



Report on Field Trials for the Tool in 3 Reference Animal Farms



Submitted to:

REEEP



Submitted by:

Winrock International

June 30, 2010

Background:

Funded by REEEP, Winrock International with its partners has developed a user-friendly computer based tool that will allow the small and mid-sized animal farms in Brazil to estimate technological and financial requirements to install a biodigester and electricity generation system in the farm. The tool will also allow the users to estimate the carbon offset by replacing grid electricity and flaring the excess biogas.

In order to validate the assumptions and results of the tool, field trials for the tool were conducted in three reference farms.

The process of conducting the field trials included:

- Selection of three reference farms that were representative of most farms in South East Brazil
- Visit to all of three farms
- Meeting with the farm owner and/or manager to discuss the project and the tool
- Interview at the farm to fill in the input page of the tool
- Inspection of the farm to take pictures and get better understanding of the actual conditions
- Running the tool to prepare the results
- Analysis of the results and discussion with the farms to correct mistakes
- Preparation of report for the farms that can be used as marketing document

This report discusses the results of the field trials in the 3 reference farms.

Reference Farms:

Following 3 farms were selected as reference farms:

Reference Farm	1	2	3
Name	Estância Bosque Belo	Pork Terra	Fazenda Caconde
Location	Boituva, SP	Rodovia Caconde - km 7 - Bairro Conceição	Rua Floriano Peixoto, 249 - Caconde - São Paulo
Type of Animals	Beef Cattle	Swine	Beef Cattle
Number of Animals	1000	1700 (Market); 190 (Breeding)	350
Breed	Western European	Western European	Asian
Average Weight	550 kg	90 kg (market); 110kg (breeding)	400 kg
Dung collected	90%	100%	10%
Baseline management system	Open Lagoon	Liquid dung directly disposed to the river	Spread
Improved management system	Covered lagoon	Covered lagoon	Covered lagoon

Reference Farm 1: Estância Bosque Belo

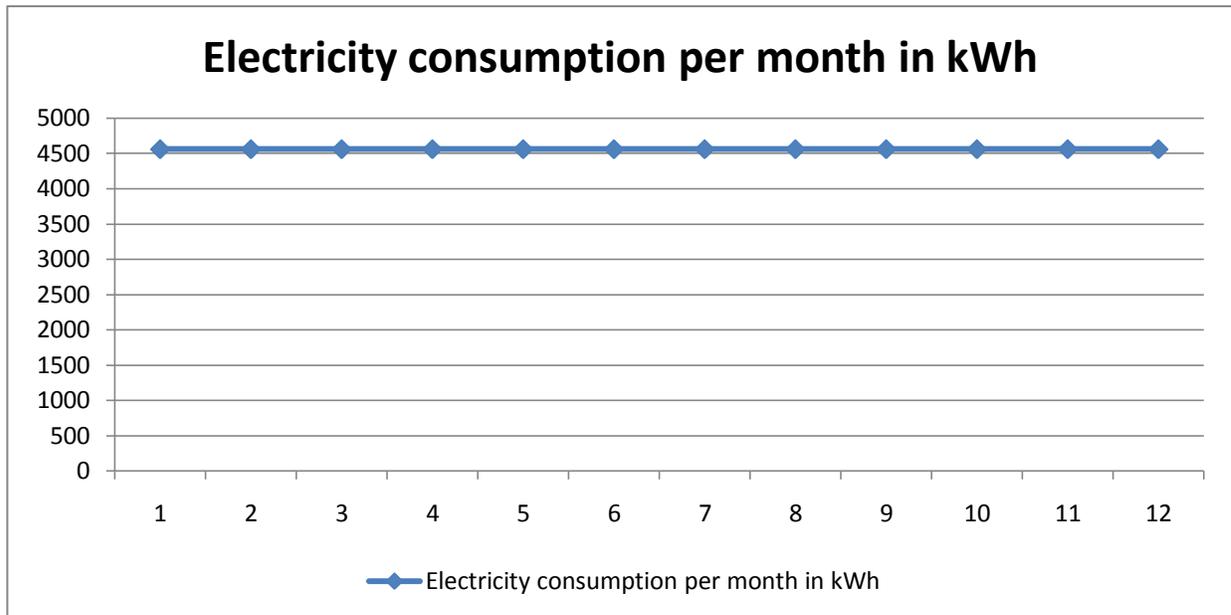
Estância Bosque Belo in Boituva, Sao Paulo is the first reference farm. This is a Beef Cattle Farm where young cattle are brought and fattened over a year to sell as meat.

