

CTCN Technical Assistance

Development of a technical and economic feasibility study for anaerobic digestion of the organic fraction of solid waste from households, hotels, and markets in Mauritius

Output 6: Cost & Revenue analysis and Business model

Deliverable 6 (6.1, 6.2, 6.3 and 6.4)

Submitted to:

- Climate Technology Centre and Network
- Department of Environment, Ministry of Environment, Solid Waste Management & Climate Change, Republic of Mauritius
- Solid Waste Management Division, Ministry of Environment, Solid Waste Management & Climate Change, Republic of Mauritius

Submitted by:

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NOMENCLATURE

AD	Anaerobic digestion
CapEx	The capital expenditure
CapEx _{Digester}	The capital expenditure for the anaerobic digester (\$/digester)
CapEx _{CHP}	The capital expenditure for the combined heat and power unit (\$/CHP)
CapEx _{biogasCleaning}	The capital expenditure for the biogas cleaning (\$/unit)
CapEx _{Total}	The total capital expenditure (\$/biogas plant)
CHP	Combined heat and power
E _{Electricity}	The net annual electricity (kWh-e/year)
E _{Heat}	The net annual heat (kWh-e/year)
E _{Gas}	The size of the engine (kW)
OpEx	The operational expenditure
OpEx _{feedstock}	The operational expenditure for the feedstock (\$/year)
OpEx _{Transportation}	The operational expenditure for the transportation (\$/year)
OpEx _{Digester}	The operational expenditure for the digester (\$/year)
OpEx _{CHP}	The operational expenditure for the combined heat and power unit (\$/year)
OpEx _{Total}	The annual operational expenditure for a biogas plant with a given biogas production (\$/year)
Revenue _{solid digestate}	The revenues from solid digestate (\$/year)

6. OVERVIEW

Deliverable 6 consists of four components namely:

- Cost Analysis
- Revenue Analysis
- Cost-Benefit Analysis
- Business Model

Deliverable 6 looks at the ‘Cost and revenue analysis and development of business model’ of the anaerobic digestion of the organic fraction of solid waste from households, hotels, and markets in Mauritius. Essentially, the economic costing relies on secondary information drawn from a wide range of similar projects elsewhere in the world contextualised to the designed biogas plant for Mauritius (see Output 5). Deliverable 6 thus uses variables from preceding sections of the project. A central feature of biogas technology (as for many other renewable energy technologies (RETs), and other than for conventional energy sources), is that almost all expenses need to be financed upfront (Capital Costs), with relatively lower operating expenses (operation and maintenance costs) thereafter. The economy of an anaerobic digester is characterised by high initial investment costs. This is problematic where poverty is endemic. Although the biogas industry is usually characterised by zero to low feedstock cost (if any, it is mostly due to the transportation cost), large-scale production will also be limited by local feedstock organic fraction of solid waste resource availability.

6.0. INTRODUCTION

Output 6 of CTCN's Mauritius Technical Assistance request will provide the cost analysis, the revenue analysis and a cost-benefit analysis and business model of the project. Like other energy projects of this magnitude, economic considerations of the biogas plant depend on several factors among which includes plant capacity, cost, revenue generation and return on investment. The preliminary costs presented at this stage only provide a coarse estimate. The costs were drawn from an extensive literature search of publications, documented reports, and historical costs of biogas plants with varying capacity cost and where possible quotations were used. All costs derived from varying sources and currencies have been converted to USD for consistency using the official exchange rate of the 9th of March 2022. As the cost is based on the likely process equipment requirements and biogas plant size capital costs variation of +/- 30% is anticipated.

6.1. COST ANALYSIS

Based on the biogas plant design data on deliverable 5, an economic analysis was then conducted to determine the viability of the biogas production plant. The biogas plants' items capital and operational expenditures (CapEx and OpEx) were assessed and used in the economic analysis. Capital cost of a project does not always vary linearly with the biogas plant capacity. The cost of a specific item depends on size or scale and can usually be correlated by the approximate relationship (Bauman, 1964; Remer and Chai, 1990; Brennan, 1998; Marouli and Maroulis, 2005):

$$\frac{C_1}{C_2} = \left(\frac{Q_1}{Q_2}\right)^n \quad (1)$$

where C_1 = cost of the reference item at size or scale Q_1 ; C_2 = cost of the reference item at the size or scale Q_2 . n = scale exponent or cost capacity factor; k = a correlation constant (normal cost of the item at unit size or scale). A value of n equal unity ($n = 1$) indicates a constant return to scale and capital costs increase proportionately with plant size.

Economies of scale exists where the capacity factor value is less than unity ($n < 1$), indicating that capital investment costs per unit of capacity decrease with increasing plant capacity, while a value of $n > 1$ depicts diseconomies of scale. In general, the value of n depends on the phase that is being processed and it increases along the sequence of gas phase, liquid phase and solid phase.

In this context we had to estimate the cost of the equipment given that limited data was available for the size of operational capacity. We had to apply the *six-tenths factor* rule¹. According to this rule, if the cost of a given unit at one capacity is known, the cost of a similar unit with **X** times the capacity of the first is approximately $(\mathbf{X})^{0.6}$ times the cost of the initial unit. The next equation indicates that a log-log plot of capacity versus equipment cost for a given type of equipment should be a straight line with a slope equal to 0.6.

$$\text{Cost of equip. } a = \text{cost of equip. } b \left(\frac{\text{capac. equip. } a}{\text{capac. equip. } b} \right)^{0.6} \quad (2)$$

More generally, if one assumes constant prices for capital, this can be written as:

$$C_K = \alpha_K Q^{\beta_K} \quad (3)$$

where C_K and Q denote the capital cost and capacity, respectively, and α_K and β_K are constants. The term β_K is usually called the scale coefficient (capacity factor) of capital. The dimensions of Q must be chosen to suit the type of item. The values of k and n depend upon the type of item and the characteristic dimension used, they can be derived from historical costs and using appropriate escalation factors known as cost index, the ratio of costs at a particular time to costs at a specified base year such as Chemical Engineering Plant Cost Index (CEPCI), Engineering New Record (ENR), the Nelson Refinery Cost Index (NRCI) to update from previous installations.

The biogas plant costs have broadly been divided into segments namely, Capital Expenditure (CAPEX) and the Operating Costs (OPEX).

6.1.1. Determination Capital Expenses (CAPEX)²

The cost of the anaerobic digester, biogas cleaning unit, and CHP unit are all included in CapEx. The following equations were used to compute the CapEx of specific unit operations. The total CapEx for a biogas plant with a given biogas production ($\text{CapEx}_{\text{Total}}$, \$/biogas plant) was computed as follows:

$$\text{CapEx}_{\text{Total}} = \text{CapEx}_{\text{digester}} + \text{CapEx}_{\text{BiogasCleaning}} + \text{CapEx}_{\text{CHP}} \quad (4)$$

The anaerobic digester's capital expenditure ($\text{CapEx}_{\text{Digester}}$, \$/digester) is calculated as a function of the biogas flow rate (Sliz-Szkliniarz et al., 2012). The anaerobic digester takes into account

¹ Peters, Max Stone, (1991) Plant design and economics for chemical engineers/Max S. Peters. Klaus D. Timmerhaus.4th ed (McGraw-Hill) chemical engineering series. ISBN 0-97-100871-3.

² USD:MUR exchange rate on 12 April 2022 (1:14,25)

the annual biogas production ($m^3/year$) and the operational hours per year of the biogas plant (hr) based on the CHP operation. The CapEx for the CHP ($CapEx_{CHP}$, \$/CHP with an engine size of $E_{GasEngine}$) is correlated with the electrical power output of the engine. The cleaning unit ($CapEx_{biogasCleaning}$, \$/unit) CapEx is also calculated based on biogas flow rate. To clean biogas, a biological H_2S removal method is used.

