INDUSTRIAL EFFICIENCY IN SOUTH AFRICA

REPORT

Green Support Incentive Programme for Small Enterprise in Gauteng

Cohamet Engineering Pty Ltd

Solar PV system due diligence

08/06/2022

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Authors:	M Ramahudu	
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Issuing Organisation: National Cleaner Production Centre South Africa PO Box 395 0001 Pretoria RSA	Telephone: (Nat) (012) 841 3772 (Int) + 27 12 841 3772 Telefax: (Nat) (012) 841 5039 (Int) + 27 12 841 5039	
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I, **Molebatsi Ramahudu,** in my capacity as the technical consultant, hereby confirm that I have assessed, analysed, and compiled this solar feasibility study at **Cohamet Engineering Pty Ltd**. I confirm all the report findings and representative reflection of the current status of **Cohamet Engineering Pty Ltd.**

Executive summary

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 Cohamet Engineering 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 Cohamet Engineering 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 consumes an annual electricity capacity of 36 559kWh at R93 976 from the council, with no backup capacity for production. With priorities given to two main production lines, the site can install a 12kWp accompanied by a 15kWh storage. The system will generate 24 024kWh/year saving R61 755/year and 25tCO_{2e}.

Abbreviations

CO_{2e}	Carbon dioxide equivalents
CP	Cleaner Production
Deg. C	Degrees Celsius
FC	Fraction Capacity
HRS	Hours
IPA	In-Plant Assessment
Kj	Kilojoules
Kl	Kilolitres
R/W	Rands per Watt
GDED	Gauteng Department of Economic Development
GHG	Greenhouse Gas
MWh	MegaWatt Hour
PV	Photovoltaic
MW	MegaWatt
LPM	Litres per minute
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
TE	Transfer efficiency
W	Watts

Contents

List of Figures

List of tables

List of appendices

1. Introduction

Cohamet Engineering as part of SMME has been facing challenges of business disruptions (Covid-19 business recovery and load shedding) which in retrospect affect business performance and thereof its contribution to Gauteng's economic stability. Founded in 1972, with a level 1 BBB-EE (51% black woman owned), and an International Organization for Standardization (ISO) 9001:2015 accredited. The core business is quality precision machining (nylon, rubber, stainless steel, steels, aluminium, bronze, brass, and copper) for the manufacturing sector. Cohamet Engineering provide training and business support for architects, shop fitters, construction engineers, the mining sector, and security industry in Southern Africa and internationally.

The site has an 8am to 5pm 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.

Using data analysis, consulting literature, and online resources, Gauteng has a capacity of 216-232 Watts/Square Metre (W/m^2) per annum on average as compared to low irradiation of 50-150W/m^2 of the European landscape. This gives Gauteng an advantage of having potential solar out puts of about a minimum of 3.9kWh/m^2 (winter) and a maximum of 7kWh/m^2 [1].

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 initiative was made possible by Gauteng Province's green incentive to Small, Medium, and Micro Enterprise (SMME) upliftment to support business success with the hope promoting employment retention and economic growth within the SMME in corporation with the NCPC and DTI.

[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.

2. 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. The Boundary of the project is Cohamet Engineering Pty Ltd (No.4 Robert Road, Robertville, Roodepoort, 1709, Gauteng, South Africa) and the scope is to conduct a solar PV feasibility study as methodology is shown by Figure 1.

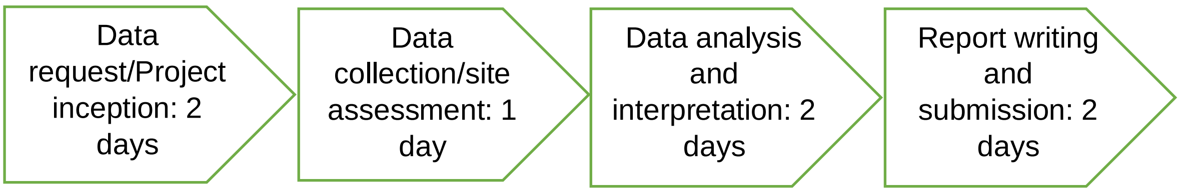


Figure 1: Overview of the project methodology

2.1. Quantitative data

2.1.1. Requested data:

The data is comprised of the 12 months energy bills from May 2021 to April 2022 (Appendix 1), in analysing the data, a chart is used to present the energy demand versus the costs pattern for a 12 month period.