I. Basic Farm Information

Animal Type	Avg Number of Animals	Avg Wt.	Breed	Baseline Manure Mgmt	Improved Manure Mgmt	Annual Growth Rate	Dung Collection
Dairy Cattle	-	-	-	-	-	-	-
Beef Cattle	1000	550	Western European	Lagoon	Closed Lagoon Biodigester	-	90%
Market Swine	-	-	-	-	-	-	-
Breeding Swine	-	-	-	-	-	-	-

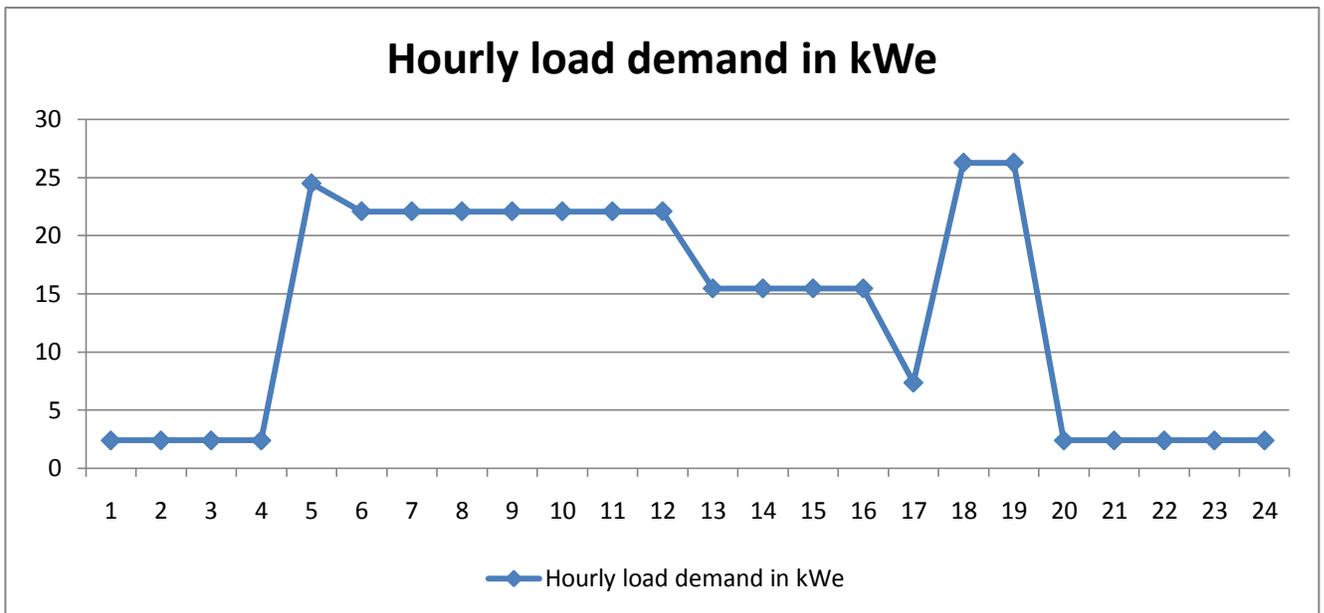
This farm has an average of 1000 Beef Cattles in a year of an average of 550kg. Current manure management is open lagoon and the farm wants to switch to closed lagoon biodigester and electricity generation. Dung collection rate is 90% with scrapped barn method.

II. Electricity Consumption Pattern (Recent Past Year)



Electricity consumption in the farm is around 4600kWh per month. This is based on recent electricity bills paid by the farm. The farm is currently paying around R\$ 0.86 per kWh. This includes electricity tariff, demand charge for the transformer and other fees.

IV. Hourly Load Demand in the farm



The hourly load demand in the farm is as shown in the graph above. Peak load is around 27kW between 1800 and 1900 hours. Table below shows the various equipment and appliances operated by the farms, energy ratings and hours of use.

