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REPORT

Gauteng Department of Economic Development (GDED) SME Green Support Incentive Program Technical Report For At The Rocks Country Estate

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Department:
Trade, Industry and Competition
REPUBLIC OF SOUTH AFRICA

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TECHNICAL REPORT

Prepared for: **At The Rocks Country Estates**
No 42, R104 Bronkhorstspruit Rd
Rietfontein Farm, Rayton
Gauteng Province, South Africa
S25.46'59.8; E28.30'021

Prepared by: National Cleaner Production Centre South Africa
P O Box 395
Pretoria
0001

ACKNOWLEDGEMENTS

This report was prepared on behalf of the National Cleaner Production Centre South Africa by Ariel Energy Solutions, and the NCPC-SA wishes to acknowledge the work undertaken by Farai Mambwere.

I, **Farai Mambwere,** in my capacity as the technical consultant, hereby confirm that I have assessed **At The Rocks Country Estate** and have analysed and compiled this **Baseline & Solar PV Feasibility study**. I confirm that all the report findings and representative reflection of the current status of **At The Rocks Country Estate.**

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Company	**Contact Person**	**Copy Number**
At The Rocks Country Estate	Mrs Lulama Letlape	1

1. EXECUTIVE SUMMARY

State what this report serves as; state the name of the company or plant that is covered in this report. State the main objectives covered in this report. 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.

At The Rocks Country Estate was established in 2016. It is located on a 12.8ha farm, on Plot No 42, R104 Bronkhorstspruit Rd, Rietfontein Farm, Rayton (S25.46'59.8; E28.30'021), in the Gauteng Province of South Africa. At The Rocks, is a 3-star Country Estate which provides accommodation, functions such as weddings, team building activities and corporate business meetings. The facility offers accommodation with 7 en- suites and one (1) family room. All rooms are luxurious and selected suites also have ventilation fans. The facility employs 5 permanent, and 5 ot 6 casual staff depending on the functions taking place.

Electricity is supplied by Eskom Holdings, under the Landrate 3 tariff structure, designed for rural / farm holdings. Annual Electricity consumption is 41,188kWh per annum amounting to R 11,923.72 per annum. Since there are estimates, this figure was adjusted to 51,079kWh/y.
Calculations and Google Earth were used to simulate the number of solar panels that can be installed on the rooftop and the potential solar energy that can be harvested. The Gauteng Global annual radiation is 2 042.98kWh/m^2/year. The facility can install 36kWp solar panels with a 2 x 10.8kWh battery storage. The system should potentially supply the energy requirements of the facility. In addition, alternative solar water heating and lighting was also recommended.

Table 1: Summary of potential solar energy savings and cost

No.	Savings Opportunities	Estimated Savings per Annum			% Saved of Total kWh/kL	Investment Cost (Rand) (Excl VAT)	Average Cost of Hardware (Rand)	No of Units	Simple Payback Period (Years)
		kWh/kL	Rand	Kg CO_2					
1	Install solar LED lighting	12,045.00	8,179.83	12.56	16%	28,500	2,850	10	3.5
2	Retrofit the existing electric geysers with solar water heaters	7,843.17	18,054.20	8.18	15%	118,000	14,500	8	6.5
	Subtotal	**19,888.17**	**26,234.03**	**20.73**	31%	**146,500**			

Facility	Capacity (kWp)	Energy Yield (kWh)	No of Modules	Energy Revenue	Capital Cost	TCO_2	Payback
Solar PV	36	51,079	80	R117,580	R767,340.86	53.3	6.53

Table 2: Summary of recommendations. Solar PV Geyser & Lighting

There is also possibility to install solar PV systems in phases, e.g., a 10kWp system this financial year at a cost of R230,000. Additional systems can be added with time. This option is in **Annexure 01**: Alternative 10kW Solar PV System

Two (2) submeters for internal energy use account are also recommended. Each one costs about R3,500.

2. 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

3. INTRODUCTION

This Project Report 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.

