Sector: Energy	
Sub-Sector/Technology Option: Gasification	
Technology Application: Gasification of rice husk and wood waste for the production of electricity.	
Introduction The cultivation of rice is largely restricted to the coastal low-lands in Administrative Regions 2, 3, 4, 5 & 6 with the exception of one estate at Region 9 in the Rupununi savannahs. As a result, there are approximately eighty (80) existing rice factories in Guyana spread across these Regions. Seventy two (72) of these factories are operational with sixty seven (67) having rice milling capabilities and produce rice husk. The capacity of these rice mills range from 0.5 metric ton per hour (MT/h) to 15 MT/H and utilize energy from the grid as well as fossil fuel generators to meet its energy needs (GEA, 2014; GRDB, 2014). The 67 rice mills process approximately 611,348.60MT paddy per year and in turn generate about 122,311.90MT rice husk[40] annually (GEA, 2014). According to the GEA, 47% or 57,503MT of the total annual rice husk generated is reused by some of the factories as a energy source for paddy drying, parboiling and in one (1) instance electricity generation. The remaining 53% or 64,808.91MT is available feedstock for energy conversion instead of direct discharge into the environment or burning as currently occurs. The GEA estimated this 53% has an energy value of 31,756,364.03 kWh (31.75GWh or equivalent to 158,900.84 barrels of oil equivalent (BOE)). An approximate total of 468,342.25 MT of rice husk would be produced over a five (5) year period (2008-2012) based on estimates produced by the GEA whereby 220,120.86 MT would be utilised. The remaining 248,221.39MT discarded into the environment would be able to produce 121,628,482.33kWh (126.2182GWh or 874,238.87 BOE). The GEA conducted an assessment of the biomass energy potential from sawmill waste using 2012 data obtained from the Guyana Forestry Commission (GFC). There were a total of one hundred and eight (108) functional sawmills found along the coast and the Linden/Soesdyke Highway. The total input biomass of 176,498.78 m^3, at an average recovery rate of 63%, generated approximately 64,882.83 m^3 wood waste. The energy value for this quantity of waste was calculated as 25,872 BOE (GEA, 2014). The GEA is exploring using biomass gasifiers to convert both the rice husk and wood waste feedstock to usable electrical energy.	
Technology Characteristics	
Features	The gasification process converts organic materials such as rice husk and wood waste to carbon monoxide, hydrogen and carbon dioxide at high temperature reactions (700 degrees and above) in the presence of little or no oxygen and/or steam. Syngas (synthetic gas) is produced from this process. Favourable fuels or feedstock of biomass gasification are usually dry materials such as wood, leaf, charcoal, rice husk, coconut shells and wood waste. The reactor is the main component of the biomass gasification system where the feedstock is fed with a limited supply of air to facilitate a chemical breakdown

