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DRAFT: SUGARCANE BAGASSE IN BELIZE: AN ECONOMIC ASSESSMENT AND OVERVIEW OF POTENTIAL OPPORTUNITIES

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ABSTRACT

Sugarcane is the most important crop for the economy of Belize. With sugarcane deliveries exceeding 122 thousand metric tons in the fourth quarter of 2015, sugar is Belize's largest contributor to the agricultural sector with exports approximating BZ$140,000,000 for the year 2015. With commissioning of the Belize Co-generation Energy (Belcogen) plant completed in December 2009, sugarcane bagasse has been used for electric energy production. Currently, the single co-generation plant in the country contributes about 15% *of electricity to the national grid. Belize currently imports about* 45% *of its electric energy needs from Mexico, and to date, this is the country's most reliable energy source. With energy needs of the country projected to rise at a rate of* 4% *per annum, and with the costly import of energy, there exists the need to explore the expansion of co-generation energy technologies to increase local energy generation output to the national grid. The aim of this paper is to demonstrate the positive conditions which support such an expansion by analyzing the current co-generation technologies in the context of necessary economic, regulatory and technical pathways toward this increase of output. This is done through a discussion of various economic and technical scenarios with recommendations made for the most feasible option. The introduction of a new sugar plant in Belize with projections of annually producing 100,000 metric tons by 2020 and with intentions of introducing co-generation technologies could lead to* 20% *of local electrical energy being supplied to the national grid. It is projected that a new sugar plant of this size would grow the agricultural gross domestic product of the country by approximately* 4%. *These benefits further support the need for a discussion of co-generation technologies and the associated positive conditions supporting the expansion of the aforementioned technologies. Additionally, it is also relevant to mention the feasibility of alternative renewable energy technologies that could contribute to Belize's national goal of increasing energy efficiency, sustainability, and resilience over the next 30 years.*

INTRODUCTION

The increasing demand for energy is a global conundrum with challenges in areas of security, the environment, and economic and social development. [**?**] Population growth throughout the world has brought with it the continuous surge in energy demand. Though small, the Central American nation of Belize is no exception to this issue. With a population of about 350,000, growing at a rate of 2.4%, the country's energy demand is expected to rise at a rate of 4% per annum. It has been estimated that within the next 20 years, Belize will need to increase energy generation by about 80% to satisfy this growing demand. The country currently receives majority of its electricity supply from Mexico through a direct line into its national grid. This source constitutes 42% of the demand for electricity, and is to date, the country's most reliable source of energy. For its size, Belize has a relatively high electric energy demand. The country's peak demand is approximately 96 MW. The costly import of electricity from Mexico has prompted the country to explore several renewable energy initiatives. This started with the Chalillo and Mollejon hydro-electric systems. These systems contribute about 37

MW of power to the Belize's national grid which is 39% of the grid's total demand in peak hours.

Belize's finances are rooted in the agricultural and tourism industry. These industries combined contributed to 34% of the country's gross domestic product in 2015. In the agricultural industry, sugarcane is the dominant crop. Over 1.2 millon tonnes of sugarcane were cut in 2014. Given the country's fairly expansive sugar industry, investments were made to generate electricity using sugarcane bagasse. In 2009, the country's first bagasse co-generation plant (Belcogen) was commissioned. As of 2016, the sole co-generation plant in the country produces 27.5 MW of power. Of that amount, a portion is used to keep the plant operational, and the excess energy is sent to Belize's national grid. The electricity produced from Belcogen accounts for about 15% of the national grid's needs. In total, approximately 50% of Belize's electric energy needs are met through local renewable energy sources. Recent economic strains have prompted the rise in electricity rates in the country. In that regard, the discussion to improve and expand on the current renewable energy sources, especially as it relates to energy produced from sugarcane bagasse, has been at the forefront of the country's outlook.

BELIZE'S SUGAR INDUSTRY

Sugarcane is a crop rooted deep in Belize's history.

VERY VERY VERY VERY VERY VERY VERY VERY LONG HEADING

If the heading should run into more than one line, the runover is flush left.

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The next level of heading is boldface with upper and lower case letters. The heading is flushed left with the left margin. The spacing to the next heading is two line spaces.

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FIGURE 1. THE FIGURE CAPTION USES CAPITAL LETTERS.

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Equations should be numbered consecutively beginning with (1) to the end of the paper, including any appendices. The number should be enclosed in parentheses and set flush right in the column on the same line as the equation. An extra line of space should be left above and below a displayed equation or formula. LaTeX can automatically keep track of equation numbers in the paper and format almost any equation imaginable. An example is shown in Eqn. (1). The number of a referenced equation in the text should be preceded by Eqn. unless the reference starts a sentence in which case Eqn. should be expanded to Equation.

$$f(t) = \int_{0_+}^{t} F(t)dt + \frac{dg(t)}{dt} \tag{1}$$

FIGURES AND TABLES

All figures should be positioned at the top of the page where possible. All figures should be numbered consecutively and captioned; the caption uses all capital letters, and centered under the figure as shown in Fig. 1. All text within the figure should be no smaller than 7 pt. There should be a minimum two line spaces between figures and text. The number of a referenced figure or table in the text should be preceded by Fig. or Tab. respectively unless the reference starts a sentence in which case Fig. or Tab. should be expanded to Figure or Table.

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FOOTNOTES[1]

[1]Examine the input file, asme2e.tex, to see how a footnote is given in a head.

TABLE 1. THE TABLE CAPTION USES CAPITAL LETTERS, TOO.

Example	Time	Cost
1	12.5	$1,000
2	24	$2,000

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The ASME reference format is defined in the authors kit provided by the ASME. The format is:

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The bibliography style required by the ASME is unsorted with entries appearing in the order in which the citations appear. If that were the only specification, the standard BIBTEX unsrt bibliography style could be used. Unfortunately, the bibliography style required by the ASME has additional requirements (last name followed by first name, periodical volume in boldface, periodical number inside parentheses, etc.) that are not part of the unsrt style. Therefore, to get ASME bibliography formatting, you must use the `asmems4.bst` bibliography style file with BIBTEX. This file is not part of the standard BibTeX distribution so you'll need to place the file someplace where LaTeX can find it (one possibility is in the same location as the file being typeset).

With LATEX/BIBTEX, LATEX uses the citation format set by the class file and writes the citation information into the .aux file associated with the LATEX source. BIBTEX reads the .aux file and matches the citations to the entries in the bibliographic data base file specified in the LATEX source file by the `\bibliography` command. BIBTEX then writes the bibliography in accordance with the rules in the bibliography .bst style file to a .bbl file which LATEX merges with the source text. A good description of the use of BIBTEX can be found in [**?**, **?**] (see how 2 references are handled?). The following is an example of how three or more references [?, ?, ?] show up using the `asmems4.bst` bibliography style file in conjunction with the `asme2e.cls` class file. Here are some more [**?**, **?**, **?**, **?**, **?**, **?**, **?**, **?**, **?**, **?**, **?**] which can be used to describe almost any sort of reference.

ACKNOWLEDGMENT

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Appendix A: Head of First Appendix

Avoid Appendices if possible.

Appendix B: Head of Second Appendix

Subsection head in appendix

The equation counter is not reset in an appendix and the numbers will follow one continual sequence from the beginning of the article to the very end as shown in the following example.

$$a = b + c. \tag{2}$$

[2] Avoid footnotes if at all possible.