This project is an initiative of the Gauteng Provincial government to aid in the economic recovery of businesses still reeling from the devastating impact of Covid-19, which was followed by the July 2021 civil unrest leading to further economic damage in the province.

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 instal 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 Unconventional Waste Solution.

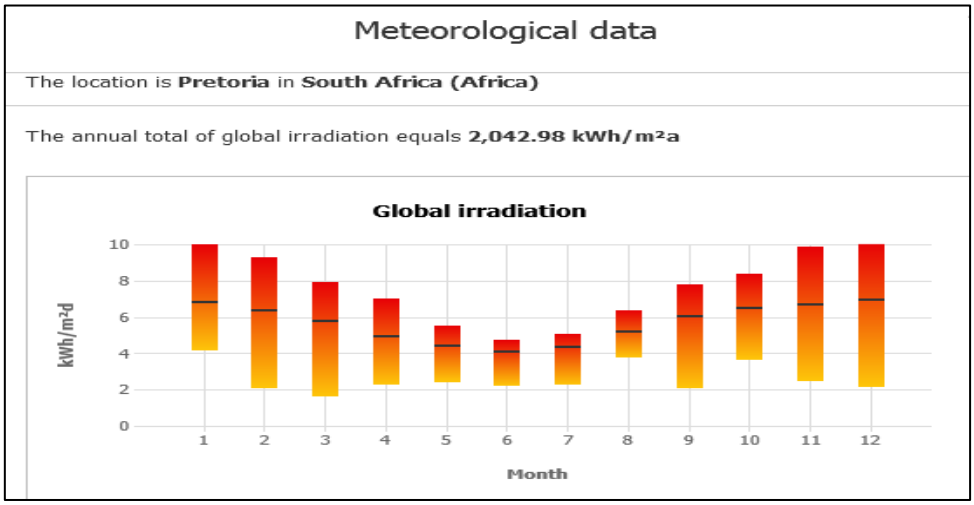
The programme aims to provide financial support for renewable energy implementation in small and medium scale enterprises (SMEs) affected by the economic downturn. The proposed interventions are evaluated for feasibility in terms of estimated investment costs and project financial metrics are applied to evaluate project feasibility.

"The Southern African region, and the whole of Africa, has sunshine all year round. The annual 24-hour global solar radiation average is about 220 W/m2 for South Africa, compared with about 150 W/m2 for parts of the USA and about 100 W/m2 for Europe and the United Kingdom. This makes South Africa's local resource one of the highest in the world. Most areas in South Africa average more than 2 500 hours of sunshine per year, and average solar-radiation levels range between 4.5 and 6.5kWh/m2 in one day", www.energy.gov.za.

4. SITE SOLAR ENERGY RESOURCES

The Gauteng Global Irradiation will be used to determine the annual energy yields. SMA Sunny Design website estimates Pretoria's global annual irradiation at **2 046.98kWh/m²year.** The daily global irradiation for each month of the year is reflected in figure 1 below

Figure 1: Global radiation data (Gauteng)



The global irradiation data for Gauteng is shown above. The months with the lowest Irradiation data are June and July and the highest are November, December and January.

4.1 Project Methodology

Table 3: Project methodology

Step	Action Plan	Purpose and results
1	Plan and organise (walk through audit and informal Interview)	Resource planning, Organise instruments and time frame, data collection, Familiarisation of process and plant activities
2	Conduct brief meetings with stakeholders	Building up cooperation, awareness creation and issuing a questionnaire
3	Primary data gathering, a Process flow diagram	Historical data analysis and baseline data collection.
4	Conduct detailed trials for different solar panels, inverters and batteries	Trials on new products available on the market
5	Identification and development of potential value addition products	Conceive, develop, and refine ideas. Review previously suggested ideas and contact vendors for new/efficient technologies.
6	Cost-benefit Analysis	Assess technical feasibility, economic feasibility and prioritisation of the most promising projects. Prioritise short, medium and long-term measures.
7	Reporting and Presentation to top management	Documentation and report presentation to top management
8	Implementation and follow-up	Assist and implement recommendation

4.2 Design criteria

The design concept to be used here is a hybrid solar PV system. It is important to note that during load shedding, when the grid is not available, the hybrid connected PV system will be available to supply the premises until the batteries power stored is 20-40%.

