

**Bagasse Cogeneration in Mauritius**

**Overview**

Caribbean countries with a significant sugar production sector can exploit bagasse-based electricity generation to contribute to the achievement of renewable energy targets. One advantage of bagasse as a renewable energy source is that, unlike wind or solar, it can be exploited as a source of baseload power. Although the renewable (bagasse) resource may only be available during certain (so-called “sugar”) seasons, coupling bagasse with another energy resource (renewable or non-renewable\(^1\)) means it can form part of a strategy to provide firm power capacity to the grid.

The case of Mauritius illustrates this quite well.

The sugar industry is an important part of the Republic of Mauritius’ economy, with sugar cane occupying 85% of arable land and sugar exports representing about 19% of foreign exchange earnings (Mauritius Island Online 2013). Mauritius succeeded in revitalizing its fledgling sugar industry, including making it a significant provider of non-intermittent renewable-based electricity. Through Mauritius’ sugar sector reformation, bagasse-based generation grew from providing 8% of the island’s electricity consumption (and 13% of installed electrical capacity) to 16.5% (and 37% of installed capacity) over the period 1994-2004 (Deepchand 2005). In doing so, the country achieved: a tangible reduction in reliance on imported petroleum products, and thus greater energy security and foreign exchange savings; a modernised and viable sugar sector; and a reduction in electricity sector greenhouse gas and pollutant emissions. This transformation of the sugar sector was achieved through a series of policies and programmes accompanied by dedicated programme funding.

**Policies**

**Sugar Sector Action Plan**

In the late 1970s and 1980s, in response to the significant decline in Mauritius’ sugar sector productivity, the government established the Sugar Sector Action Plan (SSAP) of 1985 as the overarching policy for restructuring and improving the viability of the sugar industry. The SSAP promoted exploitation of bagasse-based power generation for supply/sale to the electric grid as a means to improve the sector’s viability, while meeting a clear electricity demand need. To be in line with the needs of the demand side of the market, the framework was set up with emphasis placed on bagasse-based power production providing firm, rather than intermittent, power capacity for the grid. From a practical point of view, this meant not only maximizing the recovery of bagasse and managing its use, but also coupling bagasse use with other solid energy sources (in this case, coal) to ensure continuous availability of the energy resource, regardless of variability in sugar-production activities.

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\(^1\) Options for alternate fuel choices include coal but also other forms of biomass such as wood chips, wood pellets and other solid organic waste.
The SSAP was developed in close collaboration with private stakeholders of the sugar sector which ensured the buy-in of the sector and their participation in the policy’s implementation. Implementation of the SSAP was accompanied by a number of sub-policies specifically addressing bagasse-based electricity production.

**Sugar Industry Efficiency Act**

In 1988, the Sugar Industry Efficiency (SIE) Act was passed as a sub-policy of the SSAP. The aim was to improve the recovery of sugar and bagasse from the sugar production process, and enhance utilisation of the bagasse for firm power generation. At the time, electricity generation and supply to the grid from the bagasse by-product was done on an intermittent basis, as and when excess bagasse was produced from the (seasonal and variable) sugar production process. Since bagasse was at best treated as a by-product of the process, rather than an energy resource for generating additional revenues, **there was no incentive to save bagasse** produced from the process, **nor to optimize its production and use**. In addition, export of bagasse-based electricity production to the grid was done only for the excess production, after electricity requirements for cane processing were met; electricity production was therefore not modulated to grid needs for firm power. **There was no incentive for millers to target bagasse-based electricity production and sale as a revenue source, and thus produce it in accordance with demand needs** (firm power).

In order to incentivize the production of firm power from bagasse in the sugar sector, the SIE included the following elements:

- Incentives\(^2\) for millers to save their bagasse for sale for the generation of firm electrical power, to encourage efficient recovery and use of bagasse
- Incentives\(^3\) for both the sale of bagasse for the purpose of generating firm electrical power, and for the sale of firm electrical power itself (generated using bagasse) to the local utility, the Central Electricity Board (CEB)
- A dis-incentive\(^4\) for the sale of intermittent power from bagasse, which was placed at a lower rate than that of firm power.

**Bagasse Energy Development Programme**

The 1991 Bagasse Energy Development Programme (BEDP) addressed exclusively the energy component of the SSAP. It sought to achieve economically efficient biomass-based electricity production from the sugar sector through **modernisation of sugar industry operations** (sector modernization) and power generation capacity, and **optimization of the use of bagasse** and other sugar cane parts for **electricity generation** (energy development).

Some financing for implementation of the BEDP was provided through USD 15 million World Bank loan and a USD 3.3 million grant from the Global Environment Facility Fund (Deepchand 2002). The BEDP enabled a four-fold increase in electricity export (firm power) from 1991 to 2004 (70 GWh to 318 GWh).