Type	kW	No.	Start	End
Feed Crusher	22.08	1	5.00	9.00
Mixer	11.04	2	10.00	12.00
Feeder/Conveyor	1.47	4	13.00	16.00
Feed refiner	0.74	3	13.00	16.00
Lights	0.06	40	18.00	5.00
Water Pump	3.68	2	13.00	19.00
Water Heater	5.50	3	18.00	19.00

This farm prepares its own feed for the animals. High wattage feed crushers and mixers are operated on a daily basis to prepare fresh feed for the animals. The farm can save a lot on electricity bills by switching to biogas electricity.

III. Technical Design

Life of the project is 21 years to match with the maximum crediting period allowed under CDM

Biogas Available for Electricity Generation in Year 1	311086	m3
Electricity Demand in the Farm in Year 1	54756	kWh
Additional Electricity required from the grid	0	kWh
Biogas Available for Flaring	278110	m3
Biodigester collection tank size - Calculated	3482	m3
Biodigester collection tank size - Recommended	3482	m3
Generator size based on energy demand	19	kWe
Peak energy demand	26	kWe
Generator size - Recommended	40	kWe
Flaring Equipment Size - Calculated	29	m3/hr
Flaring Equipment Size - Recommended	29	m3/hr

Based on the data provided by the farm, the tool has calculated design parameters for various aspects biogas production and electricity generation for the farm as illustrated above.

The farm can produce 311,086m³ of biogas in year 1 if dung from all 1000 animals is used. This amount of biogas can produce around 516 MWh of electricity in a year. However, the electricity demand in the farm is only 55 MWh per year. So, this results in around 278,110m³ of biogas being flared. This also results in a biodigester lagoon size of 3482m³ with hydraulic retention time of 35 days. Based on 8-hour operation average electrical power demand is 19kWe and the peak demand is 26kWe. Based on this recommended standard off-the-shelf generator size is 40kWe. Recommended size of the flare equipment is 29m³.

Local manufacturers of biodigester and flare equipment have informed that these equipment can be custom sized as required by the farm.

V. Carbon Reduction

Calculations for carbon reduction are based on IPCC small-scale methodologies

Crediting Period	1	2	3	Total	
Baseline Emissions	13479	13479	13479	40436	tCO ₂ e
Emission Reduction					
Electricity Generation only	119	88	88	294	tCO ₂ e
Flaring Only	10023	10023	10023	30068	tCO ₂ e
Max electricity/excess flared	10325	10293	10293	30912	tCO ₂ e

The carbon offset calculations have been done using small scale CDM methodologies. Three 7-year crediting periods have been used. Baseline emission of the farm is around 1925 tCO₂e per year. If electricity is generated and excess biogas is flared, around 75% reduction or 1470 tCO₂e can be reduced per year.

VI. Financial Analysis

All amounts are in Brazilian Real (R\$)

Total Project Investment (Year 0)	451824	100%		
	Equity	90365	20%	
	Debt (Bank Loan)	361459	80%	
Bank Loan Interest Rate (Annual)	8%	Project Period	21years	
Bank Loan Period	10years	Discount rate	10%	

Financial Indicators	Without Carbon Revenue	With Carbon Revenue
Financial IRR (FIRR)	5%	11%
Net Present Value (NPV)	(109,005)	17,548
Benefit Cost Ratio (BCR)	0.84	1.02
Simple Pay Back Period	15.10	12.86
Discounted Pay Back Period	-	19.27

The project investment is R\$ 451,824 for biodigester, genset and flare equipment including installation. Salvage value of the equipment at the end of the project period is taken as 10%. 80% is assumed to be bank loan and 20% as farm's equity. Project life for financial analysis has been taken to be 21 years to match with the three 7-year crediting period for the carbon offset sales. Bank loan period is 10 years and the interest rate in 8%. Annual inflation rate is 5% and the financial discount rate is 10%.

With these figures and assumptions, the project does not seem to generate good return without carbon revenue and has 11% rate of return with carbon revenue. The main reasons for low rate of return are i) over-sizing of biodigester increasing investment and also comparatively high cost of equipment manufactured in Brazil compared to manufacturers in other countries. Since the savings from replacing grid electricity with biogas electricity is the biggest contributor to improving financial returns, it is recommended to maximize use of biogas electricity and size the biodigester based on biogas demand for electricity generation.