Considering the above points, a distributed design approach was adopted as it offers more benefits from a security point of view (i.e., backup configuration). It also takes advantage of the electrical infrastructure already available, i.e. low voltage electrical panels.

5. CONTACT DETAILS

Table 4: Company information

Company name	At The Rocks Country Estate
Address	No 42, R104 Bronkhorstspruit Rd, Rietfontein Farm, Rayton (S25.46'59.8; E28.30'021)
Phone, Fax	082 881 5554
e-mail	info@attherocks.co.za
Website	www.attherocks.co.za
Trading since (year)	2016
No. of Employees	Five (5). 2 housekeepers, 2 maintenance & 1 manager. In addition, 5 to 6 casuals, depending on the event.
Contact person:	
Name	Mrs Lulama Letlape
Position	Owner / Manager
Phone & mobile numbers	+27 82 881 5554

6. PRODUCTION PROCESSES

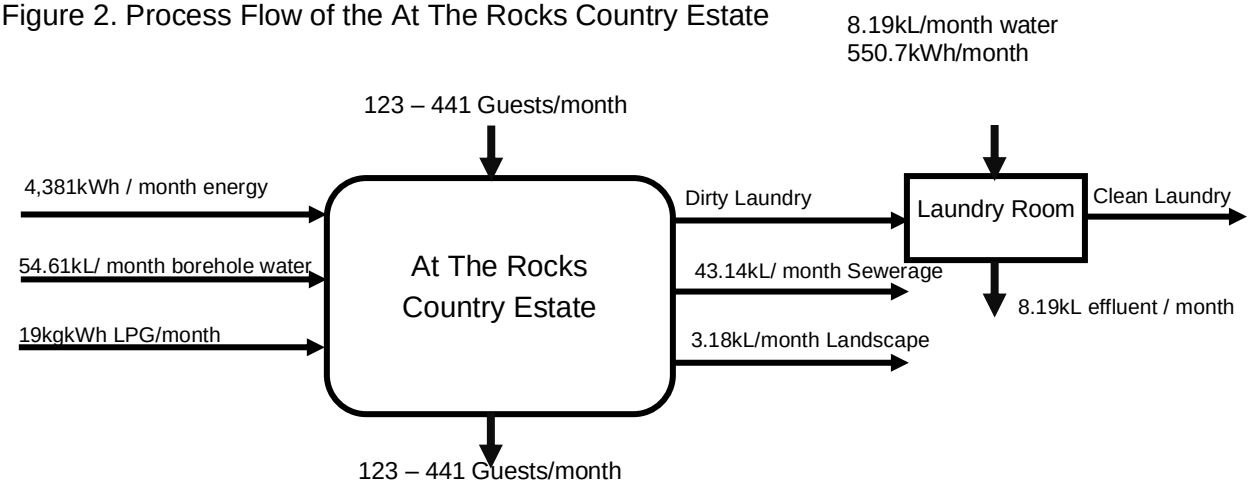
6.1 Process Description

At The Rocks, is a 3-star Country Estate which provides accommodation, functions such as weddings, team building activities and corporate business meetings. The facility offers accommodation with 7 en- suites and one (1) family room. All rooms are luxurious and selected suites also have ventilation fans. The facility employs 5 permanent, and 5 or 6 casual staff depending on the functions taking place.

6.2 Process Flow Chart

The average monthly guests for April 2021 to March 2022 were 232. The theoretical maximum number of guests which can be accommodated per month is about 744. The average electrical energy usage was 4,381kWh per month. Water consumption is not measured., but the estimated average monthly usage figures are 54.61kL. Estimating water usage figures was based on the average monthly water consumption of 235L/day/person. The average figures for water consumption for South Africa varies from 183.89L per person per day[1] to 235L per person per day. The figure of 235L was used.