As the estimates were drawn from literature and documented reports, the biogas plant' capital costs (CAPEX) were based on several assumptions which are enlisted in Table 6.1 below.

Table 6.1. Assumptions for estimating CAPEX 1

Item	Cost Components	Assumption Description
Construction	Land	1. **Estimated required area of land = 4 Hectares. @49147 Eur per hectare (2311500,12 MUR). 2. **The land will be required for: (Refer Output 5 section 2.4).
	Waste collection and storage system	3. **Collection and Transportation to be handled by the Mauritius Government. Not included in this costing.
	Waste management equipment. (Temporary Storage and Processing + weighbridge)	4. ** Plant processes 100 tons per day. Average monthly tonnage = (3000 tons/month), estimated cost of civil works @ 10939 USD (473150,36 MUR).
	Civil works (Excavation and Construction)	5. ** Plant capacity 10/tons per day estimated cost of civil works @ 36465 USD (1577239,97 MUR). Source: (City of Joburg 2016)
Purchased Equipment (EPC)	Engines and its Accessories	6. ** Plant capacity and Engine Quotation figures from Siemen's energy were applied.
	Digester and its accessories	7. ** Plant capacity and estimate costs drawn from South African Engineering Company (WEC)
	Gas conditioning system and flaring system	8. ** Plant capacity 10/tons per day estimated cost of Conditioning System @13492 USD (583576,63 MUR) (City of Joburg 2016).
	Heat exchanger and pumps	9. ** Plant capacity 10/tons per day estimated cost of Heat pumps @19691 USD (851705,26 MUR) (City of Joburg 2016).
	Biogas upgrading system	10. ** Plant capacity 10/tons per day estimated cost of Upgrade @64907 USD (2807456,87 MUR) (City of Joburg 2016).
	Biomethane compression and dispensing system	11. ** Plant capacity 10/tons per day estimated cost of methane compression @7293 USD (315447,99 MUR) (City of Joburg 2016).
	Freight and Duties	11. ** Freight and Import Duties etc., @ USD 3000 (129760,59 MUR per container (Amigun <i>et al</i> 2006) and 0.65 increase * Three Containers.
Building & Logistics Infrastructure	Process control and instrumentation	12. ** Plant capacity 10/tons per day estimated cost for process control @14221USD (615108,45 MUR) (City of Joburg 2016).

	Process Buildings e.g., Control room building.	13. ** Building control @8022 USD (346979,82 MUR) (City of Joburg 2016).
	Auxiliary Buildings i.e., laboratory.	
(Service Facilities)	Utilities: Showers and change rooms	14. ** Building @850 USD (36765,5 MUR) per square meter. Working with a 500 Square meter building.
	Facilities and Non-Process Equipment	15. Support Equipment
Others	Engineering	16. Plant capacity 10/tons per day estimated cost for process control @18232 USD (788598,36 MUR) (City of Joburg 2016).
	Project permits and licenses	17. Permits @ 7293 USD (315447,99 MUR).
	Contingency	18. These could be 5% of the total bill.

NB: Refer to Appendices 1 for detailed figures and Quotations applied in this context

Capital Expenditure (CAPEX)

Table 6.2. Estimate of CAPEX 1

Investment (CAPEX)		Depreciation	Depreciation	Year 1	
		[USD/a]	[years]	[USD]	[MUR]
Project Development					
		0	20	0	0
	Biogas project development	-12 116	20	121 159	5240554,44
	Agent Fees	-9 000	20	90 000	4232913,72
	Total Project Development			211 159	9931309,2
Plant Construction (including engineering and construction)					
	Capital Cost (Construction-Civils, Installation & Commissioning)	-34 404	20	688088	32362412,6
	Purchased Equipment (EPC)	-525495	20	10509909	439872272,00
	Building Logistics & Service Facilities	-45 884	20	917680	43160669,56
	Preliminaries	-7 053	20	-141 058	-6634292,7
	Other	-11 236	20	-224 728	-10569491,49
	Plant Construction			-12692622	529876352
	Plant Construction + Project Costs			-12903781	-538,691,565
	Operational Costs Year 1			-1330018	55,523,995
	Total CAPEX and OPEX Cost (Year_1)			-14233798	594,215,518

NB: Refer to Appendices 1 for detailed figures and Quotations applied in this context

The total estimated capital expenditure (CAPEX) is over twelve million USD (\$12903781.00) equivalent to over 538MUR Mauritius Rupee. Purchase capital equipment is the major costs factor followed by civil construction³. Combined Plant costs for the first year is over fifteen million USD (\$14) mil which is equivalent to over 594 mil MUR.

6.1.2. Determination of Operational Costs & Maintenance Costs (OPEX)

In general, the biogas OpEx includes the costs of feedstock, transportation fuels, feeding, plant operation and maintenance, feedstock storage and effluent handling, and labour and administration. It is estimated using the feedstock, transportation, digester, and CHP unit operations. Projected operational costs were based on assumptions using current rates in Mauritius where possible, and indicative figures were derived from literature. Fixed operation and maintenance and variable costs were considered. The broad categories and assumptions of line items included consumables, labour, utilities, Maintenance, Interests and Tax. The annual OpEx for a biogas plant with a given biogas production ($OpEx_{Total}$, \$/year) can also be calculated as:

$$OpEx_{Total} = OpEx_{digester} + OpEx_{Transportation} + OpEx_{CHP} \quad (5)$$

The OpEx for the transportation ($OpEx_{Transportation}$, \$/year) is calculated based on the annual round-trip transportation mileage and fuel cost. Mileage is based on the annual round-trip transportation mileage (km/year), and cost per unit distance (\$/km) for the truck with a load of estimated tons which includes fuel consumption, labour, insurance, truck rental, toll, and truck maintenance etc. The anaerobic digester's and CHP's annual operating expenses are set at 4% and 3% of total CapEx, respectively (Sliz-Szkliniarz et al., 2012). For both unit operations, the following formulae are used to compute the OpEx.

$$OpEx_{digester} = 0.04 \times CapEx_{Total} \quad (6)$$

$$OpEx_{CHP} = 0.03 \times CapEx_{Total} \quad (7)$$

where $OpEx_{Digester}$ and $OpEx_{CHP}$ are the OpEx (\$/year) for anaerobic digestion and CHP operations, respectively.

³ Bamikole Amigun and H. von Blottnitz, (2010), Capacity-cost and location-cost analyses for biogas plants in Africa. Resources, Conservation and Recycling 55 63–73.

Table 6.3. Projected operational costs.

Annual Expenses (OPEX)	[USD]/Annum	[MUR]/Annum
Transport and Chemicals	-125800	-5,251,747.00
Fixed O & M	-387113	-16,160,729
Variable O&M	-210 000	-210 198
Labor	-340 200	-14,202,261
Rates, water and services	-210 603	- 8,830,840
Replacement and intervals cost	-56 103	-2,342,121
Total	--1 330 018	-55,523,995.00

NB: Refer to Appendices 1 for detailed breakdown of opex line items and figures

The average annual operational costs is estimated to be around USD 1.330 018 million. This is projected to increase over time as described on the costs benefit analysis section to come.

6.2. REVENUE ANALYSIS

The renewable electricity and solid digestate provide the plant revenues. The anaerobic digestion plant is expected to bring revenue in terms of sales of electricity to the utility company that is the Central Electricity Board (CEB), sales of digested compost to the farmers and tipping fee (gate fee) for processing the waste. Given that the plant will be operated by a private company, the business model must be such that is profitable, and it can recover the investment in a reasonable time frame. In fact, the revenue generated will determine the viability of the project.