Reference Farm 2: Pork Terra

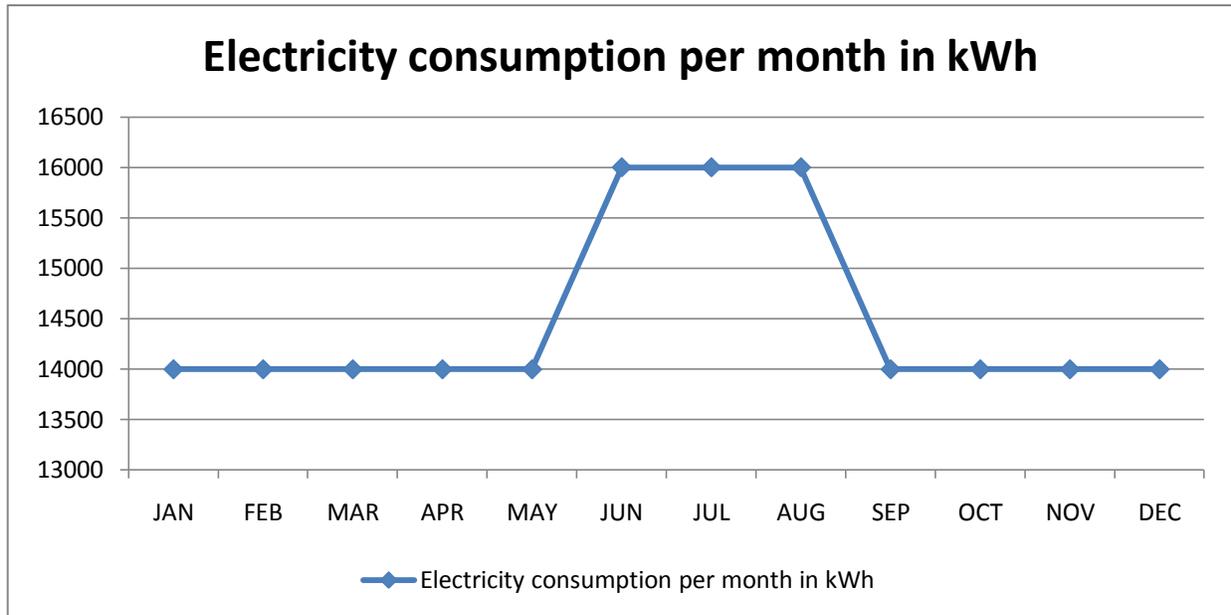
Pork Terra in Rodovia Caconde - km 7 - Bairro Conceição is the second reference farm. This is a Swine Farm with both market and breeding swines.

I. Basic Farm Information

Animal Type	Avg Number of Animals	Avg Wt.	Breed	Baseline Manure Mgmt	Improved Manure Mgmt	Annual Growth Rate	Dung Collection
Dairy Cattle	-	-		-	-	-	-
Beef Cattle	-	-		-	-	-	-
Market Swine	1700	90	Western European	-	Closed Lagoon Biodigester	-	100%
Breeding Swine	190	110	Western European	-	Closed Lagoon Biodigester	-	100%