Figure 2. Process Flow of the At The Rocks Country Estate



Note: The exact distribution of energy and water usage is not easy to measure. The consultant used results from existing information researched by other organisations. The 2 organisations referenced here are the Water Research Commission[2] of South African, EDC Tanks[3], a water harvesting and

[1] https://www.greencape.co.za/assets/Uploads/WATER-MIR-2019-WEB-01-04-2019.pdf

https://www.news24.com/Analysis/do-south-africans-each-guzzle-235-litres-of-water-per-day-20180412
https://albertonrecord.co.za/174599/water-wednesday-much-water-average-south-african-consume/

[2] https://www.wrc.org.za/wp-content/uploads/mdocs/TT%20606%20web.pdf

[3] https://edctanks.co.za/household-water-usage.html

recycling company and Green Cape, an organisation based in the Western Cape and which does practical research and work on energy, water and environmental issues.

7. CURRENT ENERGY CONSUMPTION DATA

7.1 Summary of -pre-implementation metering equipment used

Historical energy usage covers a minimum period of 12 months. Since it is not possible to measure energy usage retrospectively, the energy data was based on the Eskom meter readings as reflected on the energy bills. This covered a period of 12 months from April 2021 to March 2022.

7.1.1 Metering period

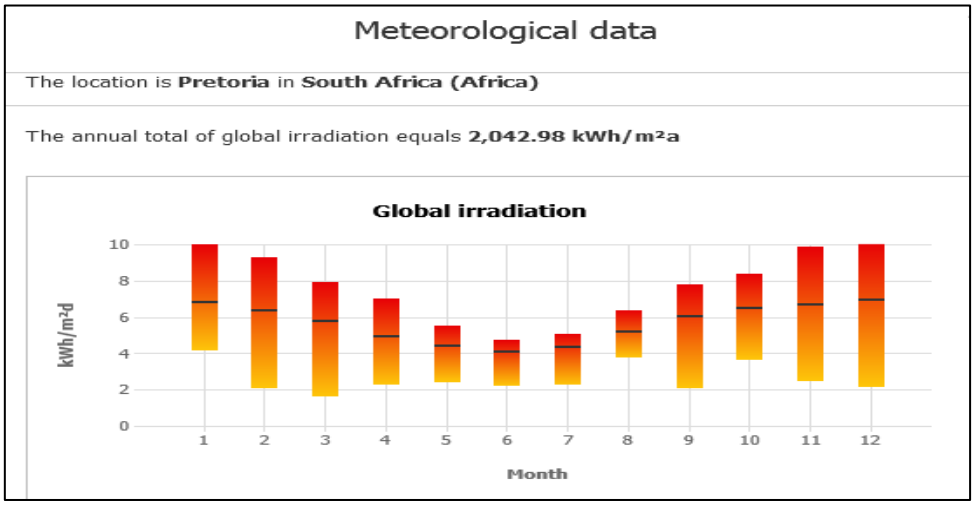
The other data needed for calculations was the solar radiation data. This is information is based on previous studies already done.

"The Southern African region, and the whole of Africa, has sunshine all year round. The annual 24-hour global solar radiation average is about 220 W/m2 for South Africa, compared with about 150 W/m2 for parts of the USA and about 100 W/m2 for Europe and the United Kingdom. This makes South Africa's local resource one of the highest in the world. Most areas in South Africa average more than 2 500 hours of sunshine per year, and average solar-radiation levels range between 4.5 and 6.5kWh/m2 in one day", www.energy.gov.za.

7.1.2 Site Solar Energy Resources

The Gauteng Global Irradiation will be used to determine the annual energy yields. SMA Sunny Design website estimates Pretoria's global annual irradiation at **2 046.98kWh/m²year.** The daily global irradiation for each month of the year is reflected in figure 1 below

Figure 3: Global radiation data (Gauteng)



The global irradiation data for Gauteng is shown above. The months with the lowest Irradiation data are June and July and the highest are November, December and January.