About 100 tons of OFMSW is envisaged to be processed per day to produce 47.3 MWh. It is assumed that the plant will operate for 300 days annually, and the selling price of electricity is 3.5 MUR/kWh. The selling price of compost is assumed to be 5000 MUR/ton and a tipping fee of 1000 MUR/ton is used.

Revenue from the anaerobic digestion plant

Table 6.4: Revenue Estimates 1

		Unit
OFMSW	100	Tons/Day
Electricity	47271	kWh/day

Annual Electricity	14	GWh
Cost of sales of electricity	5	MUR/kWh
Amount of compost	3440	tons/year
Cost of sales of compost from digestate	5000	MUR/ton
Gate (tipping) fee	1000	MUR/kg
Annual operational (days)	300	days
Revenue from sales of electricity	70906500	MUR
Revenue from sales of compost	17200000	MUR
Revenue from tipping fee	30000000	MUR
Total revenue	118106500	MUR

The annual revenue from the sales of electricity is around 70 M MUR, from the sales of the compost is around 17 M MUR and from the tipping fee is 30 M MUR which gives a total annual revenue of over 118 M MUR which is approximately 2746663USD.

6.3. COST BENEFIT ANALYSIS

We developed a 20-year model to project the future financial outlook and sustainability of the anaerobic digestion of the organic fraction of solid waste plant. Essentially, the model assumes three key income/revenue streams for the biogas plant namely: electricity sales, sale of compost as well as tipping fees as described in the preceding revenue section. The main income drivers are highly dependent on the capacity of the plant. The revenue projections have been kept constant over the 20-year period USD 2.7 million. Other revenue streams may eventually be considered e.g., carbon credits. On the other hand, the operational expenses are anticipated to increase exponentially from around 1.4 million in the base year to over 9 million by 2042. Some of the reasons for the increase includes price increase, and depreciation factors. Other metrics that were considered in the model include Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA), Earnings before interest and Tax (EBIT), Earnings before Tax (EBT). Refer to Annex 2.

6.3.1. Determination of NPV, IRR and Breakeven Point

6.3.1.1. Net present Value

To derive the Net Present Value (NPV) of the project the developed financial model used the following formula.

$$NPV = \frac{\text{Cash flow}}{(1 + i)^t} - \text{initial investment}$$

where:

i = Required return or discount rate

t = Number of time periods

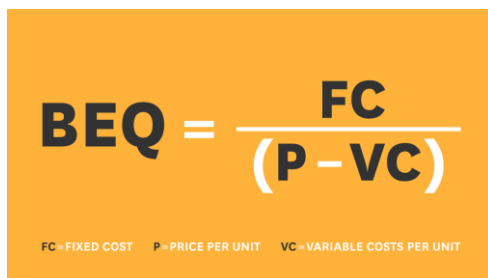
The model derived a NPV for the project of **USD 15 053 801** over the 20 Year period (2022-2042) at a discount rate of **7.3%**.

6.3.1.2. Internal Rate of Return (IRR)

The internal rate of return (IRR) is a metric used in financial analysis to estimate the profitability of potential investments. The model derived a relatively low **IRR 9.3%** for the project.

6.3.1.3. Breakeven Point

To determine the breakeven point the following formula was applied.



The graphic shows the Breakeven Point (BEQ) formula: $BEQ = \frac{FC}{(P - VC)}$. Below the formula, it defines the variables: FC = FIXED COST, P = PRICE PER UNIT, and VC = VARIABLE COSTS PER UNIT.

ITEM	QUANTITY/PRICE
Quantity	269.78 kwh
Unit Price	58.9
Fixed cost	7326.53
Unit cost	30.94
Revenue	0
Fixed cost	-7 327
Variable Cost	0.00
Net Profit	-7 327

The breakeven point is approximately 270Kwh/day which is within the daily plant generation capacity assuming additional revenue streams of tipping fees and sale of compost are considered.

6.3.1.4. Payback Period

Assuming the business's payback is for Capital Expenditure the payback period will be approximately 7 years for the business will have recovered all the sunk costs provided the subsidies for the huge capital costs are considered.

6.3.2. Sensitivity Analysis

The value of the efficiency indicators is determined for strictly defined investment parameters, such as the size and time distribution of investment expenditures and the assumed economic effects. The result of the analysis, i.e., the values of the indicators, are therefore an assessment of the profitability of the investment for rigidly defined assumptions valid as at the date of the analysis⁴. However, the values of individual parameters are subject to a degree of uncertainty, hence the need to perform a sensitivity analysis.

6.3.2.1. Building Scenarios

The value of the efficiency indicators is determined for strictly defined investment parameters, such as the size and time distribution of investment expenditures and the assumed economic effects. The result of the analysis, i.e., the values of the indicators, are therefore an assessment of the profitability of the investment for rigidly defined assumptions valid as at the date of the analysis⁴. However, the values of individual parameters are subject to a degree of uncertainty, hence the need to perform a sensitivity analysis.

OPTION 1: (5MUR)	TOTAL REVENUE (USD)	IRR	NPV (USD)	BREAKEVEN POINT	PAY BACK PERIOD
Electricity Sales	1648988	9.3%	10 033 129	269KwH	7 Years
Compost Sales	400000				
Tipping Fees	697674.4				
OPTION 2: (4MUR)					
Electricity Sales	1484090	5%	7 901 676	412.75KwH	10+ Years
Compost Sales	400000				
Tipping Fees	697674.4				
OPTION 3: (3.5MUR)					
Electricity Sales	1154292	--	6 840 728	-	May not be viable despite the positive NPV
Compost Sales	400000				
Tipping Fees	697674.4				

** Option 1 and 2 assumes the project will have a 50% to 75% subsidy on initial Capital Costs (CAPEX) to attract potential investors.

Scenarios at various sale of electricity were considered and indications show that the sale of electricity at MUR 5 per kWh could be the better option provided some of the initial investment costs are subsidised. The huge capital investment required for a mega project of this magnitude

⁴ Gołębiewski, M.; Galant-Gołębiewska, M. Economic Model and Risk Analysis of Energy Investments Based on Cogeneration Systems and Renewable Energy Sources. *Energies* 2021, 14, 7538.

would need to be absorbed through other means for the business to attract investors considering many other low carbon trajectory spinoffs.

6.3.2.2. Subsidies

Assuming the government of Mauritius attains a grant for the project from international donor agencies such as Sustainable Energy Fund for Africa (SEFA) or Global Environmental Fund (GEF) facilities which provides catalytic finance to unlock private sector investments in renewable energy and energy efficiency. The model assumes a subsidy of 0% on the initial capital costs however any percentage on the initial capital investment could provide a good incentive to potential investors. The subsidies however do not have much effect on the long-term financial projection on the model.

The above financial results demonstrate that it is economically viable to build a biogas plant. However, the long-term planning will require innovative approaches to increase the plant's income base and other circular economy initiatives let alone optimisation process to reduce the long-term depreciation and cost escalations for the plant to retain its profitability. Apart from the economic viability, biogas technology represents one of large-scale technologies that offers the technical possibility of low carbon future approaches to development in Africa. It provides significant benefits to human and ecosystem health. See Appendices 2 for detailed model profile.

6.3.2.3. Additional Considerations

Additional benefits and drivers of the biogas plant need not to be looked at in isolation but to include political, economic, social, technological, and environmental spinoffs which could benefit Mauritius.

