NCPC

INDUSTRIAL EFFICIENCY IN SOUTH AFRICA

REPORT

Gauteng Department of Economic Development (GDED)
SME Green Support Incentive Program

Technical Report

For

Eco-Hope Management

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Department:
Trade, Industry and Competition
REPUBLIC OF SOUTH AFRICA

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TECHNICAL REPORT

Prepared for:

Eco-Hope Management
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Prepared by:

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0001

ACKNOWLEDGEMENTS

This report was prepared on behalf of the National Cleaner Production Centre South Africa by Mega Unit Consulting, and the NCPC-SA wishes to acknowledge the work undertaken by Molebatsi Ramahudu

I Molebatsi Ramahudu in my capacity as the technical consultant hereby confirm that I have assessed Eco-Hope Management and have analysed and compiled this Sola PV due diligence, and I confirm that all the report findings and representative reflection of the current status of Eco-Hope Management.

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EXECUTIVE SUMMARY

The National Cleaner Production Centre, South Africa (NCPC-SA) and the Gauteng Department of Economic Development (GDED) invited Small and Medium Enterprises (SME's) based in the Gauteng Province to apply for support from the Green Support Programme. The programme aims to provide relief to SME's affected by power interruptions and the economic downturn of the past two years by supplementing a portion of their energy needs with renewable and efficient energy technologies. The programme is aimed at providing financial support for renewable energy implementation at the operations of SMEs affected by the economic downturn of the past two years.

This report serves as a due diligence for a solar Photo Voltaic (PV) system under which the main objective was to determine the alternate supplementary energy source capacity for Eco-Hope Management as guided by their needs. The latter is related to challenges of both the load shedding that disrupts business and the forever increasing electricity prices (as compared to a flat/R0/kWh of levelized cost of electricity for a solar PV). This report takes into account the current status and needs of Eco-Hope Management with regards to electricity usage and business prospects.

The methodology is complementary of the assessment procedure, literature consultation, and additional online resources. All in all the status of and capacity of the site's needs is outlined and measures with regards to the solar irradiation (South Africa, Pretoria) are used to estimate possible solar PV output per month with respect to corresponding cost analysis.

The site's is a municipal subsidiary at which electricity billing is not up to date as to how much is consumed per month. Currently the process is considered to be at an incubation stage whereby their needs are not catered for by the municipal, also noting that they are affected by load shedding and frequently have to stop postpone work and therefore creating a pile of backlog. Their needs of an alternate source of energy is in line with commercialising the recycling business and being competent with less/no business disruptions. Therefore the system was designed based on the green incentive budget of R220 000 and will generate 20 020kWh/year (back up storage of 18kWh/day at a capacity of 55kWh/day) saving 21tCO_{2e}/year at a total cost of R211 130.

ABBREVIATIONS AND ACRONYMS

V	Voltage
W	Wattage
kW	Kilo-Watts
kWp	Kilo-Watts Power
kWh	Kilo Watts Hour
DC	Direct Current
AC	Alternating Current
Ah	Ampere Hour
hrs	Hours
mm	Millimetre
m^2	Meter squared
R	Rand
CO2	Carbon dioxide
PET	Polyethylene Terephthalate
PE	Polyethylene
BBB-EE	Broad-Based Black Economic Empowerment
RECP	Resources Efficiency and Cleaner Production
GDED	Gauteng Department of Economic Development
SMME	Small, Medium, and Micro Enterprise
NCPC-SA	National Cleaner Production Centre-South Africa

CONTENTS

1. INTRODUCTION

Eco-Hope Management as part of SMME has been experiencing challenges of business disruption (Covid-19 business recovery and being disconnected from the gird electricity power source) which in retrospect affect business performance and thereof its contribution to Gauteng's economic stability (company location is in the Ekurhuleni municipality's East Rand/Katlehong). Founded in 2018, with a level 1 BBB-EE (100% black owned). The core business is recycling all sorts of waste except for agricultural, food and bio waste.

Currently the site stands as a buy back centre for companies that uses paper-based waste as raw material. While also cleaning used cooking oil to make biodiesel (currently used for some of the incubation vehicles).

The site has an 8am to 4pm Monday to Friday operating model in which production is determined by business request from customers such that sometimes because of electricity disruptions, the backlog becomes more than expected and some business is taken by competition thereby creating a gap for trust and possibilities of losing waste collection centres.

