NCPC

INDUSTRIAL EFFICIENCY IN SOUTH AFRICA

REPORT

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

For

BONO FURNITURE'S

the dtic
Department:
Trade, Industry and Competition
REPUBLIC OF SOUTH AFRICA

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TECHNICAL REPORT

Prepared for:

XYZ-ABC Conglomerate
35 Richard Rd,
Industria North,
Johannesburg

Prepared by:

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Pretoria
0001

ACKNOWLEDGEMENTS

This report was prepared on behalf of the National Cleaner Production Centre South Africa by **Mega Unit Consultancy**, 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 **Bono Furniture's** and have analysed and compiled this Resource Efficiency & Production Assessment report, and I confirm that all the report findings and representative reflection of the current production status of **Bono Furniture's.**

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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 aim was to determine the alternate supplementary energy source for Bono Furniture's as guided by their needs. The study is related to challenges of both load shedding that disrupts business operations and the factory not having enough power capacity to run all machinery to manufacture furniture.

The methodology consist 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 are used to estimate possible solar PV output per month with respect to corresponding cost analysis.

Key Findings and Recommendations

- Bono Furniture has not implemented any cleaner productions interventions.
- The factory power capacity is not enough to run all machinery, the owner had to move some of the machinery to another factory nearby for smooth operation.
- The estimated annual electricity consumption is 100 268 kwh/year, amounting to R257 690, assuming that the site operates on full capacity without power outages.
- The system was designed based on the energy required to run the business with minimal interruptions taking into account the Green Support incentive budget cap of R220 000.

The proposed solar PV system will generate 10.16 kWp with a 20 kWh battery storage. The potential energy savings is 17 046 kwh/year equivalent to R 43,807 /year. The project requires an investment of R226 005 with a payback period of 7.87years. The CO_2 offset from the use of renewable energy (solar PV) is 10.89 tons a year.

ABBREVIATIONS AND ACRONYMS

CO_{2e}	Carbon dioxide equivalents
CP	Cleaner Production
Deg. C	Degrees Celsius
HRS	Hours
IPA	In-Plant Assessment
kWp	Kilowatt peak
R/W	Rands per Watt
GDED	Gauteng Department of Economic Development
GHG	Greenhouse Gas
MWh	MegaWatt Hour
PV	Photovoltaic
M^2	square metres
NCPC-SA	The National Cleaner Production Centre of South Africa
P	Power
QS Assessment	Quick-scan Assessment
R	Rands
SME	Small and Medium Enterprises
GSIP	Green Support Incentive Programme
W	Watts

CONTENTS

1. INTRODUCTION

Bono Furniture is a local manufacturing company situated in Industria, Johannesburg West. It was established in 1980 since then it has been creating beautiful designed furniture pieces of great quality. The company supplies well known reputable furniture stores in across the country. Bono furniture has a dedicated team of 33 workers

The site operates from 7:30am to 5pm Monday to Friday and 7:30am to 12:30pm on Saturdays. The production is determined by demand/orders from customers such that sometimes because of the power outages challenges, they operate during the night and weekends to meet customer's turnaround time.

The assessment commenced on the 24th of June 2022 with an inception meeting followed by a site walkthrough. During the site walk, observations were made and an electrical equipment register was developed. The objective was to identify all the energy inputs with its use and the electrical load according to its discrete function.

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 Bono Furniture's.

The assessment consisted of evaluating the company's RECP management practices, observing the operations of significant resource users. This report discusses the findings of the assessment as well as providing proposals for resource efficiency interventions that can be implemented at the new factory. The interventions are evaluated for feasibility in terms of estimated investment cost savings and simple payback period.

2. PROJECT METHODOLOGY

The adopted methodology is comprised of data collection, analysis, and measures as guided by the cleaner production principles, supported by online resources and literature.

Scope and Boundary

The focus of the assessment is on the entire operations of Bono Furniture with the emphasis on electricity usage within the factory and the scope is to conduct a solar PV feasibility study as shown by the methodology below in **Error! Reference source not found.**.

Figure 1: Overview of the project methodology

The following steps were followed to conduct a solar PV feasibility study:

- Study the existing factory capacities and its performance to assess its operations.
- Collection of requisite data to analyse and identify areas with potential for conservation of energy.
- Determine the overall electricity usage using the electrical register and calculate electricity consumption per department/section.
- Measurements of operational parameters and calculations of energy balance.
- Design a solar PV system based on the collected data, online resource such as PVGIS software and literature studies.
- Calculations of cost benefit analysis in terms of savings in energy consumption and pay-back period.