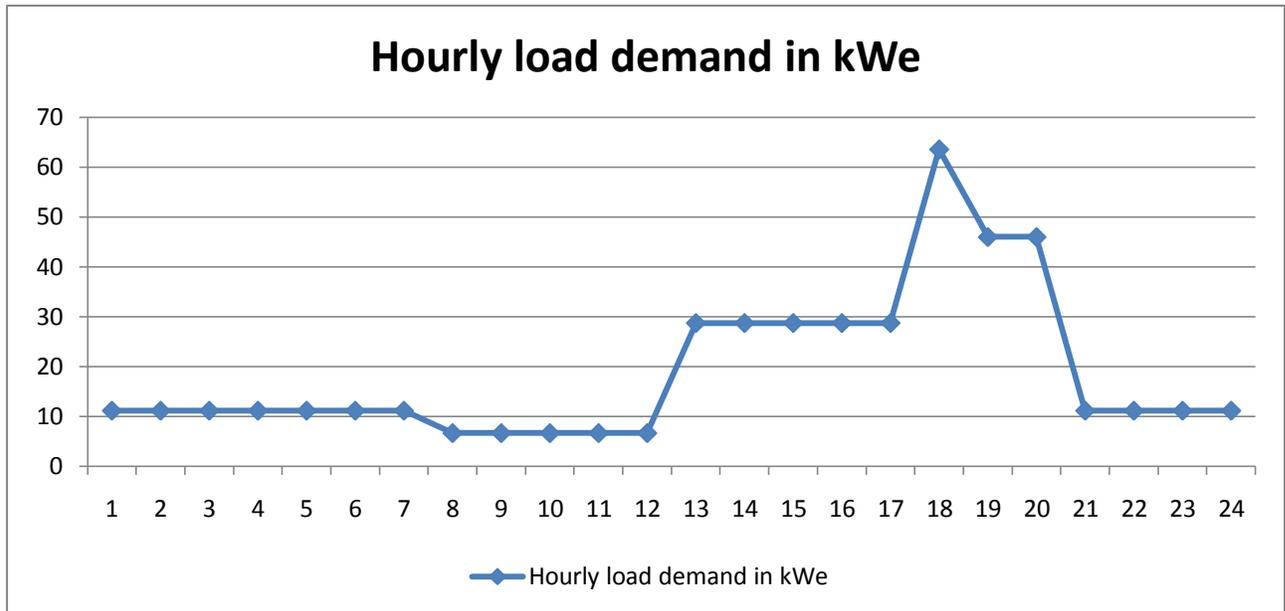
This farm has an average of 1700 Market Swines and 190 Breeding Swines in a year with average weights of 90kg and 110 kg respectively. Currently the liquid dung is directly channeled into the river. Dung collection rate is 100% with flush barn method.

II. Electricity Consumption Pattern (Recent Past Year)



Electricity consumption in the farm is around 14,000kWh per month for 9 months and around 16,000 kWh for 3 months (June to August). This is based on recent electricity bills paid by the farm. The farm is currently paying around R\$ 0.28 per kWh as electricity tariff. This does not include other fees.

IV. Hourly Load Demand in the farm



The hourly load demand in the farm is as shown in the graph above. Peak load is around 63kW at 1800 hours. Table below shows the various equipment and appliances operated by the farms, energy ratings and hours of use.

Type	kW	No.	Start	End
Lights 1	0.06	75	19.00	7.00
Televisions	0.08	11	18.00	20.00
Electric Showers	3.00	11	18.00	20.00
Lights 2	0.10	10	18.00	20.00
Refrigerators	0.30	10	1.00	24
Cold Chamber	3.68	1	1.00	24
Coolers	18.39	1	13.00	18.00
Meat Grinder/Mixer	3.69	1	13.00	18.00

III. Technical Design

Life of the project is 21 years to match with the maximum crediting period allowed under CDM

Biogas Available for Electricity Generation in Year 1	245312	m3
Electricity Demand in the Farm in Year 1	174000	kWh
Additional Electricity required from the grid	0	kWh
Biogas Available for Flaring	140522	m3
Biodigester collection tank size - Calculated	942	m3
Biodigester collection tank size - Recommended	942	m3
Generator size based on energy demand	60	kWe
Peak energy demand	64	kWe
Generator size - Recommended	80	kWe
Flaring Equipment Size - Calculated	15	m3/hr
Flaring Equipment Size - Recommended	15	m3/hr

Based on the data provided by the farm, the tool has calculated design parameters for various aspects biogas production and electricity generation for the farm as illustrated above.

The farm can produce 245,312m³ of biogas in year 1 if dung from all animals is used. This amount of biogas can produce around 407 MWh of electricity in a year. However, the electricity demand in the farm is only 174 MWh per year. So, this results in around 140,552m³ of biogas being flared. This also results in a biodigester lagoon size of 942m³ with hydraulic retention time of 35 days. Based on 8-hour operation average electrical power demand is 60kWe and the peak demand is 64kWe. Based on this recommended standard off-the-shelf generator size is 80kWe. Recommended size of the flare equipment is 15m³.

Local manufacturers of biodigester and flare equipment have informed that these equipment can be custom sized as required by the farm.