7.1.3 Baseline Data (Electricity)

Historical energy usage covers a minimum period of 12 months. Since it is not possible to measure energy usage retrospectively, the energy data was based on the Eskom meter readings as reflected on the energy bills. This covered a period of 12 months from April 2021 to March 2022.

7.1.4 Define the boundaries

The boundaries for the baseline being developed was from grid-supplied electrical energy only. Additional energy in the form of wood (biomass) and liquified petroleum products (LPG) is also used but is not accurately measured. In addition, the fuel used for business related work was also not available. Wood is collected from the farm, and it is not measured. LPG is purchased in 19kg cylinders. The usage is estimated at 1 cylinder per month. These unknow and estimated figures cannot be used to establish a reliable baseline consumption.

7.1.5 Define the baseline period

The baseline period is based on the availability and reliability of the data gathered or available. For electricity and occupancy figures, this covered a period of 12 months from April 2021 to March 2022.The only challenge is that on 4 out of the 12 months are actual readings, the other 8 months are estimates. Baselines using regression analysis method cannot be used on estimated data.

7.1.6 Define the relevant variables

The variables which impact on energy usage at the Country Estate are occupancy and weather. Weather is defined in heating degree days (HDD) and cooling degree days (CDD).

A heating degree day (HDD) is a measurement designed to quantify the demand for energy needed to heat a building. It is the number of degrees that a day's average temperature is below 18^{o} Celsius, which is the temperature below which buildings need to be heated. A similar measurement, cooling degree day (CDD), reflects the amount of energy used to cool a home or business.

The HDD and CDD are measurable values are derived from Weather Bureaus. This information is fed into this website, www.degreedays.net. The HDD and CDD values are downloaded using the nearest reliable weather station to At The Rocks Country Estate. The variations are primarily due to the seasonal variations in temperature.