In understanding more about the business operation an assessment was conducted on the 2nd of June 2022, which started with an introductory meeting, followed by a site walk with the site and production manager, relevant data was collected, and observations made with a purpose of understanding the priority needs through boundary and scope.

This project forms part of the National Cleaner Production Centre's Resource Efficient and Cleaner Production (RECP) Programme, whose objectives are to assist companies in different industry sectors achieve sustainability and competitiveness through resource efficient production practices.
The forms part of the Gauteng Department of Economic Development (GDED)'s SMMEs Green Support Incentive Program whose objectives are to assist SMMEs based in Gauteng to install alternative sources of energy to mitigate the high cost of energy and green their operations through reduced carbon emissions. The NCPC-SA is responsible for conducting the on-site assessment and the whole project life cycle at the Eco Hope Management.

The assessment consisted of evaluating the company's energy requirements and needs by observing the operations of significant resource users. This report discusses the findings of the assessment as well as providing proposals for alternate source of electricity and possibly a supplement to the grid

electricity consumption should they be connected to the grid source. The interventions are evaluated for feasibility in terms of estimated investment cost savings and simple payback period.

2. GENERAL DISCUSSION OF PURPOSE OF REPORT

The purpose of the report was to determine the capacity of an alternate/supplementary energy source for Eco-Hope Management based on their need and challenge(s). Post the site assessment and data analysis, it was learned that the site is a municipality subsidiary and has been disconnected from the grid since the day of operation. With their vision of expansion and a budget incentive of R220 000, a capacity of 10kWp solar PV was determined to be suitable for the site's current operation, that being, 100% solar power dependence and less than 100% in the near future if the site is reconnected to the grid.

3. PROJECT METHODOLOGY

A detailed assessment was done during the site walk wherein later on the collected data/information was analysed to determine the capacity of the alternate energy source/solar PV.
The steps followed to conduct the due diligence are:

- Data collection through observations and interviews (site walk)
- Data compilation, analysis, and literature (South Africa's irradiation capacity) and online material (solar panels, inverters, and batteries) consultation.
- Determine kWh capacity of the solar PV system through a theoretical energy balance.
- Cost projection determination of the electricity generation from the solar PV on scenario basis using Eskom's previous electricity percentage price increases with respect to the council's cost of electricity.

4. COMPANY INFORMATION

This chapter gives a brief company profile and contact information. If available, a small site map can be useful to demonstrate the area of assessment and the location of the departments.

Company information table:

Company name	Eco-Hope Management
Address	Stand No. 2, Moseleke East, Katlehong, 1431
Phone, Fax	(+27)61 197 1725
e-mail	rsipho49@gmail.com
Website	www.Eco-Hope-Management.business.site
Trading since (year)	2018
No. of Employees	
Company size	Micro-Enterprise
Annual turnover in rand value	
Industrial Process used	Chemical and physical
Onsite Project Team:	
Assigned Project Manager and position within the organisation	*These are the people who will be trained on how to operate the solar system including M&E processes*
Team members and positions	Sipho Radebe
Contact person:	
Name	
Position	
Phone & mobile numbers	
Fax	
Email address	

5. PRODUCTION PROCESSES

5.1 Process Description

The site's business model is recycling buy back centre with three processes processing different products on site, that first being, (one process stage) the bailing of recycled paper material whereby all sort of paper material collected from different locations within Katlehong are bailed and sold to customers of interests. The second (one process stage) is that of grinding Polyethylene Terephthalate (PET) and PE low and high density-based material (mostly plastic bottles). The third (two process stage), being that of a biodiesel processing from used cooking oils, whereby the oil is mixed with processing chemicals, allowed to settle and later on to produce two streams of a product (liquid) and a by-product (pulp) which is use as fertiliser for the site's garden.

5.2 Process Flow Chart

Figure 1 shows the three different processes onsite with respect to section 5.1.'s context.