2.1.2. Onsite data collection:

During the site visit relevant data was collected and analysed using Microsoft's Excel (Appendices).

2.1.3. Data analysis and interpretation:

In addition to the requested and collected data, online resources and literature was used to support common knowledge and help modify feasibility measures conducted.

2.2. Qualitative data

2.2.1. Site assessment:

During the site assessment, the site and production manager explained the business and production operations with regards to the past, current, future plans. From the discussion relevant data with regards to the scope of the project was elicited in order to help the quantitative feasibility measures.

2.3. Reference energy resource landmark

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 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.

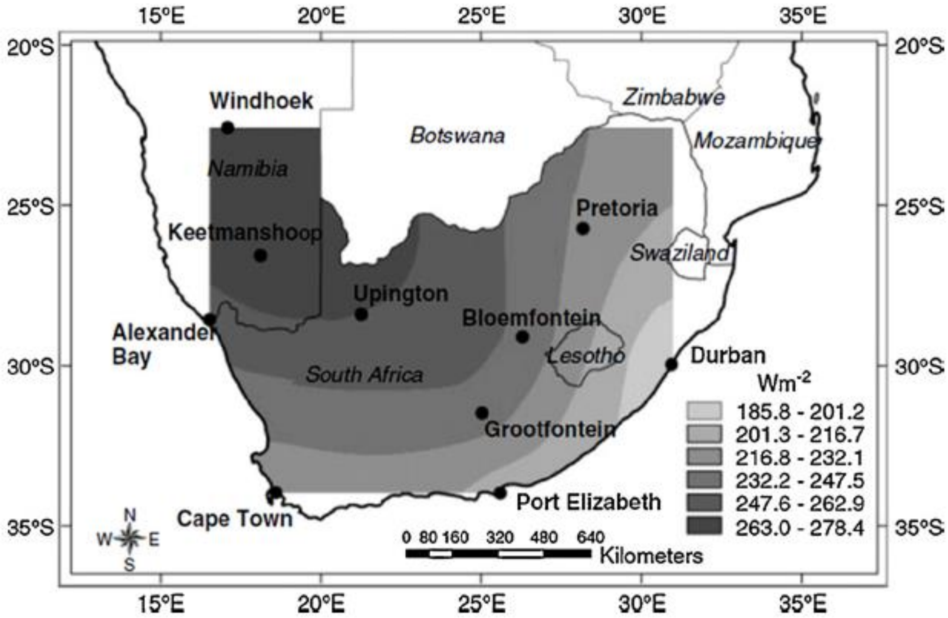


Figure 2: South Africa's solar irradiation capacity per region[2]

[2] 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.

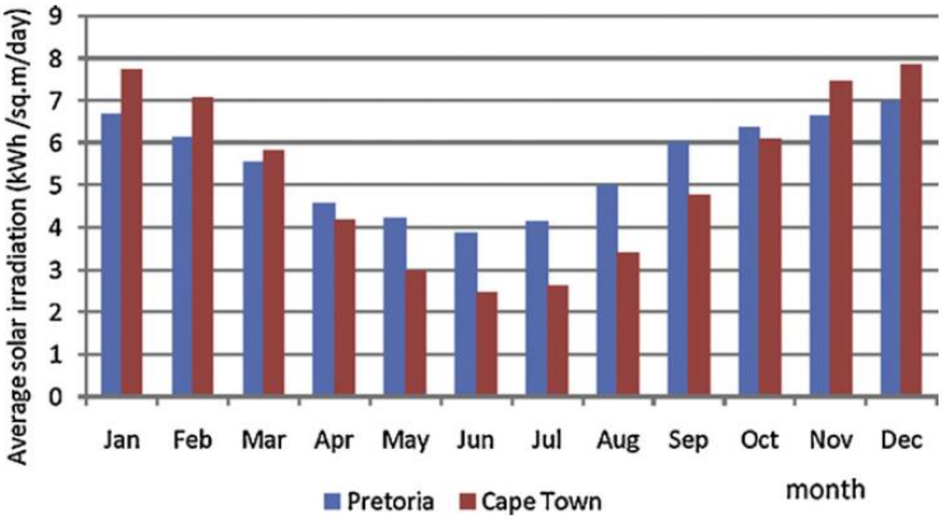


Figure 3: Average monthly solar irradiation in the north and south of South Africa[3]

3. In plant assessment

During the site walk, a better understanding of the business needs were elicited from the process and business discussions with the site personnel. Beginning with the ready highlighted challenges (Covid-19 business recovery, frequent load shedding, and increasing electricity costs), the site has decided that they foresee a need to have a supplementary alternate energy source which will relief both the cost of electricity and support the load shedding gaps.