7.2 Baseline Methodology

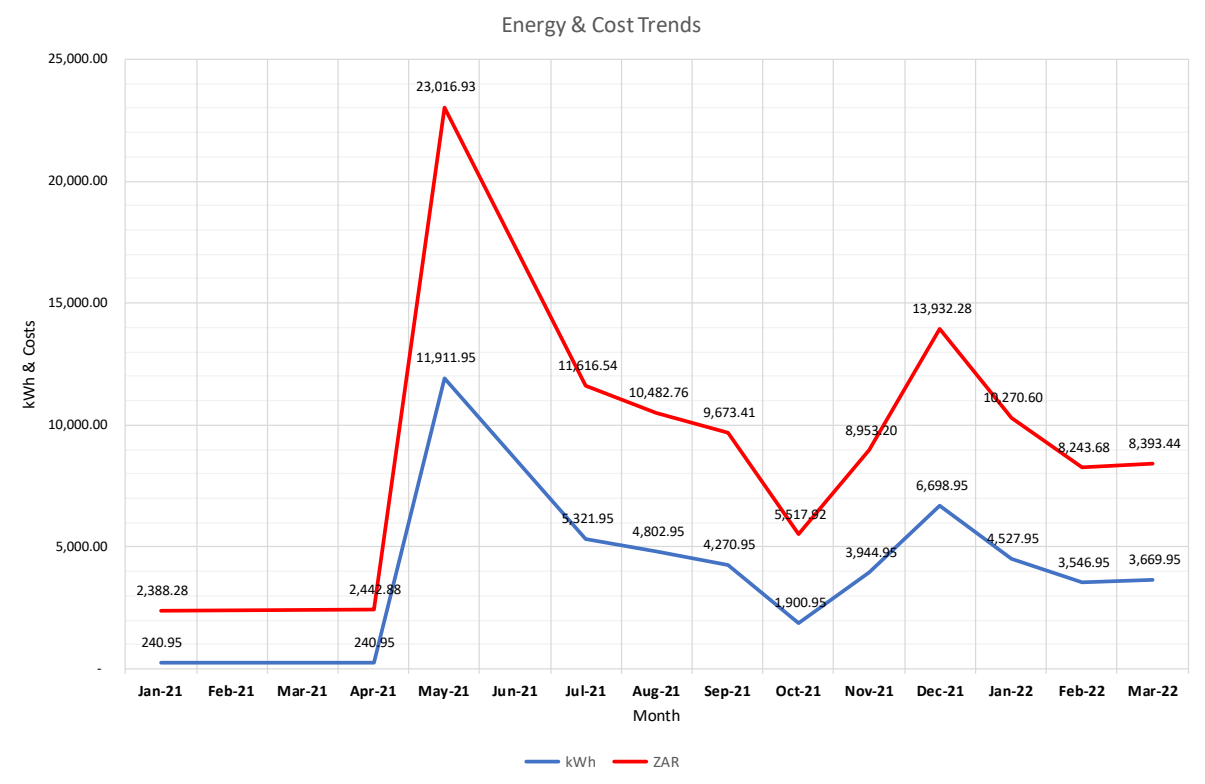
7.2.1 Energy Consumption & Costs

The At The Rocks Country Estate, energy consumption was 48,188kWh from April 2021 to March 2022. LPG usage was estimated at 1 x 19kg cylinder per month for the owner's house. Firewood, which is collected free from the farm is also used, unfortunately the quantities used could not be determined.

Table 5: Energy Consumption and Costs Trends

Energy	Meter No 3125070015088. TARIFF NAME: Landrate 1,2,3					Occupancy (Bed-Nights)			Weather	
	kWh	kg	kWh (Equiv)	kWh	ZAR	Max	%	Actual	CDD	HDD
Apr-21		19.00	240.95	240.95	2,442.88	720	31%	221	73	48
May-21	11,671	19.00	240.95	11,911.95	23,016.93	744	32%	237	24	122
Jun-21	-	19.00	240.95	240.95	2,388.28	720	22%	156	12	177
Jul-21	5,081	19.00	240.95	5,321.95	11,616.54	744	17%	123	7	226
Aug-21	4,562	19.00	240.95	4,802.95	10,482.76	744	33%	249	32	129
Sep-21	4,030	19.00	240.95	4,270.95	9,673.41	720	30%	216	84	53
Oct-21	1,660	19.00	240.95	1,900.95	5,517.92	744	33%	249	72	52
Nov-21	3,704	19.00	240.95	3,944.95	8,953.20	720	32%	228	108	28
Dec-21	6,458	19.00	240.95	6,698.95	13,932.28	744	59%	441	79	25
Feb-22	3,306	19.00	240.95	3,546.95	8,243.68	744	27%	198	100	5
Jan-22	4,287	19.00	240.95	4,527.95	10,270.60	672	30%	201	108	11
Mar-22	3,429	19.00	240.95	3,669.95	8,393.44	744	36%	270	94	19
Total	**48,188**	**228.00**	**2,891.40**	**51,079.40**	**114,931.92**	**8,760**		**2,789**		
Ave	**4,381**			**4,256.62**	**9,577.66**	**730**	**32%**	**232**		

Figure 4 Energy Consumption Profile



The figure above shows the energy consumption trend. Energy consumption is highest in winter months. This is understandable and heating is needed the electric geysers. This is also a motivation to further upgrade or retrofit them with solar water heaters.

The energy drivers for the facility are occupancy and weather (cold degree days, CDD and heating degree days, HDD). These are all used in the model.