3. COMPANY INFORMATION

Company information table:

Company name	Bono Furniture
Address	35 Richard Rd, Industria North
Phone, Fax	27 (0) 72 383 8913
e-mail	hendricktre@gmail.com
Website	-
Trading since (year)	1980
No. of Employees	33
Company size	Micro-Enterprise
Annual turnover in rand value	-
Industrial Process used	Furniture manufacturing
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	
Contact person:	
Name	Hendrick Rankhododo
Position	Owner
Phone & mobile numbers	27 (0) 72 383 8913
Email address	hendricktre@gmail.com

4. PRODUCTION PROCESSES

4.1. Process Description

Bono furniture's manufactures household furniture such as dining chairs, tables, headboard and couches. The process used to make furniture include cutting, bending, molding, assembly and finishing of materials such as wood, metal, plastic and glass. Post to finishing, the products are moved to packaging area where they will be packaged and dispatched to various customers.

The procedure is described as follows:

Cutting - is the first of component process where material will be cut and split according to the size of the product to be made.

Bending and molding – a process where materials are made into desired shapes of furniture

Assembly – The desired shaped pieces of different furniture components are assembled into furnished goods.

Finishing – this is the last process of furniture manufacturing. It is a process of layering surfaces with the purpose to make the final product look beautiful and also protect furniture from moisture air.

4.2. Process Flow Chart

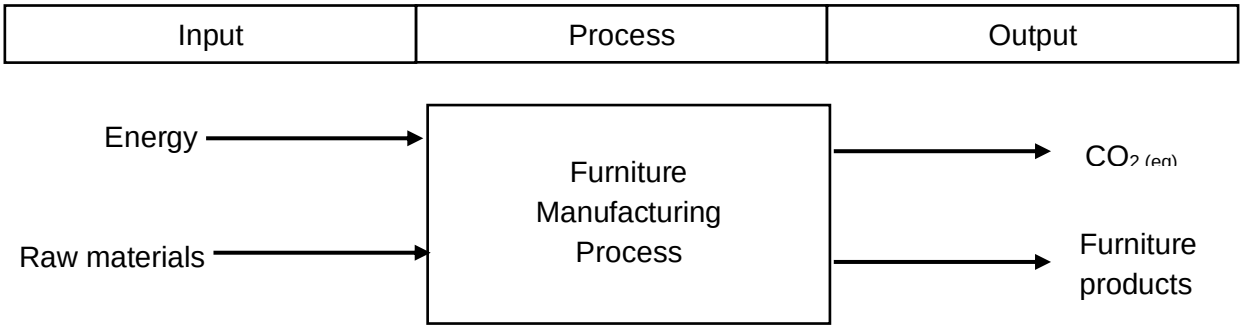

Figure 2: Bono furniture process flow

4.3. Production data

Although Bono furniture has been manufacturing furniture for years, they do not have records of the production data.

5. CURRENT ENERGY CONSUMPTION DATA

5.1. Energy data

Bono furniture has rented a working space and it's on prepaid billing. They purchase electricity units of a range of R2000 – R4000 depending on production demand. It does not keep record of monthly receipts and does not note down how much they have spent on electricity.

5.1.1. Site energy trend

Annual electricity usage of the factory was calculated based on the electrical equipment register taking into account the operational hours. Figure 2 below shows electricity usage per equipment used in the factory, and machinery consumes most of the electricity as compared to other energy users.