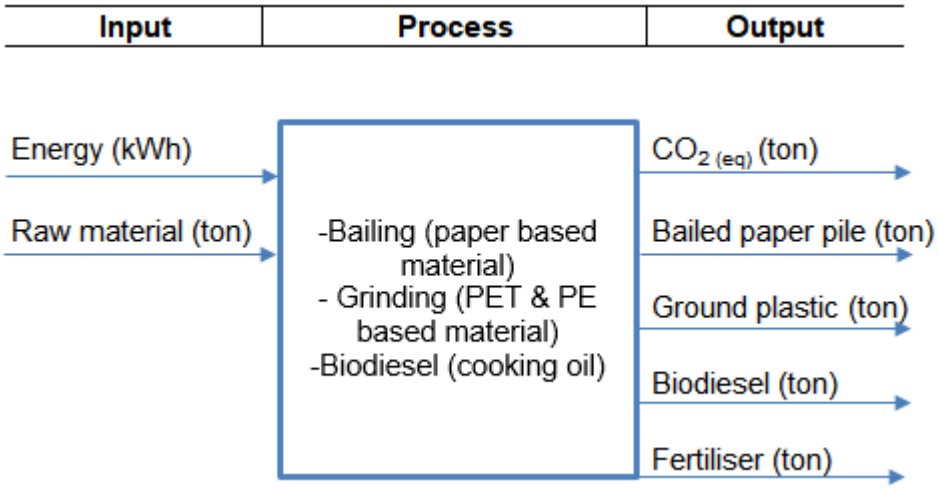

Figure 1: Eco-Hope Management's process flow

5.3 Production data

Even though the site has been operating since 2018, there has not been a consistent documentation of the production data. Noting also that they have been mostly operating within an incubator parameter (inconsistence trial and error production).

6. CURRENT ENERGY CONSUMPTION DATA

With respect to section 5.3. and findings from the site walk, the site's electricity source has since been disconnected from the grid during the early days of operations. Especially for the two processes, that is, the bailing and grinding. The biodiesel process has been using a diesel generator as a source of electricity for the process, with the some of the product being used to fuel the same generator during operations.

7. RENEWALABLE ENERGY SOLUTION

7.1. Description of the renewable energy

South Africa has some of the highest solar irradiation in the world, with measures amounting to about 263-278W/m^2 (Figure 2). This gives an ideal space for large and small solar PV installation. Though during winter, the irradiation subsides (Figure 3: 3.9kWh/m^2 as compared to summer with a 7kWh/m^2) it is still commercially viable to reduce significant amount of energy demand from the national grid.

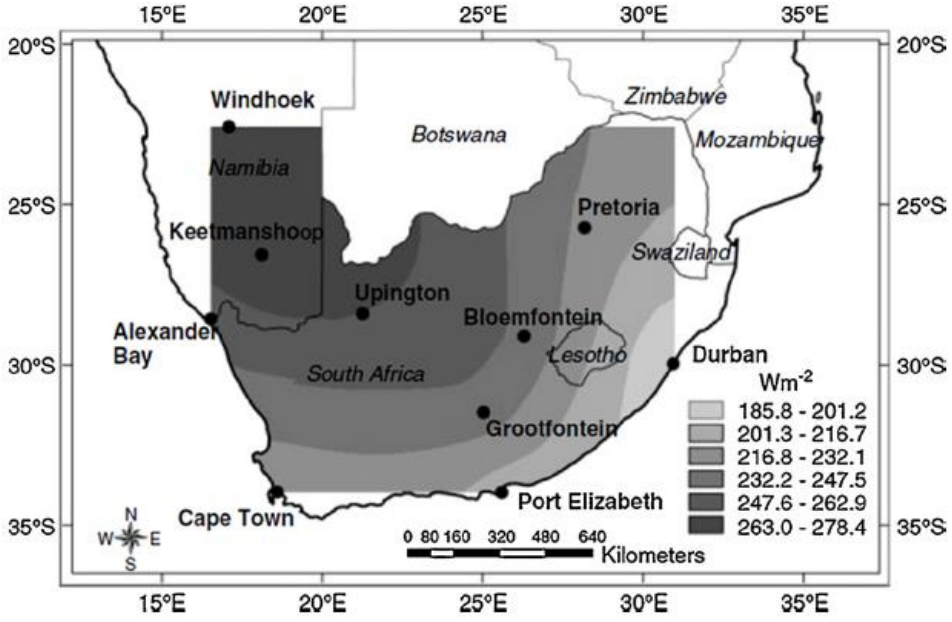

Figure 2: South Africa's irradiation capacity by region [1]

[1] Power HC, Mills DM. Solar radiation climate change over Southern Africa and assessment of the radiative impact of volcanic eruptions. International Journal of Climatology 2005;25: 295–318.