Economic

- Additional income from biogas, electricity generation and sale of compost as well as tipping fees.
- Building a circular economy solution (Recycling of municipal solid waste).

Political

- Renewable energy and GHG Emissions reduction
- Government support mechanisms

Social

- Employment creation -Job opportunities technical and non-technical.

- The vectors for contagious diseases, for humans and animals alike, are minimised through improved management of waste.
- Improved energy security essential for households and economic development.

Technological

- Technology diffusion in particular biogas plants and biomethane upgrading

Environmental

- Replacing fossil fuels
- Emission reduction

6.4. DEVELOPMENT OF A BUSINESS MODEL

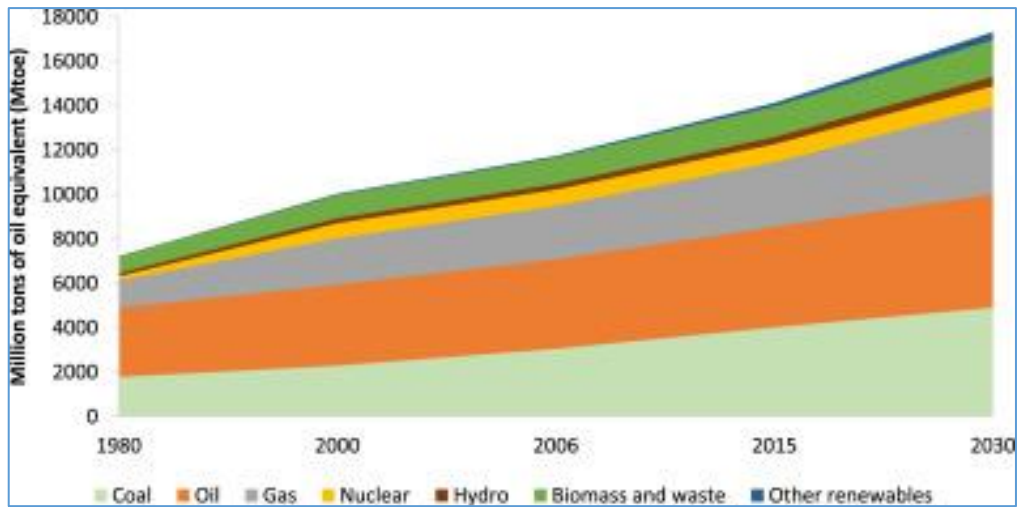
One of the major parameters influencing profitability is the price of energy, which depends on several variables such as fuel prices, environmental fees and exchange rates etc. Many of them can change however the long-term goal is to ensure profitability of the business. Indications from the financial forecast show the need for fusion of incentives for example subsidies to increase the annual turnover of the plant.

The implementation of anaerobic digestion in Mauritius is being proposed as a Public Private Partnership (PPP) under the Design, Finance, Build, Own and Operate (DFBOO) mode of procurement. This mode of procurement is being privileged for the following reasons:

- Construction of a (solid organic waste) biogas plant has high upfront investment costs (CAPEX) which may represent a financial burden for the Mauritian Government in view of other projects in priority areas.
- The Ministry currently does not have any state land at its disposal and choosing the DFBOO instead of the Design, Finance, Build, Operate and Transfer (DFBOT) implies that the private promoter will come with its own land and will retain the facility at the end of the concession period of 20 Years. The Ministry will only have to pay the tipping fee of MUR 1000 for each tonne of solid organic waste processed by the biogas plant, as determined under Output 6. This will be more financially sustainable as opposed to the high investment costs.

6.4.1. The Business Case

At present Mauritius' primary energy supply is dominated by non-renewables with approximately 60% oil, 27% coal and 14% renewables. Bagasse (sugarcane waste) is currently the leading source of renewable energy (55 %). Mauritius derives its other renewable electricity generation from hydro, wind, landfill gas, fuelwood, cane trash, and solar.



Introduction of energy supply from Organic Fraction Municipal Solid Waste can only go a long way in propelling an effective energy mix for the country. Therefore, the forecast is that this will be a good investment opportunity for the following:

- The preceding sections have demonstrated a viable economic analysis of the project. Projections pointing towards meeting a breakeven point around the 1st Year from the inception of the project.
- The country is expected to drive the low carbon future Agenda, and this is one of the options to achieve that goal.
- Reduced GHG Emissions from non-renewable energy technologies.
- More Jobs Created.
- Reduced importation of coal.
- Coming on board of the Private Sector and possibility of Joint Collaboration with the Public Sector.

6.4.2. The Resource

Available Organic Fraction Municipal Solid Waste (OFMSW).

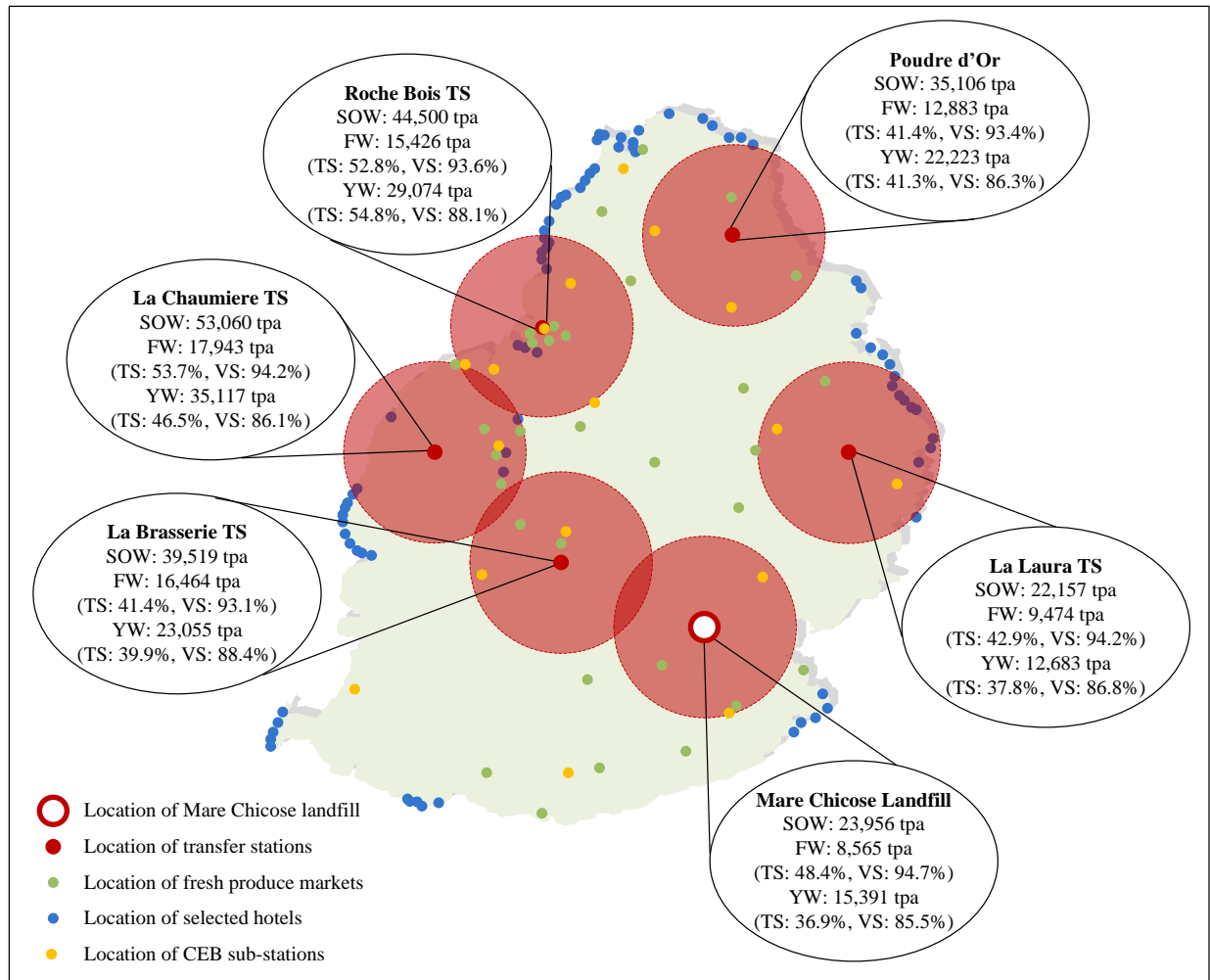


Figure 1. Location of solid organic wastes generation points and sub-stations of the Central Electricity Board (Source for sub-stations: CEB, 2019)