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\(^2\) Incentives were in the form of performance-linked rebates on sugar export duty  
\(^3\) Incentives were in the form of income tax exemption  
\(^4\) The dis-incentive was in the form of a price freeze on intermittent power from bagasse sold to the grid/utility
Lessons learnt in the implementation of the BEDP

The energy projects of the BEDP required relatively huge capital investments. Despite the loan from the World Bank, progress of project implementation was too slow which resulted in only 40% of the loan being disbursed and the remaining 60% cancelled from the world bank. Three constraints to project implementation were identified by the BEDP committee, and subsequently addressed. These were:

1. Need for an adapted financing mechanism

The World Bank’s loan was spent where stakeholders believed it would have had the greatest impact and yielded the quickest returns i.e. predominantly on increasing the efficiency of the sugar plants and bagasse recovery; that is, the sector modernization component. Consequently, little was left for the energy development component of the overall plan. Additionally, loans – needed to supplement World Bank funding – were expensive: loans in foreign currencies had a minimum interest rate of 12% and local financing was also expensive at interest rates of 14% minimum.

A fiscal framework was created to provide additional incentives to invest in the energy development component. This took the form of regulations and acts, covering tax exemptions and reductions, duties, debentures, rebates, foreign exchange control5 and relief of losses on projects focused on electricity generation from bagasse and modernization of sugar equipment (Deepchand, AFREPREN/FWD et al. 2001).

2. Addressing bagasse supply costs and logistics constraints

In order to have sufficient bagasse supply to meet electricity production requirements, bagasse-based power plants had to source bagasse from several factories (called satellite factories), the logistics of which proved costly. Additionally, the BEDP favoured larger capacity boilers (for bagasse-based power plants) because of the greater processing and thus cost efficiencies obtained. The natural tendency towards having fewer, larger factories, on the basis of economies of scale, led to the closure of several mills, with the production gap being filled through increased capacity(ies) of adjoining mill(s). One such closure, considered a success, due to its engendering of increased efficiency and bagasse-based energy generation capacity in an adjoining mill/plant, provided the basis for the creation of a blue print on consolidation of cane milling activities. The blue print placed significant emphasis on linking any closure (or request thereof) with energy generation from bagasse and hence served as the back bone for the BEDPs consolidation/centralization strategy. Millers wishing to close their plants in Mauritius were/are required by law to adhere to this blue print6.

3. Developing appropriate and transparent tariffs

The pricing formula initially developed for the Power Purchase Agreement (PPA) between the utility and the millers was a source of disagreement, due to differences in interpretation, which stalled project implementation under the BEDP. As a result, a Technical Committee was set up at the Ministry of Energy to study and interpret the

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5 The Government abolished foreign exchange controls in July 1994. Since then, settlement can be done in foreign currency, and foreign currency accounts can be opened in Mauritius. Banks are also now permitted to repatriate currency freely at their client’s request. (AABF 2003, Baker Tilly International 2012)

6 Closure of a sugar factory in Mauritius must be done under the Mauritius Cane Industry Act, where approval must be received from the relevant minister (Ranjit Dowlutta 2011)
clauses of the draft PPA. This prompted an in-depth analysis of the price setting mechanism, the outcome of which was the recommendation of a kWh price for coal and bagasse units based on **avoided costs**, both economic and financial (Deepchand 2002). The basis was the cost of a diesel plant of 22MW capacity, proposed by the CEB to arrive at the avoided cost for the firm power plant\(^7\). The effect was to enhance transparency and buy-in amongst the sugar sector.

**REPLICABILITY**

If conceived as part of a coherent sector strategy, the development of an “electricity product” from the sugar industry can lead to additional revenues for the sector, improving its viability, and contribute to meeting increased electricity demand needs while moving towards the attainment of renewable energy targets.

The Mauritius case study indicates the following elements for a successful strategy for creating an enabling environment for renewable energy production from bagasse from the sugar industry:

- An over-arching policy framework to set objectives, define goals and engage all relevant public and private stakeholders, thus providing a coordinated long-term basis for reform
- Engagement and inclusion of all stakeholders in policy- and objectives-setting
- Targeted sub-policies and programmes to address specific objectives/goals/targets of the over-arching policy, such as sugar sector modernization and optimization of bagasse use
- Targeted measures to: a) address barriers to policy/programme implementation e.g. measures to address high capital costs faced by the sector in implementation; and b) achieve greater efficiency in implementation e.g. sector consolidation to achieve economies of scale in implementation
- A well-thought out and adapted strategy for financing the implementation of policies and programmes, including appropriate frameworks and instruments to provide long-term security for the sugar sector to make the necessary investments
- Simplification of administrative processes to facilitate and encourage potential developers to get onto the grid.

\(^7\) This capacity was based on a proposed ideal capacity of 22 MW for coal and bagasse (dual fuel) units under the BEDP.
REFERENCES


