

## DOCUMENTATION OF RE PROJECTS IN THE ECOWAS REGION

### KEYS FACTS, LESSONS LEARNED AND CHALLENGES

# Sunbird Energy

## SIERRA LEONE



### BACKGROUND

Sunbird Bioenergy Sierra Leone Limited is a company that, in 2016, took over the majority of ownership of the bioethanol production plant in Mabilafu, near Makeni town in Sierra Leone. The project, originally implemented by Addax Bioenergy in 2010 and with its production start in 2014, has the capacity to produce 83 million liters of fuel grade bioethanol and 20 million liters of extra neutral alcohol (ENA). While fuel grade bioethanol is mainly exported to Europe, ENA serves the national and regional demand in West Africa. The factory uses bagasse, a waste product during bioethanol production, to produce energy. Of an installed electrical capacity of 32 MW, 15 MW are available for the national power grid.

### KEY INFORMATIONS

Site	Mabilafu, near Makeni town, in Bombali and Tonkolili districts, Sierra Leone
Technology	Bioethanol production from sugar cane & Grid-connected biogas plant
Installed Electrical Capacity	32 MW (15 MW for power grid supply)
Developer	Addax Bioenergy
Operator	Sunbird Bioenergy Sierra Leone Limited
Commissioning	2014
Investment Costs	Between 258 and 455 million EUR
Financing	55.6% development financing institutions, 44.4% equity



## PROJECT DEVELOPMENT

Through the “Everything but Arms”- European Union initiative from 2001 that promotes the import of all goods but arms from least developed countries, and the Renewable Energy Directive from 2009 that specified that 10% of fuels should be from renewable sources, an attractive regulatory framework existed for the implementation of bioethanol production in Sierra Leone with subsequent import to Europe.

Addax Bioenergy, as part of the Addax and Oryx Group, started the exchange with the Government of Sierra Leone resulting in a Memorandum of Understanding that was signed in 2010. This MoU confirmed amongst other the land leasing of 50,000 ha from communities around Mabilafu and its availability for sugarcane cultivation.

Through the financial support from eight European and African Development Finance Institutions as well as approval from the Government of Sierra Leone and the local

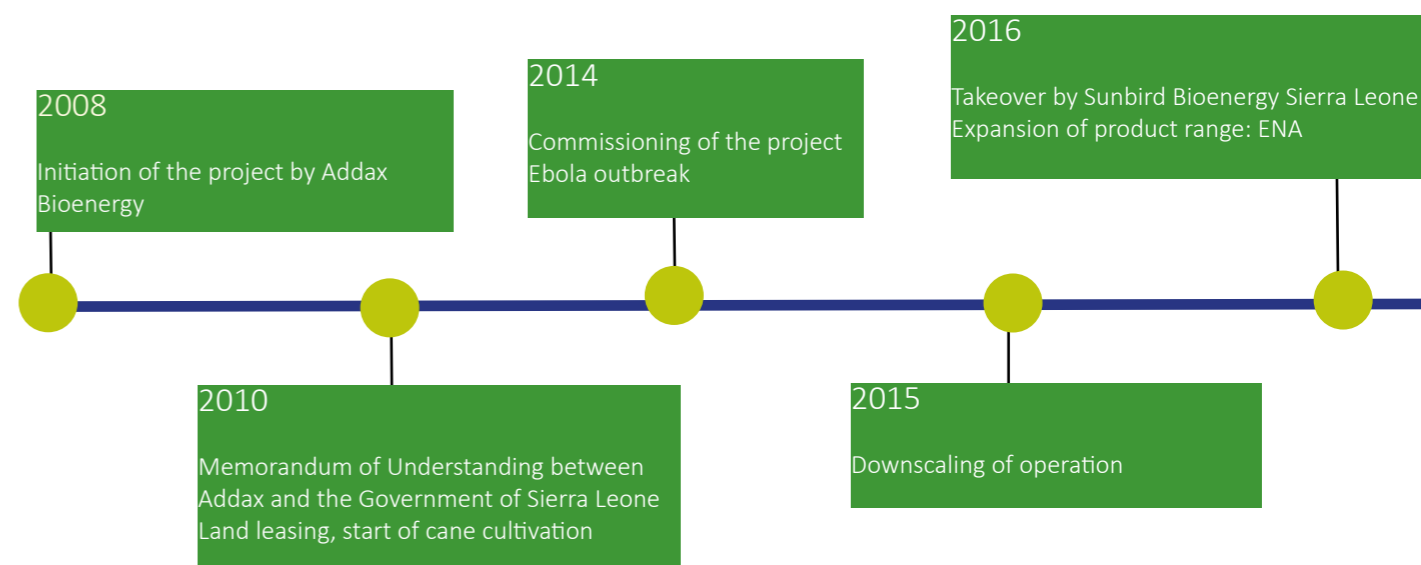
leadership in the project area, the bioethanol production project was implemented.