V. Carbon Reduction

Calculations for carbon reduction are based on IPCC small-scale methodologies

Crediting Period	1	2	3	Total	
Baseline Emissions	0	0	0	0	tCO ₂ e
Emission Reduction					
Electricity Generation only	379	278	278	935	tCO ₂ e
Flaring Only	-2725	-2725	-2725	-8176	tCO ₂ e
Max electricity/excess flared	-1764	-1865	-1865	-5494	tCO ₂ e

The carbon offset calculations have been done using small scale CDM methodologies. Three 7-year crediting periods have been used. Baseline emission of the farm is assumed 0 tCO₂e per year because the liquid dung directly channeled into the river. Installing a biodigester and flaring the gas will result in increase carbon emissions by 260 tCO₂e per year. Electricity generation will reduce 45 tCO₂e per year.

VI. Financial Analysis

All amounts are in Brazilian Real (R\$)

Total Project Investment (Year 0)	346449	100%		
Equity	69290	20%		
Debt (Bank Loan)	277159	80%		
Bank Loan Interest Rate (Annual)	8%		Project Period	21 years
Bank Loan Period	10 years		Discount rate	10%

Financial Indicators	Without Carbon Revenue	With Carbon Revenue
Financial IRR (FIRR)	15%	-1%
Net Present Value (NPV)	84,703	(201,214)
Benefit Cost Ratio (BCR)	1.17	0.72
Simple Pay Back Period	10.36	-
Discounted Pay Back Period	14.44	-

The project investment is R\$ 346,449 for biodigester, genset and flare equipment including installation. Salvage value of the equipment at the end of the project period is taken as 10%. 80% is assumed to be bank loan and 20% as farm's equity. Project life for financial analysis has been taken to be 21 years to match with the three 7-year crediting period for the carbon offset sales. Bank loan period is 10 years and the interest rate in 8%. Annual inflation rate is 5% and the financial discount rate is 10%.

With these figures and assumptions, the project seems to generate acceptable return without carbon revenue. However, with negative carbon offset, it is not recommended seek carbon funding. Rate of return can be improved by optimizing the size of the biodigester to produce biogas just sufficient the demand for the electricity generation. High cost of equipment manufactured in Brazil is also the reason for low rate of return. It is recommended to look for alternate cheaper equipment. Since the savings from replacing grid electricity with biogas electricity is the biggest contributor to improving financial returns, it is recommended to maximize use of biogas electricity and size the biodigester based on biogas demand for electricity generation.

Reference Farm 3: Fazenda Caconde

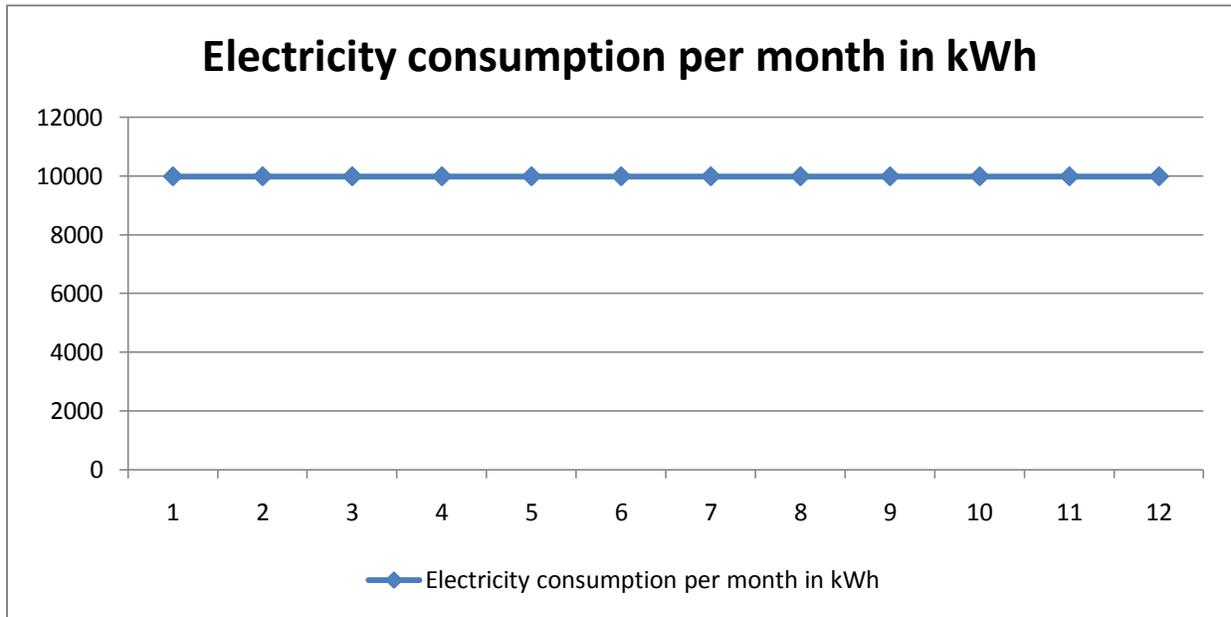
Fazenda Caconde in Rua Floriano Peixoto, 249 - Caconde - São Paulo is the third reference farm. This is a Beef Cattle Farm where the animals are left open for grazing.