6.4.3. Financial Model

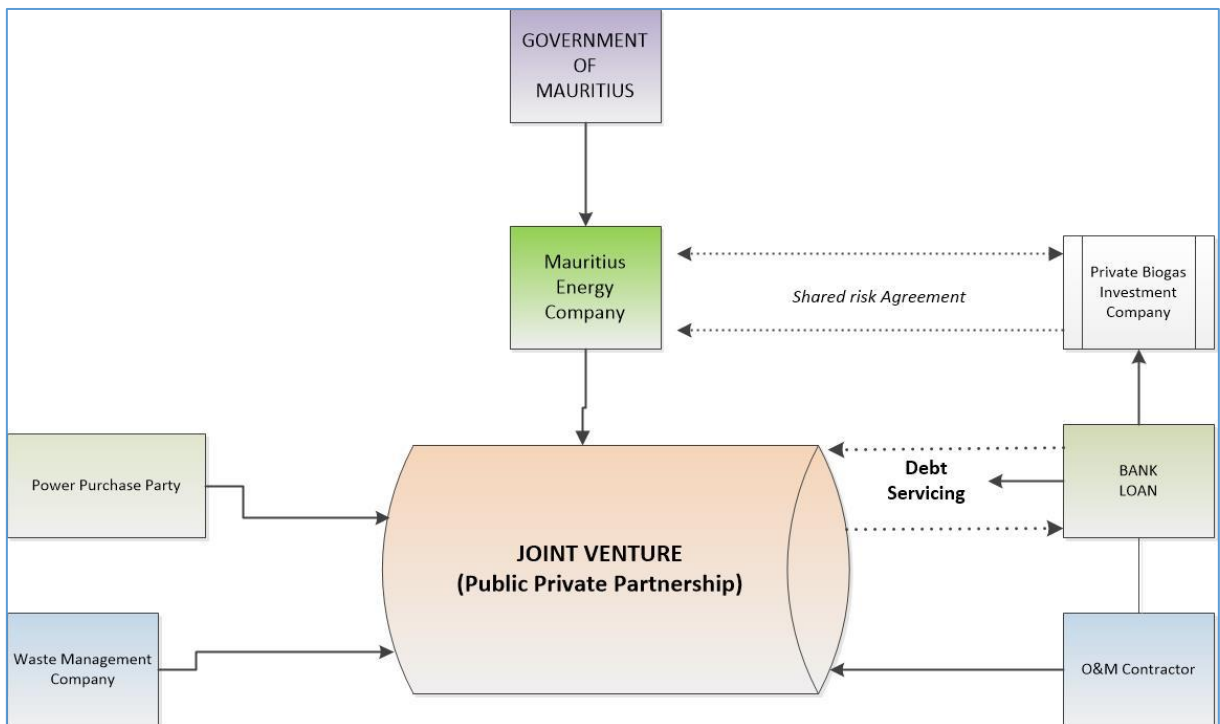
For any projects being implemented under the PPP route, the BOT Projects Unit under the Policy Procurement Office in Mauritius and mandated by the BOT Projects Act 2016 has devised a 9-step process, as summarised below (Modified from: BOT Projects Unit, 2016):

- Identification of the anaerobic digestion project as a PPP project by the Contracting Authority (i.e., the national Solid Waste Management Division);
- Registration of the anaerobic digestion project as a PPP project with the BOT Projects Unit;
- Setting-up of a project management team at the level of the Contracting Authority (i.e., the Solid Waste Management Division) to manage the anaerobic digestion project from conception to closure (up to the end of the concession period);
- Structuring of the anaerobic digestion project through the recruitment of a Transaction Advisor for the commissioning of a feasibility study to assess the commercial viability of the project to be implemented under the PPP route;
- Seeking the approval of Cabinet to implement the anaerobic digestion project under the PPP route;
- Preparation and launching of the request for proposal document to invite potential bidders to set-up and operate the biogas plant (**Note:** The Transaction Advisor can also be tasked with preparation of the request for proposal document);
- Evaluation of the bids received (including negotiation with preferred bidder (with assistance of Transaction Advisor) on minimum waste guaranteed tonnage, conditions of Power Purchase Agreement (PPA) with the Central Electricity Board, conditions of compost sales agreement (if any) with the compost purchaser (Ministry of Agro-Industry and Food Security, the Food and Agricultural Research and Extension Unit (FAREI) or the Small Farmers Welfare Fund);
- Seeking the approval of Cabinet prior to award of the Contract; and
- Awarding of Contract.

Following the feasibility study being commissioned under this Technical Assistance through the Climate Technology Centre and Network (CTCN), the Solid Waste Management Division

will be required to undertake each of the 9 aforementioned Activities as specified by the BOT Projects Unit.

6.4.4. Implementation Matrix



6.5. SUMMARY/RECOMMENDATIONS

- The scenario showed a techno-cost-benefit evaluation of the biogas utilization pathway.
- Estimated Initial Capital Investment is about **USD 12 million on the first Year.**
- Estimated Revenue generation is about **USD 2 747 432 per annum.**
- Project Break Even Point around the 1st Year from base year when the project commences.
- The project is financially viable.

- They are additional spinoffs which the project will bring among which includes, social, environmental, political and technological all which are critical for achieving Sustainable Development Goals (SDGs) in particular SDG 7, 8, 9, 11 and 13.