40 Rice husk is about 20-22% of the paddy weight (GEA, 2014; GRDB, 2014).

	and eventually generate syngas. This gas is then treated/cleaned and directed to an internal combustion (IC) engine to produce electricity. In cases where sawdust is being considered a feedstock, it is necessary to convert the sawdust into briquettes for the gasification process. There are a number of gasification technologies available on the market. The selection of technology depends on the physical, chemical and morphological characteristics of the fuel or feedstock.
Capital Investment Cost	The total investment cost to secure and install a gasifier is approximately GYD 20-40M (USD 100,000 – USD200,000) with an estimated payback period less than one (1) year (GRDB, 2014; GRDB, 2015). According to the study conducted by the GEA, for a 100kW fix bed gasifier system using rice husk, the capital investment cost is expected at about USD 4000/kW with a payback time of 1.4 years evaluated over a project life of 10 years (GEA, 2014). Further, the study conducted by the GEA for a 20kW wood waste gasifier, the capital investment of about USD53,000 with a payback time of approximately two (2) years over a 15-year period.
Operating Cost	It will take approximately GYD 2M (USD 10,000) per year to maintain and operate the dual fuel fired gasifier installed at Ramlakhan Rice Mill.
Maturity	Gasification using both rice husk and wood waste as feedstock is mature in terms of development and application. The selection of a specific gasifier depends on the physical, chemical and morphological characteristics of the fuel or feedstock.
Country Specific Applicability	
Status of technology in country	Gasification systems are still new to Guyana. The first functional gasification system was installed during 2014-2015 at the Ramlakan & Sons rice mill using rice husk as the feedstock with an installed capacity of 400kW. The rice mill has a capacity of 4.5MT/h and produces 2T of dry rice husk daily[41]. The installed gasification system has the capacity to utilise 60,600 pounds of rice husk daily. The syngas produced from the burning of the rice husk is used in the modified generators (250kW) to produce power. This process is expected to replace 70% of the diesel required to operate the generator[42] (GRDB, 2014; GRDB, 2015).
Market potential	There is significant market potential for the installation of gasifiers to utilise the excess wood waste and rice husk.
Scale of application and time horizon	Short to medium term.
Institutional and Organisational requirements	The institutional and organizational requirements to generate electricity through gasification of rice husk and wood waste are within ambit of the Guyana Energy Agency, Guyana Rice Development Board, Environmental Protection Agency, Guyana Forestry Commission and the Guyana Power & Light. Specific policies, regulations and standards will be required before deployment.

[41] Guyana Times (2015).

[42] 5kg of rice husk is required to replace 1L of diesel.

Operation and maintenance	Institutional and local capacity building is critical for the application of technologies in the sector to ensure availability of local expertise for the operation and maintenance of the systems.
Scale/size of beneficiary group	The main beneficiaries are millers and the population surrounding the rice mills and sawmills.
Acceptability to local stakeholders	The technology is acceptable and can be diffused on a wider scale once the barriers are addressed.
Endorsement by experts	Both local and international experts endorse the diffusion of gasification, especially to address the environmental concern of burning paddy waste.
Barriers and Disadvantages	▪ The downdraught gasifier equipment cannot operate on unprocessed fuels. ▪ Using low density materials in the system can contribute to flow problems and pressure fluctuations. This requires solid fuel to be pelletized or briquetted thereby increasing the cost for the use of some feedstocks. ▪ Lack of bunker flow and slogging are some of the challenges using a fluidized bed gasifier. ▪ The cost of gasifiers, could deter mass-market uptake, especially in the wood sector given the small scale of some operations.
Mitigation Benefits	
Greenhouse gases abatement potential	The GEA estimated annually 53% or 64,808.91MT rice husk is discharged directly into the environment or burnt thus contributing 24,199,495.41 kg carbon dioxide annually. Region 5 produces the largest share of rice husk and thus is responsible for 7,941,842.406 kg of carbon dioxide released over the period 2008-2012. Over this 5-year period, and based on the total amount of rice husk discarded, approximately 92,685,292.84 kg of carbon dioxide was released. In particular, the use of rice husk as feedstock for gasifiers to produce electricity will result in greenhouse gas emission reduction at an estimated 0.762kg carbon dioxide/kWh of diesel. Therefore, it is estimated that alternative use of the 53% rice husk will result in a total, annual reductions of 24,199495.41 kg carbon dioxide (GEA, 2014).
Potential Development Benefits: Economic, Social, Environmental	
Economic Benefits	▪ Reduces the conventional cost of electricity assocuated with processing paddy. ▪ Reduces national expenditure on imported petroleum-based fuels due to less fossil fuel consumed annually.
Social Benefits	▪ Creates additional jobs through the collection of feedstock and servicing and maintaining the gasifiers. ▪ Improve effiencicies in the rice industry and create opportunity for the production of value added products.
Environmental Benefits	▪ Reduces air emissions (particulate matter and smoke) as a result of using rice husk and wood waste as feedstock for the gasifier. ▪ Reduces the volume of solid waste (rice husk and wood waste) otherwise disposed directly into the environment. ▪ Reduces the use of fossil-base fuel to produce electricity. ▪ Uses locally available resources such as rice husk and wood waste.

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