I. Basic Farm Information

Animal Type	Avg Number of Animals	Avg Wt.	Breed	Baseline Manure Mgmt	Improved Manure Mgmt	Annual Growth Rate	Dung Collection
Dairy Cattle	-	-	-	-	-	-	-
Beef Cattle	350	400	Asian	Spread	Closed Lagoon Biodigester	-	10%
Market Swine	-	-	-	-	-	-	-
Breeding Swine	-	-	-	-	-	-	-

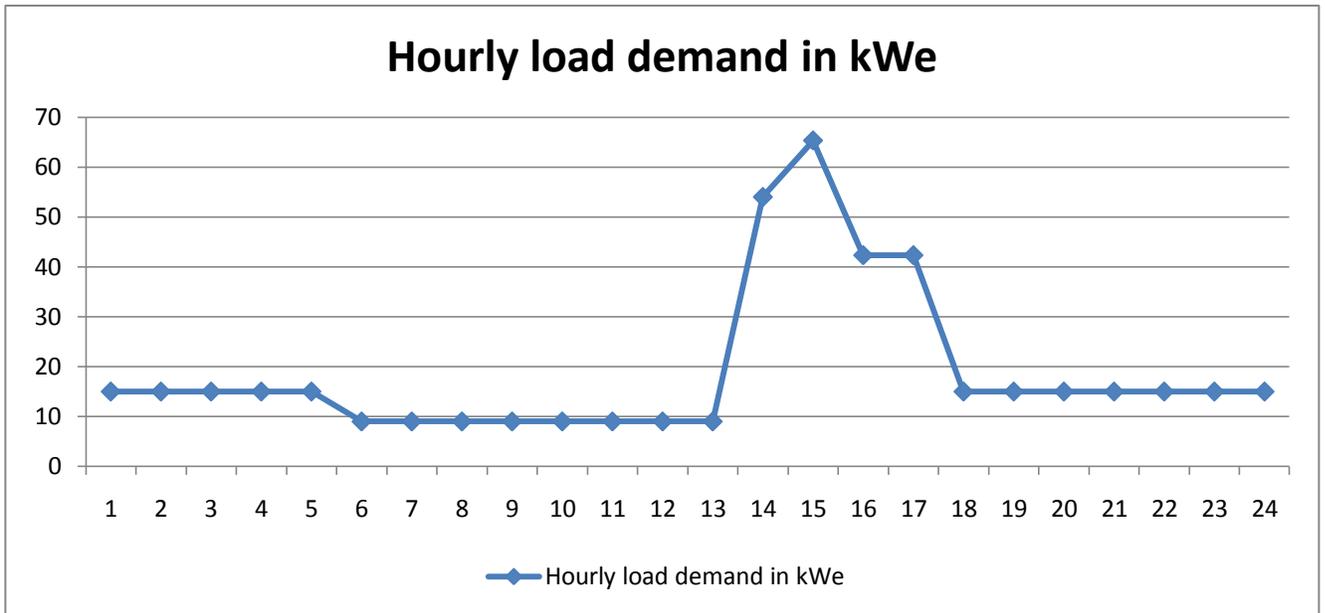
This farm has an average of 350 Beef Cattles in a year of an average of 400kg. Current manure management is spread in the fields and the farm wants to switch to closed lagoon biodigester and electricity generation. Dung collection rate is 10% with pasture method.

