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Utilizing Bagasse Waste To Battle Deforestation

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BARA Industrial Plant Consultants recently designed and built a pellet plant in rural Malawi, aiming to utilize sugar manufacturing waste and reduce deforestation.
IMAGE: BARA INDUSTRIAL PLANT CONSULTANTS

Like large parts of the developing world, Malawi is a country that faces severe deforestation with a heavy reliance on rudimentary energy sources. To understand the energy landscape within Africa, one must know that at the root of every home cooked meal is charred wood as the main energy source. Locals will buy this charred wood at their nearest market and carry it over underdeveloped terrains on bicycles, most of the time over long distances. The charred wood is then used in a drum-type grill setup in the open air. Within this cooking setup, the locals are not equipped with fire lighters, which necessitates the use of waste plastic and some kindle from a nearby bush to set the char ablaze. The fire would then be required to sustain heat for approximately two hours, in which typically Chambo and Nsima would be cooked (freshwater fish from nearby lake Malawi and an unsalted maize porridge).

According to the Global Forest Watch, a decline of 224,000 hectares (approx. 553,500 acres) of tree cover has been reported in Malawi since 2001. The loss in tree cover equates to 94 metric tons CO_2e emissions. This is especially prevalent in areas surrounding northern and central Malawi, with Nkhota Bay and Mzimba being responsible for 52% of the total tree cover loss in the country. On a global scale, this equates to below 0.1% of total deforestation, but this is quite significant, considering that Malawi has a population of less than 20 million people. While deforestation is so prevalent in these areas, the far north of Malawi is partially protected due to the conservation reserve located on the northwestern border with Zambia. However, a marked decline in tree cover within these areas can still be noted, regardless of the conservation status.

Considering the statistics and the energy landscape within Malawi, a solution is required to produce an affordable fuel alternative—something that will change the energy landscape and empower the locals to better living conditions. This is true for most of the developing world, but the boundaries of such a solution are tightly defined. Being that it must be cost effective, as most of Malawi is far below the global average poverty line, the solution must outperform in the market with the charred wood product. It has to be durable and easy to combust within the current cooking setup without doing any modifications. The last point is extremely relevant when taking a new product to market within an underdeveloped world: The product will not sell if it cannot be used on what is at home. This would mean that an energy-dense product with a high calorific value and a low burnout time would be required. Furthermore, this energy source must measure up or even outperform any durability test and standards, as the product will face harsh handling conditions.

Considering all these requirements, one of Malawi's sugar producers approached BARA Industrial Plant Consultants (a multi-disciplinary consulting firm with a footprint in both the U.S. and Southern Africa) to design, manufacture and implement a solution that would utilize bagasse waste from the sugar mill while addressing the energy landscape and deforestation need, as well as the sugar mill's problem of waste handling. In addition, a solution that could potentially change the energy landscape in Malawi and create a previously nonexistent revenue stream—the perfect solution for the sugar mill and the local communities.

During the initial feasibility studies, direct feedstock briquetting was ruled out as a solution due to the lack of durability thereof, thus making it unfeasible for the rough terrain the product needs to travel. Direct feedstock briquetting also showed that it would not be able to sustain the heating requirements, and that the preconditioning requirements would render the process as unviable from an economic standpoint. That is considering that the moisture content in the raw bagasse is quite high and variable, depending on the time of milling season. Alternatively, biofuel technology like pyrolysis and torrefaction

of the bagasse were considered, but the liquid market and upfront investment were found to be outside the scope of the current project. However, this was placed as a future consideration, as it does show promising return on investment. The biggest hesitation in this case was market maturity of pyrolysis products for the Malawian landscape.

A solution was developed to use the bagasse as-is in a densification process, for pellets 12 millimeter (mm) by 15 mm, and then secondary projects would include further biomass beneficiation via thermochemical processing techniques. The project kicked off with much excitement, but it was soon realized that to get things done in central Africa does not come without its headaches. From power installations to availability of resources like quality steel for fabrication, or even concrete for flooring, were all extremely challenging. However, after a 12-week manufacturing and installation period, commissioning started.

As the plant was made live and the equipment started, Junior Fakane, a Malawian plant operator, excitedly exclaimed, "Today, I will cook Nsima with the product from my plant!" But much to his dismay—within the first hour—the plant grinded to a halt. It was soon learned by the whole team that pelleting of bagasse is not as easy as one would think, considering that bagasse is exposed to various elements, forms of degradations and upstream variability in the sugar extraction process. All these factors contribute to the large-scale variability in feedstock, posing a significant question: How can such large-scale variability be overcome while still maintaining pellet integrity and keeping the process design within the limits of the equipment?

The answer did not come easy, as this led to a time of rigorous testing, first principal compression model development, investigating and optimizing every single process variable within the pelleting process, from feedstock moisture to compression ratio. The solution was found within the compression rate. Bagasse is a notoriously difficult material to handle, as it has a high enough sugar content to block any chute, choke any auger and compact any mill, a low enough density to make throughput quite challenging, and a variability in incoming fiber length that adds another layer of complexity. All these challenges are being overcome, with rigorous testing and optimization. The pellets produced are being market tested, and the feedback has been remarkable.

In conclusion, pellets from waste sources are a viable source of energy in the developing world that may not even have access to fossil fuels.

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