6.6. REFERENCES

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6.7. APPENDIX 1: MODEL ASSUMPTIONS AND COST ESTIMATES

CAPEX

ITEM	COST COMPONENT & ASSUMPTIONS	UNIT COST (USD)	SIZE/UNIT	COST(USD)
CONSTRUCTION	1. **Estimated required area of land = 5 Hectares-(Refer to output 4-Section 3) @49147 Eur per hectare (Govt Mauritius)	53512	5	267560.00
	2. **The land will be required for: (Refer Output 5 section 2.4).	0	0	0.00
	3. **Collection and Transportation to be handled by the Mauritius Govt. Not included in this costing. Storage System for a 10/tons per day estimated @ 21879	21879	1	21879.00
	4. ** Plant capacity 10/tons per day estimated cost of civil works @ 36465 USD. Source: City of Joburg 2016.**Detailed EIA & Geo-technical survey will be needed to determine the close estimates.	36465	8	291720.00
PURCHASED EQUIPMENT (EPC)	5.** Plant processes 100 tons per day. Plant capacity 10/tons per day estimated cost of waste management equipment @ 10939 USD. Source: City of Joburg 2016.	10939	3	32817.00
	6. ***Engines and Accessories (Quotation)	1629978	1	1629978.00
	7.*** Digester and Accessories (Quotation).	5381955	1	5381955.00
	8.**Biogas Storage (Round shaped inflatable rubber membrane (1*2000cubic ,meters) low pressure (Quotation)	3078216	1	3078216.00
	9. ** Plant capacity 10/tons per day estimated cost of Conditioning System @13492 USD City of Joburg 2016.	13492	9	121428.00
	10. ** Plant capacity 10/tons per day estimated cost of Heat pumps @19691 USD City of Joburg 2016.	19691	9	177219.00
	11. ** Plant capacity 10/tons per day estimated cost of methane compression @7293 USD City of Joburg 2016.	7293	10	72930.00
	13. ** Freight and Import Duties etc @ USD .3000 per container (Amigun <i>et al</i> 2006)	5122	3	15366.00
BUILDING & LOGISTICS INFRASTRUCTURE	12. ** Plant capacity 10/tons per day estimated cost for process control & Instrumentation @14221USD City of Joburg 2016	14375	3	43125.00
	13. ** Control room building @850 USD City of Joburg 2016	850	500	425000.00
SERVICE FACILITIES	14. ** Utilities Building @850 USD per square meter. Working with a 500 Square meter building.	850	500	425000.00
	15. ** Facilities and Non Process Support Equipment	24555	1	24555.00
OTHER	16. ** 5% pleriminaries	247986.84	1	247986.84
	17. **Other Costs	210142	1	210142.00
	18. **Permits @7293 USD	7293	2	14586.00
	TOTAL			12481462.84

OPEX COSTING

ITEM	COST COMPONENT & ASSUMPTIONS	UNIT COST (USD)
CONSUMABLES	Chemicals	
	<i>Sodium Bicarbonate (ton)</i>	400
	<i>Hydrochloric Acid (ton)</i>	200
	<i>Ferric oxide (USD/m3 of biogas)</i>	0.013
	Fuel (Diesel) (m3)	1000
LABOUR	Plant Manager	6000
	Process Engineer	3500
	Civil Engineer	2500
	Electrical Engineer	2500
	Mechanical Engineer	2500
	SCADA Operator (Shift)	1000
	Lab Officer	750
	Finance Officer/Accountant	750
	Sales Person/Marketing Officer	625
	Health and Safety Officer	625
	Supervisors (Shift)	500
	Skilled Workers (Electrician, Mechanic, Welder)	400
	Driver (Forklift operator, compost turner operator, lorry driver)	375
	Weighbridge operator	375
	Receptionist	250
	Security Officer/Watchman	250
	Cleaner	250
Manual Workers (Waste pre-treatment unit, fermentation unit, biogas processing unit, electricity generation unit, compost production unit)	250	
UTILITIES	Water Consumption (m3)	0.6
	Internet Connection	60
	Electricity (Not applicable-Parasitic electricity demand will be catered by the electricity generated by the biogas plant)	0
MAINTENANCE	Fixed O&M @ 3 % of CAPEX	0.03
	Replacement and Installation Costs	0.04
INTERESTS	Loans - Lending Rate (%)	8.5

6.8. APPENDIX 2: FINANCIAL MODEL

		Depreciation	Depreciation	
		[USD/a]	[years]	[USD]
Investment (CAPEX)				
Project Development				
	Biogas project development	-12115.9	10	-121159
	Agent Fees	-9000	10	-90000
	Total Project Development			-211159
Plant Construction (including engineering and construction)				
	Capital Cost (Construction-Civils, Installation & Commissioning)	-34404.4	20	-688088
	Purchased Equipment (EPC) Inc Biogas Storage	-525495.45	20	-10509909
	Building Logistics & Service Facilities	-45884	20	-917680
	Preliminaries	-7052.902	20	-141058.04
	Other	-11236.38998	20	-224727.7995
	Total Plant Construction			-12692621.84
	Total Investment			-12903780.84
Financing				
	Subsidies		0	0
	Equity		0.25	-3225945.21
	Loan		0.75	-9677835.63
	Total Capital Demand		1	-12903780.84
		Duration/ y	Interest	Start
	Conditions of Loan	20	0.1	44713
Replacement Investments				
	Requisite equipment	3		Frequency/ a
Income				
	Biogas - Electricity Income per kWh	47271	Price	34.9
	Capacity factor			1
	Revenue from Sale of compost			400000
	Revenue from Tipping Fee			697674
	Total			2747431.9
Annual Expenses (OPEX)				
	Chemicals			-125800
	Fixed O & M			-387113.4252
	Replacement and installation cost			0
	Variable O&M			-210198.18
	Labor			-340200
	Electricity and water			-210603
	Replacement intervals			-56103
	Total			-1330017.605
	First Year OpEx+CapEx			-14233798.44
	Annual price increase		10%	
	Income tax		12.00%	
	Corporation tax		12.00%	
	Annual Price Increase on fixed Expenses		7.00%	
	Annual Price Increase on Electricity, Tipping & Compost		0.00%	
	Benchmark Discount Rate		15.00%	