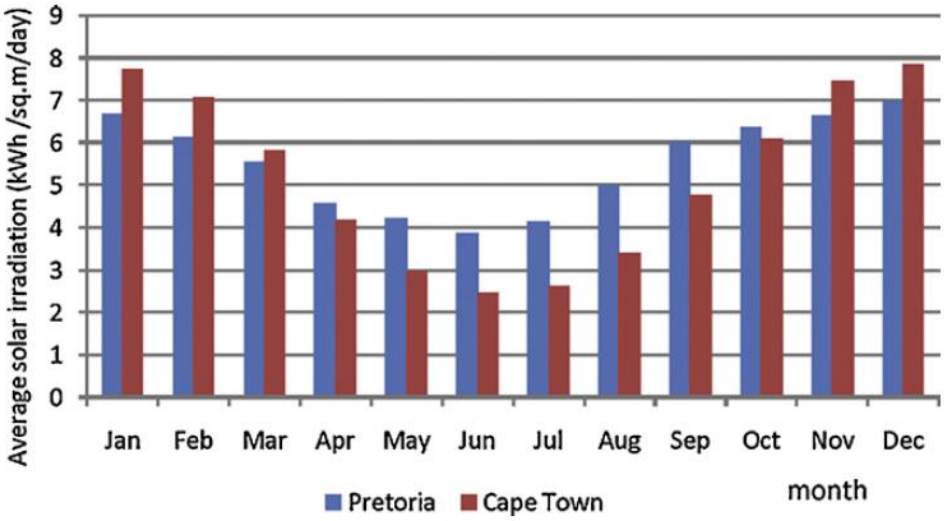

Figure 3: Yearly Irradiation for data for Gauteng and Western Cape Province [2]

Figure 3 shows an expected theoretical (Appendix 1) solar PV electricity generation profile, although modelled on an ideal state the kWh/day will differ based on weather conditions for that day or period.

7.2. System Design

Commercially renowned module types: polycrystalline and monocrystalline have well been studied and tested for their robustness in addition to their yield, efficiency, and deterioration factor over a life cycle of 20 years. They type of module recommended for the system is that of a monocrystalline type, mainly because of being resistant to harsh weather conditions, having reported efficiencies of more than 25%, retaining a yield of more than 70% even at high surface temperature [3].Table 1 shows the required capacity per day to per year with respect to the financial expectations.

Table 1: Calculations of modules as per roof capacity

Solar Power system (kWh/day)	55
Solar panels area (m^2)	51
Assumed baseline consumption	20 020
Potential kWh/year consumption	20 020
Number of panels (435W/panel)	23
System production (kWh/annum)	20 020
System production (kWh/day)	55
Day (kWh) demand	80
Night (kWh) demand	0
Number of batteries (3.5kWh/battery)	5
Battery (kWh/day)/Storage	18
Cost of kWh (R/kWh)	2
Assumed kWh/year cost (R)	45 445

[2] Doneva, G., van Sarka, W., Bloka, K., Dintchev, O., 2012. Solar water heating potential in South Africa in dynamic energy market conditions. Renewable and Sustainable Energy Reviews 16. pp 1-13.

[3] Bergmann, R.B., Berge, C., Rinke, T.J., Schmidt, J., Werner, J.H., 2002. Advances in monocrystalline Si thin film solar cells by layer transfer. Solar Energy Materials & Solar Cells 74, pp 3-8.

Potential kWh/year cost (R)	0
Capital cost	211 130
Savings (kWh/year)	20 020
Savings (R/year)	45 445
CO2equivelance (tCO2/year) reduced	21
Payback (years)	4.65
Intervention	**Installation**

Table 1 shows that the assumed daily generation is 55 kWh which will require a north facing roof of 51m^2 area. Ideally the system will generate a 20 020 kWh/year with 23 panels of 435W (Appendix 2). With respect to the recommended module type, 48V inverters accompanied by 48V batteries, and 48V charge controllers (to prevent batteries from under/over-charging) would be suitable for the system as a whole. The batteries can be connected in parallel as highlighted in Figure 4. Nonetheless the installer can advise with respect to expertise suitable for the system.

Figure 4: Block diagram of connected back up storage

7.3. System configuration

Table 2 shows major system components that will make up the system in addition to auxiliaries and peripherals.

Table 2: Major system components

Part	Item Description	Technical Description	Quantity
Panel	Navy blue 2.11 by 1.05 rectangular unit	monocrystalline solar panels	23
Inverter	Black and white electronic unit of 354x433x155mm	48V DC to AC Electronic device	2
Battery	Black boxed unit 135x442x435mm	48V, 3.5kWh, 75Ah Electronic unit	5

7.4. Installation process

This section will be updated once the system is installed.