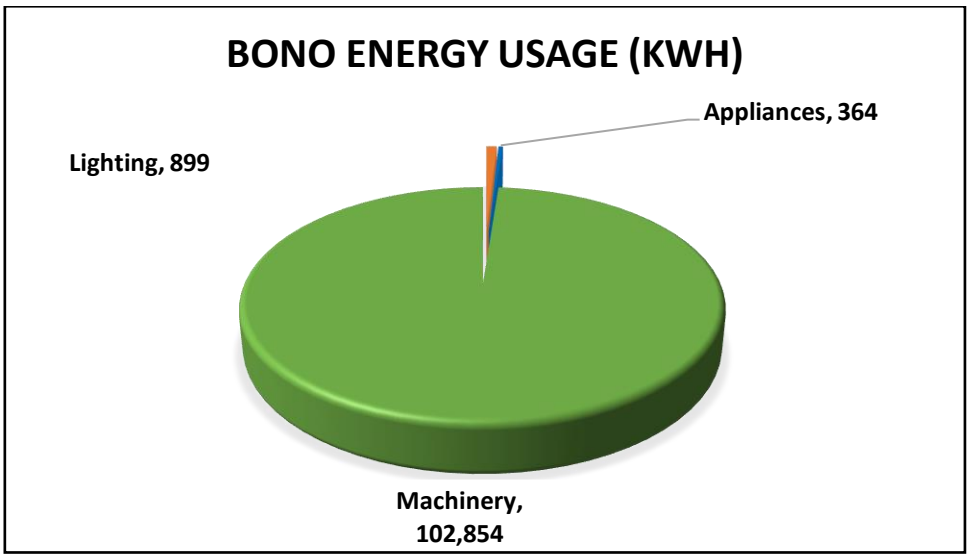

Figure 3: Annual Energy consumption

5.2. Baseline Data

A baseline could not be calculated due to the unavailability of monthly electricity and production data.

6. RENEWALABLE ENERGY SOLUTION

6.1 Description of the renewable energy

As already highlighted, South Africa has some of the highest solar irradiation in the world, with measures amounting to about 263-278W/m^2 (figure 4). This gives an ideal space for large and small solar PV installation. However during winter the irradiation subsides (figure5: 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.

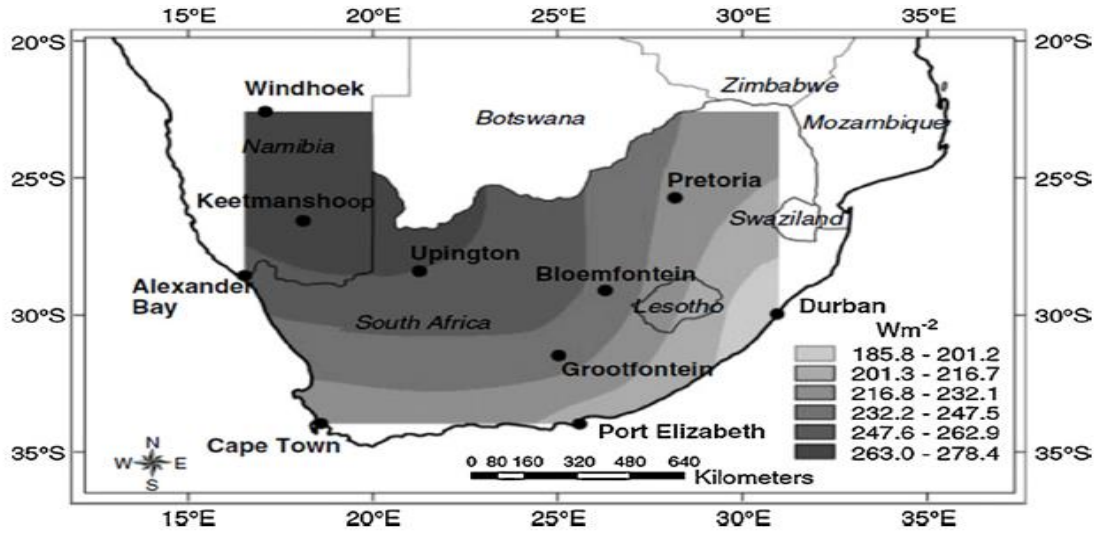

Figure 4: South Africa's solar irradiation capacity per region [1]

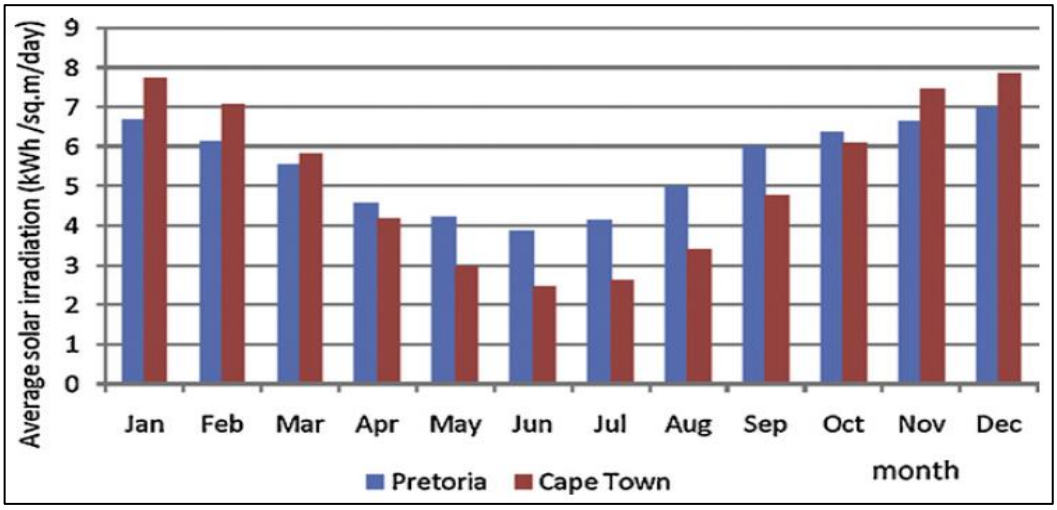

Figure 5: Average monthly solar irradiation in the north and south of South Africa

[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.