CASH FLOW

Year	2022e	2023e	2024e	2025e	2026e	2027e	2028e	2029e	2030e	2031e	2032e
Index	1	2	3	4	5	6	7	8	9	10	11
Biogas - Electricity Income per kWh	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758
Revenue from Sale of compost	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000
Revenue from Tipping Fee	697 674	697 674	697 674	697 674	697 674	697 674	697 674	697 674	697 674	697 674	697 674
INCOME/ TURNOVER	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432
Transport and Chemicals	-133 348	-141 349	-149 830	-158 820	-168 349	-178 450	-189 157	-200 506	-212 536	-225 289	-238 806
Fixed O & M	-410 340	-434 961	-461 058	-488 722	-518 045	-549 128	-582 075	-617 000	-654 020	-693 261	-734 857
Replacement and installation cost	0	0	0	0	0	0	0	0	0	0	0
Variable O&M	-222 600	-235 956	-250 113	-265 120	-281 027	-297 889	-315 762	-334 708	-354 791	-376 078	-398 643
Electricity and water	-223 239	-236 634	-250 832	-265 881	-281 834	-298 744	-316 669	-335 669	-355 809	-377 158	-399 787
Replacement intervals	-59 469	-63 037	-66 820	-70 829	-75 078	-79 583	-84 358	-89 420	-94 785	-100 472	-106 500
Labor	-360 612	-382 249	-405 184	-429 495	-455 264	-482 580	-511 535	-542 227	-574 761	-609 246	-645 801
EXPENSES	-1 409 609	-1 494 185	-1 583 836	-1 678 866	-1 779 598	-1 886 374	-1 999 557	-2 119 530	-2 246 702	-2 381 504	-2 524 394
EBITDA	1 337 823	1 253 247	1 163 596	1 068 566	967 834	861 058	747 875	627 902	500 730	365 928	223 038
Depreciation and Amortisation	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658
EBIT	800 166	715 589	625 938	530 908	430 176	323 400	210 218	90 244	-36 928	-171 730	-314 620
Interest	967 784	919 394	871 005	822 616	774 227	725 838	677 448	629 059	580 670	532 281	483 892
EBT	1 767 949	1 634 984	1 496 943	1 353 524	1 204 403	1 049 238	887 666	719 304	543 743	360 551	169 272
Loss Carryforward	1 767 949	1 634 984	1 496 943	1 353 524	1 204 403	1 049 238	887 666	719 304	543 743	360 551	169 272
Income tax	-265 192	-245 248	-224 542	-203 029	-180 660	-157 386	-133 150	-107 896	-81 561	-54 083	-25 391
Corporation tax	-265 192	-245 248	-224 542	-203 029	-180 660	-157 386	-133 150	-107 896	-81 561	-54 083	-25 391
RESULT	1 237 565	1 144 489	1 047 860	947 467	843 082	734 466	621 366	503 512	380 620	252 386	118 490
EBT	1 767 949	1 634 984	1 496 943	1 353 524	1 204 403	1 049 238	887 666	719 304	543 743	360 551	169 272
Income + Corporation Taxes, previous year	0	-530 385	-490 495	-449 083	-406 057	-361 321	-314 771	-266 300	-215 791	-163 123	-108 165
Depreciation	537 658	537 658	537 658	537 658	537 658	537 658	537 658	537 658	537 658	537 658	537 658
Repayment Loan	483 892	483 892	483 892	483 892	483 892	483 892	483 892	483 892	483 892	483 892	483 892
Replacement Investments	0	0	0	0	0	0	0	0	0	0	0
CASH FLOW AFTER DEPT SERVICE	2 789 499	2 126 148	2 027 998	1 925 990	1 819 895	1 709 466	1 594 444	1 474 553	1 349 501	1 218 978	1 082 656
CASH POSITION	2 789 499	2 126 148	2 027 998	1 925 990	1 819 895	1 709 466	1 594 444	1 474 553	1 349 501	1 218 978	1 082 656
Cash Position cumulated; negative values compensated by current account	2 789 499	4 915 647	6 943 644	8 869 635	10 689 530	12 398 996	13 993 440	15 467 993	16 817 494	18 036 472	19 119 127
Cash Flow after Debt Service	2 789 499	2 126 148	2 027 998	1 925 990	1 819 895	1 709 466	1 594 444	1 474 553	1 349 501	1 218 978	1 082 656
Debt Service	1 451 675	1 403 286	1 354 897	1 306 508	1 258 119	1 209 729	1 161 340	1 112 951	1 064 562	1 016 173	967 784
Cash Flow before Debt Service	1 337 823	722 862	673 101	619 483	561 776	499 737	433 104	361 602	284 939	202 805	114 872
DSCR as of 2022	0.92	0.52	0.50	0.47	0.45	0.41	0.37	0.32	0.27	0.20	0.12
Debt as at 31.12.	9 193 944	8 710 052	8 226 160	7 742 269	7 258 377	6 774 485	6 290 593	5 806 701	5 322 810	4 838 918	4 355 026
Equity as at 31.12.	-1 988 381	-2 081 457	-2 178 085	-2 278 478	-2 382 863	-2 491 479	-2 604 579	-2 722 433	-2 845 325	-2 973 559	-3 107 455
DEBT to EQUITY RATIO/ abs.	4.62	4.18	3.78	3.40	3.05	2.72	2.42	2.13	1.87	1.63	1.40
Cash Flow after Dept Service, after tax	2 789 499	2 126 148	2 027 998	1 925 990	1 819 895	1 709 466	1 594 444	1 474 553	1 349 501	1 218 978	1 082 656
Cash Flow after Dept Service, before tax	3 319 883	2 616 643	2 477 081	2 332 048	2 181 216	2 024 238	1 860 744	1 690 344	1 512 624	1 327 143	1 133 437
Equity	3 225 945										
Free Cash-Flow (before tax) to Equity	6 545 829	2 616 643	2 477 081	2 332 048	2 181 216	2 024 238	1 860 744	1 690 344	1 512 624	1 327 143	1 133 437
IRR to EQUITY (befor tax to equity)	9.3%										
Free Cash-Flow to Equity	6 545 829	2 616 643	2 477 081	2 332 048	2 181 216	2 024 238	1 860 744	1 690 344	1 512 624	1 327 143	1 133 437
Benchmark Discounting after 2022	0.87	0.76	0.66	0.57	0.50	0.43	0.38	0.33	0.28	0.25	0.21
Free Cash-Flow to Equity, discounted to 2022	5 692 025	1 978 558	1 628 721	1 333 356	1 084 450	875 134	699 523	552 576	429 982	328 050	243 625
NPV to EQUITY	15 053 801										

	Year	2033e	2034e	2035e	2036e	2037e	2038e	2039e	2040e	2041e	2042e
	Index	12	13	14	15	16	17	18	19	20	21
Biogas - Electricity Income per kWh		1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758	1 649 758
Revenue from Sale of compost		400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000
Revenue from Tipping Fee		697 674	697 674	697 674	697 674	697 674	697 674	697 674	697 674	697 674	697 674
INCOME/ TURNOVER		2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432	2 747 432
Transport and Chemicals		-253 134	-268 322	-284 422	-301 487	-319 576	-338 751	-359 076	-380 620	-403 458	-427 665
Fixed O & M		-778 948	-825 685	-875 226	-927 740	-983 404	-1 042 408	-1 104 953	-1 171 250	-1 241 525	-1 316 017
Replacement and installation cost		0	0	0	0	0	0	0	0	0	0
Variable O&M		-422 561	-447 915	-474 790	-503 277	-533 474	-565 482	-599 411	-635 376	-673 498	-713 908
Electricity and water		-423 775	-449 201	-476 153	-504 722	-535 006	-567 106	-601 132	-637 200	-675 432	-715 958
Replacement intervals		-112 890	-119 664	-126 843	-134 454	-142 521	-151 073	-160 137	-169 745	-179 930	-190 726
Labor		-684 549	-725 622	-769 160	-815 309	-864 228	-916 081	-971 046	-1 029 309	-1 091 067	-1 156 532
EXPENSES		-2 675 858	-2 836 409	-3 006 594	-3 186 990	-3 378 209	-3 580 902	-3 795 756	-4 023 501	-4 264 911	-4 520 806
EBITDA		71 574	-88 978	-259 162	-439 558	-630 777	-833 470	-1 048 324	-1 276 069	-1 517 479	-1 773 374
Depreciation and Amortisation		-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658	-537 658
EBIT		-466 084	-626 635	-796 820	-977 215	-1 168 435	-1 371 127	-1 585 981	-1 813 727	-2 055 137	-2 311 031
Interest		435 503	387 113	338 724	290 335	241 946	193 557	145 168	96 778	48 389	-0
EBT		-30 581	-239 522	-458 095	-686 880	-926 489	-1 177 570	-1 440 814	-1 716 948	-2 006 748	-2 311 031
Loss Carryforward		-30 581	-270 103	-728 198	-1 415 078	-2 341 567	-3 519 137	-4 959 951	-6 676 899	-8 683 647	-10 994 678
Income tax		0	0	0	0	0	0	0	0	0	0
Corporation tax		0	0	0	0	0	0	0	0	0	0
RESULT		-30 581	-239 522	-458 095	-686 880	-926 489	-1 177 570	-1 440 814	-1 716 948	-2 006 748	-2 311 031
EBT		-30 581	-239 522	-458 095	-686 880	-926 489	-1 177 570	-1 440 814	-1 716 948	-2 006 748	-2 311 031
Income + Corporation Taxes, previous year		-50 782	0	0	0	0	0	0	0	0	0
Depreciation		537 658	537 658	537 658	537 658	537 658	537 658	537 658	537 658	537 658	537 658
Repayment Loan		483 892	483 892	483 892	483 892	483 892	483 892	483 892	483 892	483 892	483 892
Replacement Investments		0	0	0	0	0	0	0	0	0	0
CASH FLOW AFTER DEPT SERVICE		940 187	782 028	563 454	334 669	95 061	-156 021	-419 264	-695 399	-985 198	-1 289 482
CASH POSITION		940 187	782 028	563 454	334 669	95 061	-156 021	-419 264	-695 399	-985 198	-1 289 482
Cash Position cumulated; negative values compensated by current account		20 059 314	20 841 342	21 404 796	21 739 465	21 834 526	21 678 504	21 259 240	20 563 841	19 578 643	18 289 161
Cash Flow after Debt Service		940 187	782 028	563 454	334 669	95 061	-156 021	-419 264	-695 399	-985 198	-1 289 482
Debt Service		919 394	871 005	822 616	774 227	725 838	677 448	629 059	580 670	532 281	483 892
Cash Flow before Debt Service		20 792	-88 978	-259 162	-439 558	-630 777	-833 470	-1 048 324	-1 276 069	-1 517 479	-1 773 374
DSCR as of 2022		0.02	0.10	0.32	0.57	0.87	1.23	1.67	2.20	2.85	3.66
Debt as at 31.12.		3 871 134	3 387 242	2 903 351	2 419 459	1 935 567	1 451 675	967 784	483 892	-0	-483 892
Equity as at 31.12.		-3 256 526	-3 465 467	-3 684 041	-3 912 825	-4 152 434	-4 403 516	-4 666 759	-4 942 893	-5 232 693	-5 536 977
DEBT to EQUITY RATIO/ abs.		1.19	0.98	0.79	0.62	0.47	0.33	0.21	0.10	0.00	0.09
Cash Flow after Dept Service, after tax		940 187	782 028	563 454	334 669	95 061	-156 021	-419 264	-695 399	-985 198	-1 289 482
Cash Flow after Dept Service, before tax		940 187	782 028	563 454	334 669	95 061	-156 021	-419 264	-695 399	-985 198	-1 289 482
Equity											
Free Cash-Flow (before tax) to Equity		940 187	782 028	563 454	334 669	95 061	-156 021	-419 264	-695 399	-985 198	-1 289 482
IRR to EQUITY (befor tax to equity)		9.3%									
Free Cash-Flow to Equity		940 187	782 028	563 454	334 669	95 061	-156 021	-419 264	-695 399	-985 198	-1 289 482
Benchmark Discounting after 2022		0.19	0.16	0.14	0.12	0.11	0.09	0.08	0.07	0.06	0.05
Free Cash-Flow to Equity, discounted to 2022		175 728	127 101	79 632	41 129	10 159	-14 498	-33 879	-48 862	-60 196	-68 511
NPV to EQUITY		15 053 801									

