direct beneficiaries are consumers connected to the national grid. |
| Acceptability to local stakeholders | The technology is acceptable and can be diffused on a wider scale once the barriers are addressed. |
| Endorsement by experts | Local and international experts are certain that CHP is a mature technology that can be enhanced to improve efficiency and applied across all sugar estates to supply surplus electricity to the national grid, thus, allowing for a reduction in the consumption of petroleum-based imports and increase energy security through the production of electricity using renewable sources. |
| Barriers and Disadvantages | ▪ Local experts are convinced of the value of cogeneration but require policy level direction to guide interventions and processes, including the conduct of extensive feasibility studies, as well as, to understand the full cost to transition the sugar estates to produce electricity to supply the national grid.<br>▪ Insufficient quantities of bagasse feedstock – limited or no availability during off-season resulting in the use of fuel wood or heavy fuel oil to generate electricity at the GUYSUCO sugar factories.<br>▪ Dependence on petroleum-based products especially during the off-season operation of the estates. |

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| | ▪ Regulatory issues relating to interconnections with the national grid. The local utility company GPL holds a monopoly on the generation and supply of electricity. |
| **Mitigation Benefits** | |
| Greenhouse gases abatement potential | The bagasse cogeneration plant at Skeldon generates Greenhouse Gas Emission Reductions by displacing the use of light fuel oil in diesel engine-driven generators in the Berbice grid operated by the power utility, GPL. The utility had insufficient capacity in the past that led to extensive self-generation by industries and households. The cogeneration plant thus allowed for the displacement of a significant amount of this unregulated and inefficient self-generation.<br>Additionally, an estimation of the project activity emissions was conducted for the period 2008 – 2014 and was presented in the Guyana Skeldon Bagasse Cogeneration Project Design Document as submitted to the Clean Development Mechanism. It stated that carbon dioxide emissions for this period (2008-2014) were estimated as 144,048.15 $tCO_2e$. The baseline emissions were estimated as 457,181.62 $tCO_2e$ for the period 2008 – 2014 and for this same period, an estimation of the overall emissions reductions from bagasse co-generation was recorded as 313,133.50 $tCO_2e$. |
| **Potential Development Benefits: Economic, Social, Environmental** | |
| Economic benefits | ▪ Generation of new revenues from the sale of energy.<br>▪ Reduction in the total petroleum-based imports for the country and share of fossil fuel energy used to produce electricity.<br>▪ Improved electrical service to the areas resulting from supply of additional power from an indigenous renewable energy source. |
| Social benefits | ▪ Additional jobs created to support the maintenance and operation of CHPs.<br>▪ Ensuring employment of traditional workers on the estate.<br>▪ Avoidance of closure of the estate. |
| Environmental benefits | Reducing the use of fossil fuel to produce electricity, reduce GHG, and other emissions (particulate matter and NOx) at local level. |

**References:**


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