6.2 System Design

This section outlines the sizing of the solar PV system that determines the financial feasibility (**Error! Reference source not found.**) of the system.

Table 1: Solar PV system specifications and cost measures

Estimated annual electricity demand (kwh)	100,268	kwh
Energy costs	257,690	Rands
Daily load (kwh)	384	kwh
Essential load (25% capacity)	96	kwh
Specific yield based on PV GIS	1,677	kWh/kWp/year
PV Generator Size (CANADIAN SOLAR CS3W-400P)	400	Wp
Canadian 3 phase Inverter 25kw 48V	1	
Number of panels (400W/panel)	25	modules
System production (kWh/annum)	17,046	
System production (kWh/day)	46.7	
Battery (kWh/day)/Storage	20	
Number of batteries (21.3kWh/battery)	1	
Energy costs savings	43,807	Rands
CO2equivelance reduced	17.77	tCO_2/year
Investment costs	R226,005	Rands
Payback period	5.16	Years

6.3 System configuration

The following table shows the main components and the cost breakdown of the proposed solar PV system.

Table 2: Solar PV system costs

Main components	#	Unit Price	Total
PV Generator Size (CANADIAN SOLAR CS3W- 400P)	25	R3,200	R81,294
Canadian 3 phase Inverter 25kw 48V	1	R38,949	R38,949
Pylontech Force Series - Force L1 21.31	1	R55,000	R55,000
Balance of system			
Cables (DC and AC)			R5,000

Mounting system (rails, roof hooks, clamps etc.)			R3,000
Switches and safety devices			R2,000
Monitoring system			R10,000
Installation costs			R20,000
Contingency (10%)			R10,762.13
Total Excl. Vat			**R226,005**

6.4 Installation process

The main steps of installing a solar panel system includes: an engineering site visit by the installer, acquiring permits and documentation from the municipality and other relevant parties. Ordering of equipment, solar panel installation and approval from a registered electrical engineer or PV Green card holder. The final installation process will be confirmed by installer and Bono furniture representative.

6.5 System Capability and Output – Metering of the Solar System

The projected annual energy produced is 17 046 kWh/year, therefore, the solar system can supply 17% of the factory's energy use. The solar system will have a battery backup of 20kWh lithium battery to power essential load of 25% (96kWh) in case there's inadequate power supply from the PV modules. The storage was designed with the consideration that the power outage duration is 4.5 hours

6.6 System Operation and maintenance

Sunlight is captured within photovoltaic cells and transported to an inverter where it is converted from direct current DC electricity to usable AC electricity. The figure below shows the projected monthly energy production of solar panels.