		IRR: Internal Rate of return		
		Assuming same revenue over 20 years		
		MUR 5	MUR 4	MUR 3.5
Year	No	0.093432	0.04195	0.081
2022	1	2551141	2625930	2072354
2023	2	1778320	1961855	1500173
2024	3	1551287	1739132	1259049
2025	4	1347370	1520488	1036423
2026	5	1164360	1305362	830714.7
2027	6	1000253	1093195	640474.5
2028	7	853231.5	883436.8	464371.4
2029	8	721649.3	675536.4	275381.2
2030	9	604014.2	466926.9	89302.41
2031	10	498974.2	208111.9	-83520.6
2032	11	405304	-50575.7	-244260
2033	12	321894	-309839	-393989
2034	13	244866.3	-570385	-533695
2035	14	161351.7	-832930	-664280
2036	15	87647.39	-1098198	-786574
2037	16	22768.37	-1366927	-901338
2038	17	-34176.2	-1639865	-1009268
2039	18	-83991.6	-1917777	-1111003
2040	19	-127406	-2201446	-1207132
2041	20	-165078	-2491671	-1298190
2042	21	-197600	-2789278	-1384674
	Total	12903781	361.4249	-65005.8
	NPV (Net present value)	0.026662	361.4249	-65005.8
	Calculated IRR (%)	9.343199	4.195	8.1

6.9 APPENDICES 3: BIOWASTE TO BIOGAS CASE STUDIES

TTV EKOLOGAS (Forsbacka Biogas plant)



TTV EKOLOGAS (Forsbacka Biogas plant)

Manufacturer:
Thöni Industriebetriebe GmbH

Commissioning: 2017

Waste treatment capacity:
25,000 t/a

Biogas production:
600 m³/h

Investment volume:
9.7 million euros



The plant produces biogas from 25,000 tonnes of energy-rich household kitchen- and bio-waste using the largest Thöni TTV digester with a volume of 2,250 m³.

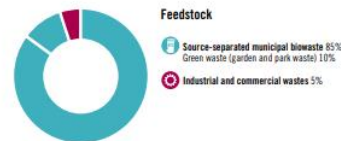
Organic waste first undergoes a pre-treatment of shredding (bag opener). The organic input is then stored in a buffer-bunker before being automatically fed via a heat exchanger into the digester.

The digestion process is thermophilic with a residence time of around 36 days to ensure complete hygienisation of the material. Homogenisation and uniformity is guaranteed by the residence time and smooth mixing action of the patented paddle-shaft in the curved-base digester. The design creates a fully controlled plug-flow process preventing sedimentation or the creation of floating layers.

At the end of the anaerobic process, digestate is pumped to the dewatering system. A proportion of the liquid digestate is recirculated in the digestion process to humidify fresh input material, and this inoculation ensures maximum efficiency of both degradation of input material and yield of biogas. Liquid digestate is stored in

tanks under gas-store membranes for use as agricultural fertilizer. The solid digestate fraction undergoes a further aerobic composting process in enclosed composting units to produce high-quality compost certified for organic farming.

Biogas produced in the digester will be further processed into high-grade bio-methane in a biogas upgrading plant by the owner. As there is no local gas grid, biomethane is filled into road-containers and transferred to local gas filling stations.



Type of digestion: Thermophilic, dry continuous digestion

Feedstock preparation: Shredding, screening, air separation, press screw separation

Digestate upgrading: Separation, composting, drying

Generated fertilizer: Liquid digestate, solid digestate

Use of the digestate: Spreading as fertilizer, marketing digestate (horticulture, landscaping, gardening)

Operator
TTV EKOLOGAS (Forsbacka Biogas plant)
Stentorpsvägen 85
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VALNOR S.A.



VALNOR, SA in Alter do Chão, Portugal

Manufacturer:
Bekon GmbH

Commissioning: 2011

Waste treatment capacity:
25,000 t/a

Installed capacity:
500 kW_{el}

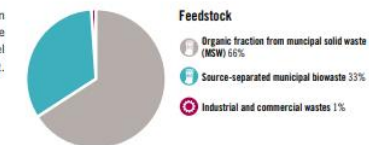
Investment volume:
7.5 million euros



VALNOR, S.A. is the company responsible for the treatment and valorisation of municipal waste, produced in the municipalities of Abrantes, Alter do Chão, Arronches, Avis, Castelo de Vide, Castelo Branco, Campo Maior, Crato, Elvas, Fronteira, Gavião, Idanha-a-Nova, Marvão, Mação, Monforte, Nisa, Oleiros, Portalegre, Ponte de Sôr, Proença-a-Nova, Sardoal, Sertão, Sousel, Vila de Rei and Velha de Ródão. The area of Intervention is 11.980 km², with a residential population of 271,516 habitants.

VALNOR, SA has established an Integrated Management System to take care of the MSW produced in this area of intervention. The system consists of several operational facilities, including biodiesel production, composting plant and anaerobic waste digestion plant.

The biogas plant is designed to treat around 25,000 tonnes per year and receives mostly the organic fraction of the communities. This plant has 8 fairly robust digesters able to treat the organic fraction of MSW of the aforementioned community. The installed power of the anaerobic installation is 500 kW and its temperature for the process is mesophilic.



Type of digestion: Mesophilic, dry batch digestion

Feedstock preparation: Air separation, sorting cabins, metal deposition, sensor technology, cutting

Digestate upgrading: Composting

Generated fertilizer: Compost

Use of the digestate: Marketing compost (vineyards)

Operator
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