7.5. System Capability and Output – Metering of the Solar System

Although the system is not yet installed at this stage, it was projected that throughout the year it will follow the pattern highlighted in Figure 3. The projection is shown in

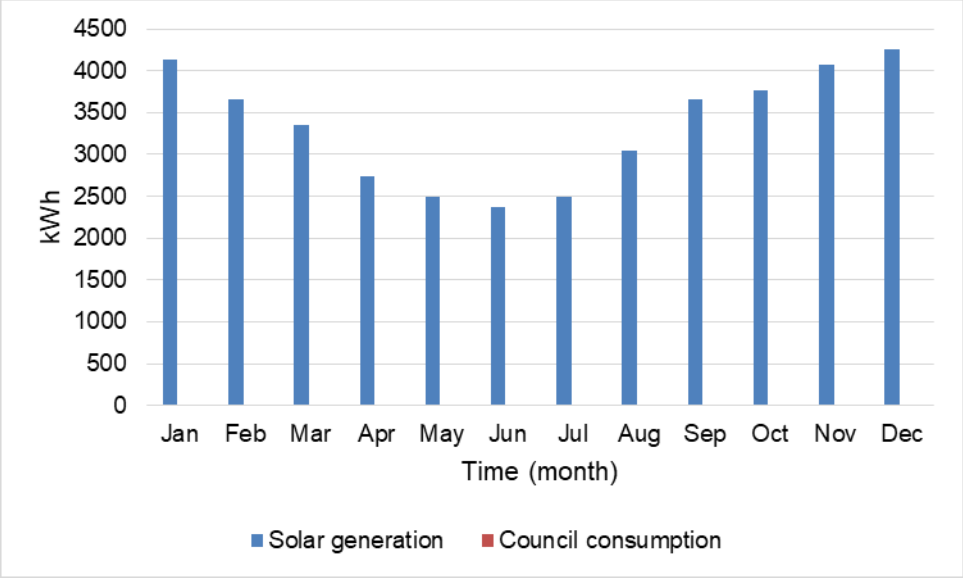

Figure 5: Expected solar PV annual electricity generation profile

The estimated 20 020 kWh will be divided throughout the year by following Figure 5 pattern on an ideal scenario. Emphasizing that even if load shedding occurs as long as the sky is clear the system will generate electricity as per South Africa's irradiation capacity (Figure 2), this profile can help with seasonal production planning

7.6. System Operation and maintenance

The system will operate based on the weather conditions with built-in online and physical metering units, fundamentally being connected online/cloud where it will show the period-based performance with respect to the yield, disturbances, and the overall efficiency performance. The end user can be able to view on an online dashboard or the system's physical monitor for hourly, daily, and monthly reports. This report will show data analysis in charts and tables for simplified documentation. On the other hand, maintenance can be handled by an internal person after they deemed capable by the NCPC-SA while additional service can be acquired ad hoc from external services provider.

8. CLEANER PRODUCTION RECOMMENDATIONS

This section highlights the recommended measure(s) identified on site during the assessment and their financial feasibility.

8.1. Identify resource saving opportunities

The major RECP opportunity identified onsite was the alternated energy source which will save a significant amount of CO2 equivalence by reducing the grid electricity consumption.

The opportunity is a high-cost CAPEX intervention as described:

R52 529 for 23 (2.108 by 1.048m, 435W, R2 285) panels,
R19 380 for 2 (48Volts, 5kW, R9 690) inverters,
R90 499 for 5 (48V, 3.5kWh, R18 099) batteries
R63 339 for contingencies/peripherals/auxiliaries and or installation.
R 211 130 for total estimated cost of the system
With a payback period of 4.65 years.

8.2. Evaluation and feasibility of the opportunities

The environmental evaluation of the system on an ideal scenario is that the annual electricity generation of 20 040 kWh, will save about 21 $CO_{2\ (equivalence)}$. This will add to the reduce expenditure on electricity should the municipality decide to bill the side. On a longer term the site's financial projection (Appendix 3) is shown by Figure 6.