It was highlighted by the assessors that the green fund project has a budget of R220 000. From this the site personnel emphasised the importance of giving priority to the two main production line which has a business capacity of 67kWh/day (64% of the daily baseline consumption of 106kWh from council).

3.1. Site energy trend

The site has a capacity of 36 559kWh/year as per business requirements at a cost of R94 547, noting that all their energy needs are supplied by the council (

Table *1*).

[3] 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.

Table 1: Monthly energy consumption in relation to the cost

Months	kWh	ZAR
May-21	2349	5411
Jun-21	4177	10373
Jul-21	4690	12869
Aug-21	3279	8956
Sep-21	2915	7764
Oct-21	3322	8535
Nov-21	2373	6096
Dec-21	2239	5670
Jan-22	2205	5558
Feb-22	2653	6865
Mar-22	3231	8359
Apr-22	3127	8089
Average	3047	7879
Total	36559	94547

Although there monthly average is about 3 000 kWh, it is to be noted that during the December/January months, business closes for the festive holidays (from the 10th to the 10th respectively. Meaning that during this time the 2 239 kWh is driven by demand and inventory management as 10 days on a normal month does not amount to approximately 2 000kWh. To emphasize the claims of paying for it is being used Figure 4 shows a trend of kWh and cost per month.

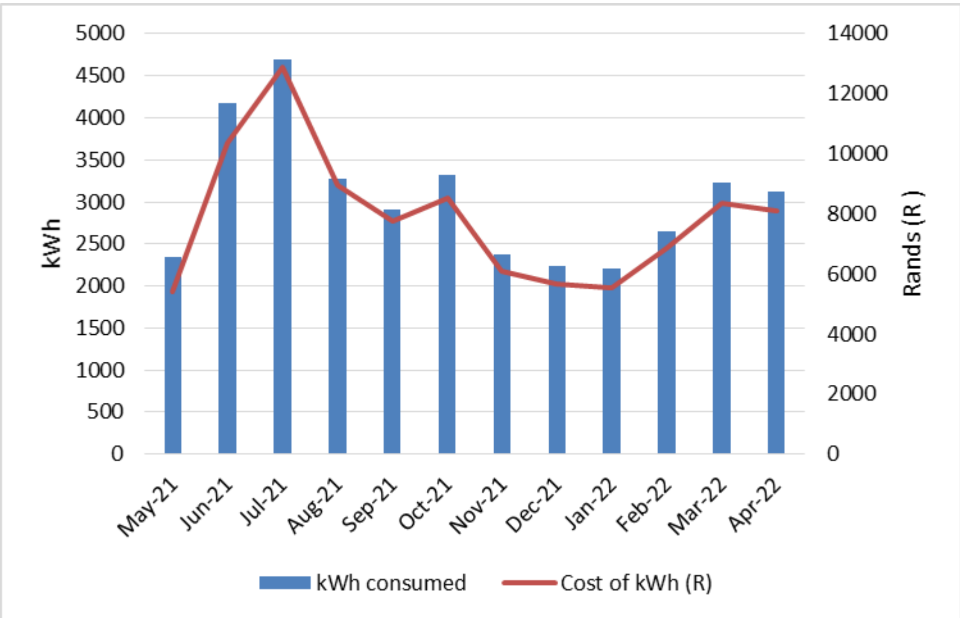


Figure 4: Energy consumption per costs per month

Figure 4 pattern is aligned perfectly, meaning that the site pays for what they use (at a rate an inconsistence rate ranging from R2.30-2.74/kWh). In correlation with the solar PV most of it will be directly used by the site, except for the festive holidays and also provided that there is no production demand from customers. Even though the supplementary energy source is to improve business operations it will by all means be of good to the capacity of business that Cohamet Engineering can accommodate.