The project was built and operated by Addax Bioethanol Sierra Leone. The ethanol and electricity production started in 2014. After the commissioning, Addax failed to obtain sufficient crop yields and the project was further impacted by the Ebola outbreak. As a consequence, the scaling down of operations followed in 2015. This included the release of land back to their landowners, so that the project remained with 23,500 ha.

In 2016, the project was resumed under Sunbird Bioenergy Sierra Leone with AOG keeping a minority interest of 24.9%. With the takeover by Sunbird, not only the management changed, but also the general approach to get the project back on track. The focus changed from export of bioethanol to European markets, to production of extra neutral alcohol for which the demand is especially high on national and regional markets in West Africa.

## PROJET MILESTONES

The bioethanol production plant is a flagship and pioneering project for Sierra Leone and entire West Africa. Since its implementation in 2010, with production start in 2014, the ownership has changed several times. With Sunbird Bioenergy Sierra Leone as operator since 2016, the project is changing its course with more focus on a new product, extra neutral alcohol, and on the regional market. The increasing production is thereby indicating a promising future.



## TECHNOLOGY

The factory includes about 10,000 ha of land for sugarcane cultivation. After harvesting and collection, the cane is transported to the factory which can process about 240 tons per hour or 5,000 tons per day.

When arriving at the site, the cane firstly passes through a shredder followed by a four-stage milling process for juice extraction.

While the juice is forwarded for further processing and fermentation, the fiber, also called bagasse, goes into the boilers to produce about 80 tons of steam, from about 40 tons of bagasse, which is used for power generation by the turbo-alternator with an installed capacity of 32 MW. 7 MW are required by the factory and another 7 MW are consumed by the irrigation system for the cultivable land. About 15 MW remain which are exported through

a 161 kV transformer station via a single 13.6 km long evacuation-transmission line into the Bumbuna-Freetown main transmission line.

The juice extracted from the sugarcane undergoes a clarification step for impurity removal. This step is followed by evaporation of the clear juice leaving a syrup of about 40 brix. This syrup is fermented for about 36 hours. The fermented mash or so-called beer reaches up to 10% alcohol concentration.

Through distillation of the beer, rectified spirit with about 96% ethanol concentration is produced. For fuel grade ethanol, the rectified spirit undergoes a dehydration stage to remove about 4% water. For extra neutral alcohol, the rectified spirit must undergo additional stages of re-distillation in order to remove all remaining impurities.

fully occupied or during off-crop season. Most of the equipment is coming from India, the origin of main contractors involved in the design and installation. Spare part management is crucial as the majority of parts needs to be imported and cannot be found on the local market. Considering the complexity of the factory, Sunbird records all maintenance works performed.

While at the project implementation, lots of works were realized by international experts, nationals are continued to be trained. Nowadays, national experts are doing the majority of work with supervision and support by internationals.

## OPERATIONS

The year can be differentiated between on-crop, operational phases, and off-crop, maintenance phases. Off-crop usually lasts from July until September. During this time, maintenance works are realized while revenues are still generated through bioethanol sales.

During the on-crop phase, the plant is operated for 24 hours covered by three shifts.

Sugarcane is harvested after around 11 of 12 months – the ideal age considering fiber and juice content. The fields are irrigated with water from the nearby Rokel river that is stored in dams and then forwarded to the pivots. In daily production summaries, cane delivered, area harvested, operation hours and other production relevant information are recorded. Maintenance is done when the plant is not

## ECONOMIC AND FINANCIAL ANALYSIS

About 55.6% of the project was financed through loans provided by different European and African development financing institutions. The remaining 44.4% are provided through equity capital. The total investment amount arose to maximum 455 million Euro.