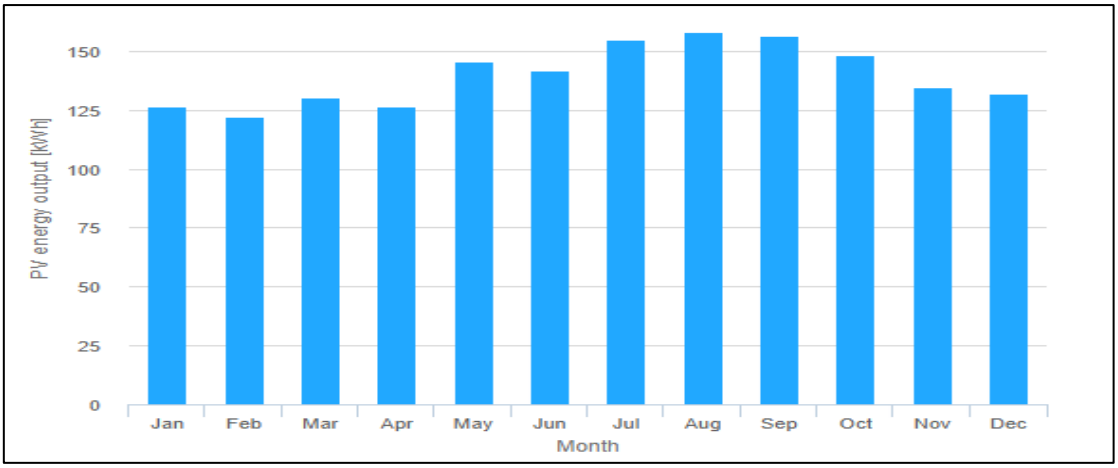

Figure 6: Projected energy yield

Solar panels require minimal maintenance to ensure that they keep working properly and producing the optimal solar energy as shown in figure 6 above. The panels needs to be cleaned twice a year to remove dirt and debris. Annual inspection should be done by a professional solar panel inspector and inspect if the solar panels get the optimal amount of sunlight. Maintenance appointments should be scheduled when needed and if Bono furniture notice any problem with solar panels. Problems that can occur is the reduction of energy output resulting in an increase in electricity bill.

7. CLEANER PRODUCTION RECOMMENDATIONS

7.1 Identify resource saving opportunities

The proposed system is called a Hybrid system, it runs on solar power and grid electricity. This system has a battery backup for power outages or period where there's no enough sunlight. The maximum daily energy demand for the factory is 384 kWh/day, which is 100 268 kWh/year. Due to budget constrained, the solar PV system had to be designed to only cater 17% of the total energy use (100 268). The projected annual energy produced is 17 046 kWh/year, therefore, the solar system can supply 17% of the factory's energy use.

The solar system will have a battery backup of 20kWh lithium battery to power essential load of 25% (96kWh) in case there's inadequate power supply from the PV modules. The storage was designed with the consideration that the power outage duration is 4.5 hours. The projected annual energy cost savings is R43 807/year, which is 17% of the annual electricity bill. The project cost R226 005 including labour installations with a payback period of 5.18 years. The recommendation is considered to be a high costs/CAPEX because it has a payback period of more than 2 years.

7.2 Evaluation and Feasibility of the Opportunities

The environmental evaluation of the system is that the annual electricity generation of 17,046kWh and will save about 17.77 $CO_{2\ (equivalence)}$. This will add to the reduce expenditure on electricity. Figure 7 below shows the financial projections of how the system can be beneficial to the site. In a 10 years period the potential energy costs to the municipality will be R5 494 329. This is because of the forever increasing electricity prices from the services provider, with the installation of a solar system, the factory can save about R934 036.

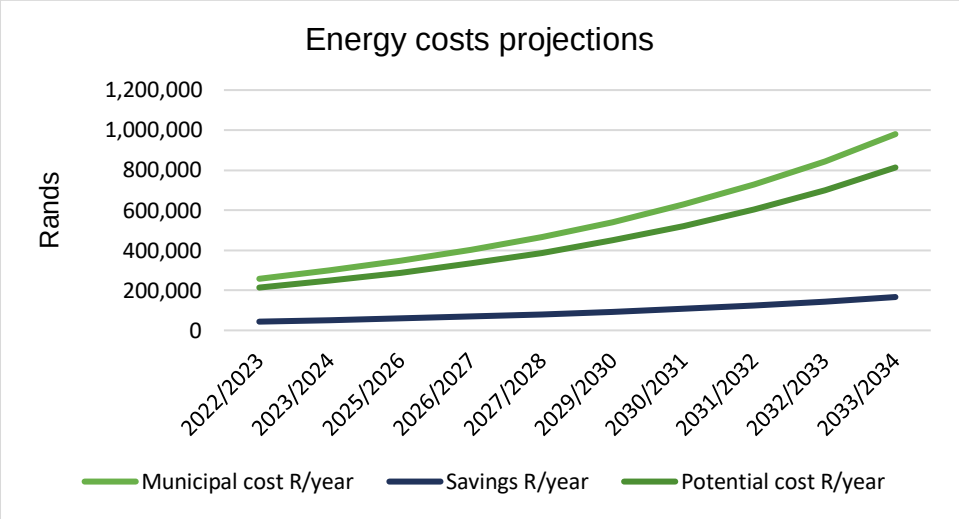

Figure 7: Projected financial performance of the system

8. IMPLEMENTATION PLAN

The following steps should be included in developing an implementations plan, the project timeline should be re-examined after execution of every step and amend the timeline should there be a need.