II. Electricity Consumption Pattern (Recent Past Year)



Electricity consumption in the farm is around 10,000kWh per month. This is based on recent electricity bills paid by the farm. The farm is currently paying around R\$ 0.28 per kWh as electricity tariff. This does not include other fees.

IV. Hourly Load Demand in the farm



The hourly load demand in the farm is as shown in the graph above. Peak load is around 65kW at 1500 hours. Table below shows the various equipment and appliances operated by the farms, energy ratings and hours of use.

Type	kW	No.	Start	End
Lights 1	0.06	100	18.00	5.00
Coffee Drying Machine	10.20	1	15.00	17.00
Television set	1.13	1	15.00	17.00
Coffee Peeler	15.00	1	16.00	17.00
Showers	45.00	1	14.00	15.00
Refrigerators	0.30	30	1.00	24.00
Coffee Grinder	7.00	1	16.00	17.00

This farm is also involved in coffee preparation and uses around three machines totaling 32kW power rating. The farm can save a lot on electricity bills by switching to biogas electricity.

III. Technical Design

Life of the project is 21 years to match with the maximum crediting period allowed under CDM

Biogas Available for Electricity Generation in Year 1	5693	m3
Electricity Demand in the Farm in Year 1	119760	kWh
Additional Electricity required from the grid	110307	kWh
Biogas Available for Flaring	5693	m3
Biodigester collection tank size - Calculated	115	m3
Biodigester collection tank size - Recommended	115	m3
Generator size based on energy demand	0	kWe
Peak energy demand	0	kWe
Generator size - Recommended	0	kWe
Flaring Equipment Size - Calculated	1	m3/hr
Flaring Equipment Size - Recommended	1	m3/hr

Based on the data provided by the farm, the tool has calculated design parameters for various aspects biogas production and electricity generation for the farm as illustrated above.

The farm can produce 5693m3 of biogas in year 1 if dung from all 350 animals is used. This amount of biogas can produce around 9,450 KWh of electricity in a year. However, the electricity demand in the farm is 119,760 kWh per year. Since the farm will have to continue subscribing a major percentage of electricity from the grid, it is not recommendable to generate electricity from biogas. The resulting biodigester lagoon size is 115m3 with hydraulic retention time of 35 days. Since electricity is not generated, all gas should be flared. Recommended flare size is 1m3 per hour.

Local manufacturers of biodigester and flare equipment have informed that these equipment can be custom sized as required by the farm.

V. Carbon Reduction

Calculations for carbon reduction are based on IPCC small-scale methodologies

Crediting Period	1	2	3	Total	
Baseline Emissions	2	2	2	5	tCO2e
Emission Reduction					
Electricity Generation only	0	0	0	0	tCO2e
Flaring Only	-62	-62	-62	-185	tCO2e
Max electricity/excess flared	-62	-62	-62	-185	tCO2e

The carbon offset calculations have been done using small scale CDM methodologies. Three 7-year crediting periods have been used. Baseline emission of the farm is minimal because much of the dung is spread in the fields. Installation of the biodigester will result increase in carbon emissions.

VI. Financial Analysis

All amounts are in Brazilian Real (R\$)

Total Project Investment (Year 0)	6971	100%		
	Equity	1394	20%	
	Debt (Bank Loan)	5577	80%	
Bank Loan Interest Rate (Annual)	8%		Project Period	21 years
Bank Loan Period	10 years		Discount rate	10%

Financial Indicators	Without Carbon Revenue	With Carbon Revenue
Financial IRR (FIRR)	#DIV/0!	#DIV/0!
Net Present Value (NPV)	(7,566)	(233,675)
Benefit Cost Ratio (BCR)	0.00	-0.01
Simple Pay Back Period	-	-
Discounted Pay Back Period	-	-

The project investment is R\$ 6,971 for biodigester and flare equipment including installation. Salvage value of the equipment at the end of the project period is taken as 10%. 80% is assumed to be bank loan and 20% as farm's equity. Project life for financial analysis has been taken to be 21 years to match with the three 7-year crediting period for the carbon offset sales. Bank loan period is 10 years and the interest rate in 8%. Annual inflation rate is 5% and the financial discount rate is 10%.

With these figures and assumptions, the project does not look feasible at all. The farm will have to increase dung collection so that adequate electricity can be generated to meet the demand. The project is not attractive for carbon sales because the baseline emission is lower than the project emissions.