Operational expenses include next to the expenses for operation and maintenance of the factory, yearly land lease payments as well as specific on-crop expenses. These include the salaries for temporary workers; in addition to 400 employees who are continuously working in the factory, 2000 temporary workers are hired according to the needs during on-crop season. Revenues are generated through the sales of fuel grade bioethanol, extra neutral alcohol and electricity. Since the implementation of the project, the global bioethanol price dropped significantly, so that the price for fuel grade bioethanol is, in 2020, around 500 USD/m<sup>3</sup>. ENA is sold for about 1.05 to 1.08 USD/liter. At full capacity, the plant can produce 83 million

liters of bioethanol and 20 million liters of ENA resulting in 41.5 million USD and 21 million USD sales revenues.

For the sales of electricity, Sunbird has a Power Purchase Agreement (PPA) with the Electricity Distribution and Supply Authority (EDSA). The available capacity for injection amounts to 15 MW. The PPA foresees the export of 100,000 MWh with a variation of plus 20,000 MWh and minus 10,000 MWh. If the amount cannot be respected, EDSA needs to be informed in advance with an explanation to avoid penalties.



### RESALE OF ELECTRICITY

Sierra Leone's installed power capacity per capita is with about 105 MW for a population of app. 7 million people in 2018, one of the lowest in the world. The electricity tariff regime is subsidized and is with 0.28 USD per kWh among the highest in Africa.

The country has a single-buyer model meaning that independent power producers such as Sunbird can only sell to EDSA or the Government of Sierra Leone.



Sunbird ENA Plant

## ENVIRONMENTAL BENEFITS

Bioethanol has several advantages compared to other sources including a more complete combustion making it a cleaner exhaust. It is further a neutral carbon emitter and does not raise the atmospheric CO<sub>2</sub> concentration. It also poses an alternative for countries that have to crude oil resources and can instead grow crops for energy use and thereby also gain economic freedom.

With production of clean energy produced from the waste by-product bagasse of the bioethanol production, electricity produced from fossil resources is substituted and Sunbird is contributing to the reduction of CO<sub>2</sub> emissions.

As the large-scale project that it is, the Sunbird bioethanol plant also benefits the population by creating jobs: up to 400 people work in the factory and up to 2000 people receive service contracts during the on-crop season.

Nonetheless, as a land-demanding project that relies mainly on sugarcane, environmental and social challenges can occur. A stable cultivation requires the application of fertilizers and during the production process other by-products are occurring that need to be adequately treated before discharge into the environment. As applied for this project, a sustainable Estate Operational Environmental and Social Management Plan is necessary including mitigation measures and responses for all potential risks.

## CONCLUSION

The bioethanol project operated by Sunbird Bioenergy is the first of its kind in Sierra Leone and a pioneer project in the West African region. The “Agenda for Prosperity” followed by the Government of Sierra Leone favours the green project. Considering the land required for raw material cultivation and the factory itself, the support from state and communities is essential. Through the support, the Sunbird project received initially 50,000 ha in a central part of Sierra Leone with good interconnection to the road system including to Freetown and its port.

With its rather complex processing technology, the factory is very energy consuming. Considering the local conditions with only 15% of the population having access to electricity, finding an autonomous solution was important. It was achieved by using bagasse as source to cover not only the plant’s demand, but producing even more so that the country could benefit. Another crucial aspect is related to the high investment costs. Such a large-scale bioethanol plant will require a variety of supporters to provide loans or subsidies. As the revenues in full operation are high as well, these kinds of projects can be profitable and could be paid off in less than ten years.



Fields of sugar canes

## CRITICAL SUCCESS FACTORS

Financing	Large-scale bioethanol production plants have very high initial investment costs. Desirable conditions and support from a variety of lenders and the government will be necessary.
Land Availability	The cultivation of large amounts of sugarcane demand large areas of land. This land needs to be available and leased in consideration of communities and local conditions.
Consistent and predictable supply	Bioethanol plants depend on the raw material. A sustainable cultivation needs to be guaranteed. If outsourced, favorable conditions need to be created for farmers.
System Adaptability	As bioethanol prices dropped while costs for export remain, it was a strategical decision by Sunbird to focus more on regional markets and thereby switch focus on ENA production. In addition to possible product expansions, the system may also need to react to changing input material.
Community involvement and government support	As land is needed and the large-scale project is impacting the entire area, communities and government should be involved starting from the implementation. Exchange needs to be continued during operation. Only with consideration of all impacted, a sustainable project can be guaranteed.
Social and environmental impact assessment	Through its largeness, these kinds of projects have extensive impact on the communities and environment. Mitigation measures need to be elaborated to guarantee a sustainable long-term integration. Last but not least, land depletion and tensions with communities can be avoided.

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