Implementation steps	Notes	Timeline
Project planning	Plan to take into account operational schedule, material lead times, permitting and utility inter connection requirements	1-2 weeks
Securing permits	Securing permits takes the longest lead time.	1 month

Schedule review	Schedule should be reviewed with operations staff and Solar system installers.	1-2 weeks
Installation	Installation of solar Pv system	2-4 weeks
Municipality/Engineer sign off	Solar Pv System to be reviewed and signed off	2-4 weeks
On – going performance monitoring	Performance should be monitored against forecast	On – going, post installation

9. CONCLUSION(S)

The site can be able to capitalise on an alternate source of energy in relation to their challenges. Over a period of 10 years the factory will realise a considerable amount of energy savings. 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.

10. APPENDICES

Appendix 1: Solar sizing iterations

Climate information			
Annual electricity demand (kwh)	100,268	kwh	
Energy costs	257,690		
Daily load (kwh) (261 working day)	384	kwh/day	
Essential load (25% capacity)	96	kwh/day	
Specific yield based on PV GIS	1,677	kWh/kWp/year	
	4.60	kWh/kWp/day	
Maximum Global irradiance (G(i))	2,260	W/m2	
PV generator			
PV Generator Size (CANADIAN SOLAR CS3W- 400P)	400	Wp	
Module outside Width	1048	mm	
Module outside Length	2,108	mm	
PV Generator Size - based on Consumption			
Generator size /PV capacity needed (in kWp)	59.77	kWp	
	10.16		
Number of modules based on generator size	25	modules	
Power sizing for invertor			
Ppv-DC	10.16	kWp	
Inverter 20% smaller than PV Generator	8.13	< inverter AC >	12.19

Suitable Inverter AC Output range	**24.83 kw to 37.24 kw**		
Canadian 3 phase Inverter 25kw 48V	**R38,949**	quantity =1	
-			
-			
Inverter Maximum input Voltage:	500	V	
Inverter MPP range:	125-425	V	
Inverter Start/Min voltage:	150	V	
Number of MPPTs:	4		
Max input Current per MPPT:	18 & 9	A	
Module Voc:			
Module Vmp			
Module Imp:			
Module temp coefficient for Voltage (αvoc):			
Battery Sizing			
Capacity =	Daily Energy Consumption * Autonomy/DoD * System voltage		
Customer's backup consumption 8 hrs.:			
Autonomy time	4.5	hrs.	
DoD (Depth of Discharge)	90%	for lithium	
System Voltage DC	48	V	
Battery Capacity	**20.0**	kwh	
	416.9	Ah	
Battery chosen: Pylontech Force Series - Force L1			
Battery Module 6			
Battery system capacity : 21.31 kWh			
No of Batteries in Battery Bank	1		
Cycles>	6,000		

Cost benefit analysis			
Current Energy consumption	100,268		
Energy costs	257,690		
Potential yield	17,046		
Energy cost savings	43,807		
CO2equivelance (tCO2/year) reduced	17.77		
Payback year	5.16		

Appendix 2: Annual energy trend for solar PV production

Pretoria irradiation (kWh/m^2/month)		% Irradiation/m^2/month	Solar generation kWh/60m^2/month
Jan	6,8	10%	2069
Feb	6	9%	1826
Mar	5,5	8%	1673
Apr	4,5	7%	1369
May	4,1	6%	1247
Jun	3,9	6%	1187
Jul	4,1	6%	1247
Aug	5	8%	1521
Sep	6	9%	1826
Oct	6,2	9%	1886
Nov	6,7	10%	2039
Dec	7	11%	2130
Total	65,8	100%	20020

11.

Appendix 3: Detailed financial projections of the system

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
2022/2023	100,268	17,046	83,223	2.57	257,690	43,807	213,883
2023/2024	100,268	17,046	83,223	2.98	298,920	50,816	248,104
2025/2026	100,268	17,046	83,223	3.46	346,748	58,947	287,801
2026/2027	100,268	17,046	83,223	4.01	402,227	68,379	333,849
2027/2028	100,268	17,046	83,223	4.65	466,584	79,319	387,264
2029/2030	100,268	17,046	83,223	5.40	541,237	92,010	449,227
2030/2031	100,268	17,046	83,223	6.26	627,835	106,732	521,103
2031/2032	100,268	17,046	83,223	7.26	728,289	123,809	604,479
2032/2033	100,268	17,046	83,223	8.43	844,815	143,619	701,196
2033/2034	100,268	17,046	83,223	9.77	979,985	166,597	813,388
Total	**1,002,685**	**170,456**	**832228**	**5.48**	**5,494,329**	**934,036**	**4,560,293**

12. LIST OF TABLES AND FIGURES