3.2. Solar PV measures

This section outlines the sizing of the solar PV system along with related cost measures that determines the financial feasibility (Table 2) of the system.

The overview of the trend between the council kWh and the solar PV generation (Figure 5) highlight that even though the council consumption fluctuates unpredictably the solar PV generation has a belly profile with reference to Figure 3. 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 (Appendix 3).

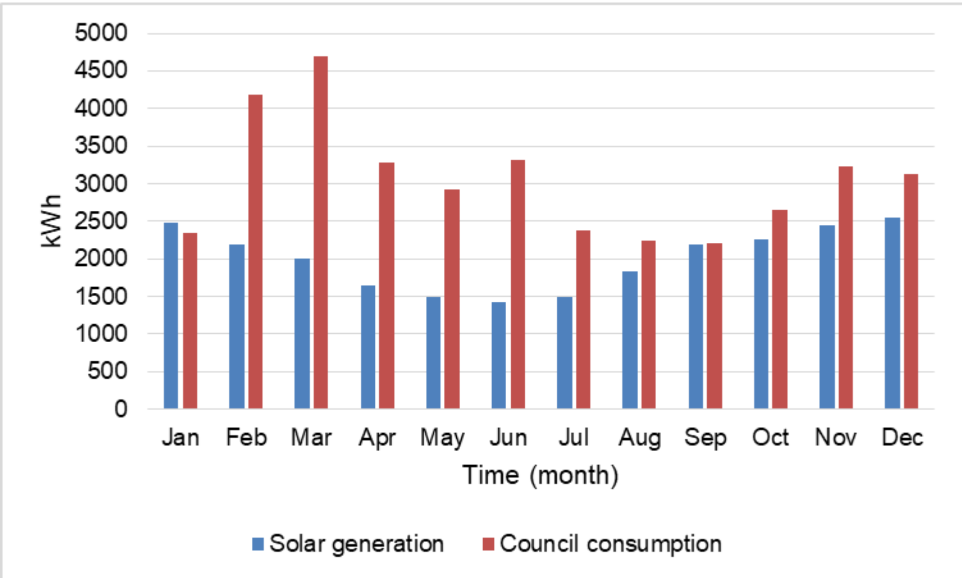


Figure 5: Energy profile between the municipal consumption and solar PV production

In retrospect the scope of the project was to do a solar PV system feasibility measures. This means that the type of solar panels, inverters, and batteries will only be measured within the sizing of the system. While the actual types can either be recommended as part of this assessment or Cohamet Engineering can decided on which installer to contact and thereof the types that may be of their preference.

3.2.1. Solar sizing

Table 2: Solar PV system sizing and cost measures

Solar Power system (kWh/day)	66
Solar panels area (m^2)	61
Baseline kWh/year consumption	36 559
Priority baseline kWh/year consumption	24 024
Potential kWh/year consumption	12 535
Number of panels (435W/panel)	28
System production (kWh/annum)	24 024
System production (kWh/day)	66
Day (kWh) demand	106
Night (kWh) demand	0
Number of batteries (3,5kWh/battery)	4
Battery (kWh/day)/Storage	15
Cost of kWh (R/kWh)	2,57
Baseline kWh/year cost (ZAR)	93 976
Potential kWh/year cost (ZAR)	32 222
Capital cost	209 678
Savings (kWh/year)	24 024
Savings (ZAR/year)	61 755
kWh % Reduced	66%
CO2equivelance (tCO2/year) reduced	25
Payback year	3,40

The daily average kWh demand of Cohamet engineering is about 106 therefore having a system that can atleast cover 50% of the demand would mean a good business sense since the basic challenges (load shedding and increasing council electricity prices) would be covered. For this system (Table 2), a capacity of 12 kW at a 66 kWh/day and a 15 kWh storage was estimated to be fit for covering the load shedding challenge.

The payback period of 3 years 4 months seems to be of a good financial investment project noting that the system will annually generate 24 024 kWh/year in comparison to the council consumption of 36 559 kWh/year. The generated kWh will reduce 66% of the council demand and save about R61 775/year accompanied by 25tCO_2e.