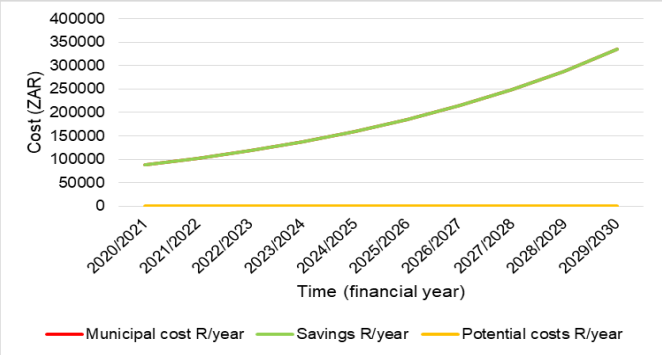

Figure 6: Financial projection benefits for the solar PV system

Figure 6 shows the financial projections of how the system can be beneficial to the site. In a 10 years period the site can save about R998 843 instead of paying R998 843 the potential costs to the municipality will be R0, depending on their grid electricity consumption with respect to their future expansion plans. This happens because of the forever increasing electricity prices from the services

provider, just based on a period from the year 2006 to 2018 the electricity prices have increased with a total of 16% ranging from 3% to 44%.

9. IMPLEMENTATION PLAN

- Long term plan:
  Once the NCPC has engaged with the solar PV system supplier(s) and the site has decided on the type of system that is suitable for their needs, it would be ideal to immediately start with the installation process.

10. CONCLUDING REMARKS

Currently the site is not connected to the grid meaning that once the solar PV system is connected, their operations at large will start being active. Overall, the site can be able to capitalise on an alternate source of energy in relation to their challenges. Over a period of 10 years and beyond savings in the order of million and hundreds of Rands will be saved. This will surely contribute to increased profits that will continue to promote business growth and Gauteng province's economic growth at the SMME level's capacity. At this point of the project, specifics with regards to the type/brand of the system are not highlighted as they will be at hand of the client or later on recommended by the consultant should there be a necessity.

11. APPENDICES

Appendix 1: Gauteng's average irradiation per month

Pretoria irradiation (kWh/m^2/month)		% Irradiation/m^2/month	Solar generation kWh/60m^2/month
Jan	6.8	10%	2 069
Feb	6	9%	1 826
Mar	5.5	8%	1 673
Apr	4.5	7%	1 369
May	4.1	6%	1 247
Jun	3.9	6%	1 187
Jul	4.1	6%	1 247
Aug	5	8%	1 521
Sep	6	9%	1 826
Oct	6.2	9%	1 886
Nov	6.7	10%	2 039
Dec	7	11%	2 130
Total	65.8	100%	20 020

Appendix 2: Solar sizing

Sizing					
PV size (W)	Production time (hrs)-maximum/efficient	Production (kWh/day)	Storage (kWh/Battery)	Production (kWh/year)	Charging time
20000	5,5	110	3,5	40040	4,675
15000	5,5	83	3,5	30030	4,675
10000	5,5	55	3,5	20020	4,675
Product: Solar & Inverter Warehouse					
Canadian Solar Panel-Poly PERC HiKU		KODAK Solar Off-Grid Inverter		Batteries-Solaradvice.co.za	
435	W	7,2	KW-Output	3,5	kWh
2285	R	48	V	48	V
2,108	m	16850	R	18099,85	R
1,048	m	5	KW-Output		
0,04	m	48	V		
24,9	kg	9690	R		
2,21	m^2				
Costing					
10,00%	**Peripherals % cost**				
20,00%	**Installation and delivery % cost**				
Small System					
23	Panels	2	Inverters (kW)	5	Batteries
52529	Cost (R)	19380	Cost (R)	90499	Cost (R)

Appendix 3: Alternate energy source's financial projection

Period (years)	Municipal consumption kWh/year	Solar generation kWh/year	Savings kWh/year	Incremental R/kWh	Municipal cost R/year	Savings R/year	Potential cost R/year
2020/2021	20 020	20 020	20 020	2.34	46 847	46 847	0
2021/2022	20 020	20 020	20 020	2.71	54 342	54 342	0
2022/2023	20 020	20 020	20 020	3.15	63 037	63 037	0
2023/2024	20 020	20 020	20 020	3.65	73 123	73 123	0
2024/2025	20 020	20 020	20 020	4.24	84 823	84 823	0
2025/2026	20 020	20 020	20 020	4.91	98 394	98 394	0
2026/2027	20 020	20 020	20 020	5.70	114 137	114 137	0
2027/2028	20 020	20 020	20 020	6.61	132 399	132 399	0
2028/2029	20 020	20 020	20 020	7.67	153 583	153 583	0
2029/2030	20 020	20 020	20 020	8.90	178 157	178 157	0
Total	200 200	200 200	200 200	4.99	998 843	998 843	0

12. LIST OF TABLES AND FIGURES