The isolated system (Appendix 2) will cost about:
R63 034 for 28 (2.108 by 1.048m, 435W, R2 285) panels,
R23 256 for 3 (48Volts, 5kW, R9 690) inverters,
R75 000 for 4 (3.5kWh, 48Volts, R18 099) batteries,
R62 903 for contingencies, peripherals, and system installation,
R209 678 for total estimated cost

3.2.2. Financial projection of the good years of the system

Noting that at the theoretically solar PV systems operate for ±20 year with a linear degradation of about 0.7%/year, by the time the system's performance becomes infeasible to operate the site would have saved a significant amount of money as compared to what otherwise could have been (Figure 6).

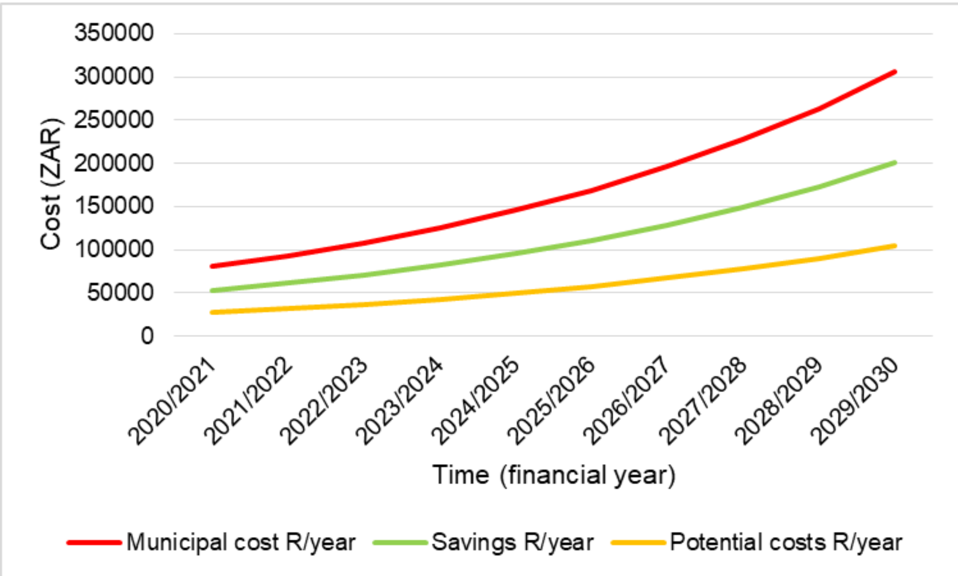


Figure 6: Projected financial performance of the system

Figure 6 shows the financial projections of how the system can be beneficial to the site as compared to their normal dealings with the council. In a 10 years period the site can save about R1 126 899 instead of paying R1 714 879 the potential costs to the municipality will be R587 979 (

Appendix 3: Annual energy trend between council kWh consumption and solar PV production

Pretoria irradiation ($kWh/m^2/month$)		% Irradiation/m^2/month	Solar generation $kWh/60m^2/month$	Municipa Consum
Jan	6,8	10%	2483	
Feb	6	9%	2191	
Mar	5,5	8%	2008	
Apr	4,5	7%	1643	
May	4,1	6%	1497	
Jun	3,9	6%	1424	
Jul	4,1	6%	1497	
Aug	5	8%	1826	
Sep	6	9%	2191	
Oct	6,2	9%	2264	
Nov	6,7	10%	2446	
Dec	7	11%	2556	
Total	65,8	100%	24024	

Appendix *4*). This happens because of the forever increasing electricity prices from the services provider, 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% (Appendix 5).

4. Conclusion

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 Guateng 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.

Appendices

Appendix 1: Consolidated monthly energy consumption

As is on the bill (avoiding as estimates as possible)						Calculated				
Type of data	From	To	Number of days	kWh	ZAR	kWh/day	R/kWh	Months	kWh	ZAR
Actual	2021/05/01	2021/05/31	31	2427	5592	78	2,30	May-21	2349	5411
Actual	2021/06/01	2021/06/30	30	4321	10731	144	2,48	Jun-21	4177	10373
Actual	2021/07/01	2021/07/31	31	4690	12869	151	2,74	Jul-21	4690	12869
Estimated	2021/08/01	2021/08/01	1	139	380	139	2,73	Aug-21	3279	8956
Estimated	2021/08/02	2021/09/07	37	3872	10312	105	2,66	Sep-21	2915	7764
Estimated	2021/09/08	2021/10/07	30	2847	7316	95	2,57	Oct-21	3322	8535
Estimated	2021/10/08	2021/11/05	29	2752	7072	95	2,57	Nov-21	2373	6096
Estimated	2021/11/06	2021/12/07	32	2430	6153	76	2,53	Dec-21	2239	5670
Estimated	2021/12/08	2022/01/07	31	2205	5558	71	2,52	Jan-22	2205	5558
Actual	2022/02/08	2022/05/09	91	9484	24537	104	2,59	Feb-22	2653	6865
								Mar-22	3231	8359
								Apr-22	3127	8089
Monthly average				3517	9052	106	2,57	Average	3047	7879
Total			343	35167	90520			Total	36559	94547

Appendix 2: Solar sizing iterations

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
12000	5,5	66		3,5	24024		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**						
Large System (20 000W)							
46	Panels		4	Inverters (kW)			Batteries
105057	Cost (ZAR)		38760	Cost (ZAR)		0	Cost (ZAR)
Medium System (15 000W)							
34	Panels		3	Inverters (kW)			Batteries
78793	Cost (ZAR)		29070	Cost (ZAR)		0	Cost (ZAR)
Small System (12 000W)							

28	Panels	2,4	Inverters (kW)	4	Batteries
63034	Cost (ZAR)	23256	Cost (ZAR)	75000	Cost (ZAR)

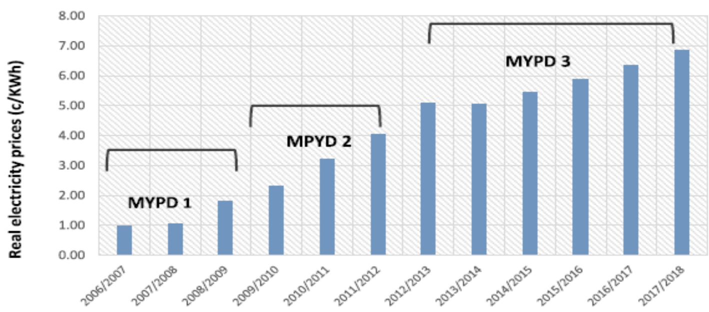
Pretoria irradiation (kWh/m^2/month)		% Irradiation/m^2/month	Solar generation kWh/60m^2/month	Municipal kWh/month Consumption
Jan	6,8	10%	2483	2349
Feb	6	9%	2191	4177
Mar	5,5	8%	2008	4690
Apr	4,5	7%	1643	3279
May	4,1	6%	1497	2915
Jun	3,9	6%	1424	3322
Jul	4,1	6%	1497	2373
Aug	5	8%	1826	2239
Sep	6	9%	2191	2205
Oct	6,2	9%	2264	2653
Nov	6,7	10%	2446	3231
Dec	7	11%	2556	3127
Total	65,8	100%	24024	36559

Appendix 3: Annual energy trend between council kWh consumption and solar PV production

Appendix 4: Detailed financial projections of the system

	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	36559	24024	12535	2,20	80430	52853	27577
2021/2022	36559	24024	12535	2,55	93298	61309	31989
2022/2023	36559	24024	12535	2,96	108226	71119	37107
2023/2024	36559	24024	12535	3,43	125542	82498	43045
2024/2025	36559	24024	12535	3,98	145629	95697	49932
2025/2026	36559	24024	12535	4,62	168930	111009	57921
2026/2027	36559	24024	12535	5,36	195959	128770	67188
2027/2028	36559	24024	12535	6,22	227312	149374	77938
2028/2029	36559	24024	12535	7,21	263682	173273	90408
2029/2030	36559	24024	12535	8,37	305871	200997	104874
Total	365589	240240	125349	4,69	1714879	1126899	587979

Appendix 5: Eskom's energy price increase [4]



[4] Ting, M.B., Byrne, R. 2020. Eskom and the rise of renewables: Regime-resistance, crisis and the strategy of incumbency in South Africa's electricity system. Energy Research & Social Science 60. pp 1-15.