7.2.2 Energy Usage & Consumption

Table 6: Historical energy usage

Meter No 3125070015088. TARIFF NAME: Landrate 1,2,3					Occupancy (Bed-Nights)		Weather	
Month	Electricity kWh	LPG kWh (Equiv.)	Total kWh	Total Cost ZAR	%	Actual	CDD	HDD
Apr-21		240.95	240.95	2,442.88	31 %	221	73	32
May-21	11,671	240.95	11,911.95	23,016.93	32 %	237	24	48
Jun-21	-	240.95	240.95	2,388.28	22 %	156	12	122
Jul-21	5,081	240.95	5,321.95	11,616.54	17 %	123	7	177
Aug-21	4,562	240.95	4,802.95	10,482.76	33 %	249	32	226
Sep-21	4,030	240.95	4,270.95	9,673.41	30 %	216	84	129
Oct-21	1,660	240.95	1,900.95	5,517.92	33 %	249	72	53
Nov-21	3,704	240.95	3,944.95	8,953.20	32 %	228	108	52
Dec-21	6,458	240.95	6,698.95	13,932.28	59 %	441	79	28
Feb-22	3,306	240.95	3,546.95	8,243.68	27 %	198	100	25
Jan-22	4,287	240.95	4,527.95	10,270.60	30 %	201	108	5
Mar-22	3,429	240.95	3,669.95	8,393.44	36 %	270	94	11
Total	**48,188**	**2,891.40**	**51,079.40**	**114,931.92**		**2,789**		
Ave	**4,381**		**4,256.62**	**9,577.66**	**32 %**	**232**		

Only 4 out of 12 of the electricity consumption figures are actual, the others 8 months are estimates. The LPG figures are also based on estimated 1 x 19kg per month and this is for the owner's house only. The annual consumption is 48,188kWh. This figure of 41,188kWh/y, is reasonable even though there are estimates. The figure was confirmed by subtracting the opening reading of April 2021 from the closing reading of March 2022. This gives (85,039 – 34,292), giving 50,747kWh. If the gas consumption figures are added, this comes to 51,079.40kWh.

Regression analysis is done on actual figures and not on estimates. In this case it means, only 4 of the 12 months can be used. Figures highlighted in yellow are estimated months.

Table 7: Regression Analysis Parameters

Month			Weather	
	kWh	Actual	CDD	HDD
Apr-21	-	221	73	32
May-21	11,671	237	24	48
Jun-21	-	156	12	122
Jul-21	5,081	123	7	177
Aug-21	4,562	249	32	226
Sep-21	4,030	216	84	129
Oct-21	1,660	249	72	53
Nov-21	3,704	228	108	52
Dec-21	6,458	441	79	28
Feb-22	3,306	198	100	25
Jan-22	4,287	201	108	5
Mar-22	3,429	270	94	11

Source: HDD and CDD

Source:	www.degreedays.net
Accuracy:	Estimates were made to account for missing data: the "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)
Station:	Grand Central, ZA (28.14E,25.99S)

In this model, instead of only using 4 months of July, Aug, Sep and Dec 2021, only April to June 2021 is excluded from the model. The reason is that although these figures are estimates, they are close to actual. This is confirmed by subtracting the opening meter reading of July 2021 from closing meter reading of March 2021 and the results are the same.

7.2.3 Multi-variable Analysis (Occupancy HDD & CDD)

Regression analysis is a statistical analytical tool used to develop the relationship between energy usage and production or service provided. It is important and helps to; understand this correlation, energy usage when there is no production and also establish a baseline future performance measurement. For At The Rocks Country Estate, the occupancy, weather (HDD & CDD) are the drivers for energy usage used in this analysis.

For this reason, April to June 2021 were not used. In addition, even though October & November 2021 and also February, March & January 2022, these are included in this model because the figures are close to the real numbers. This was determined by subtracting the opening meter reading of September 2021 from January 2022.

In the regression linear equation, the parameters which are most useful, in simplified terms are;

- R-square value (R^2). This is the measure of confidence between energy usage and the energy drivers. It is generally agreed that this value should be above 0.75
- P-Value. This is the probability that the effect or prediction observed in the sample, or a large data range is acceptable. A large value, >0.1 means the analysis model is not acceptable and a lower p-vale, <0.1 means the model is acceptable.
- Intercept – for this linear energy and production/service relationship, this is the water or energy used when there is no production or service provision. This is also referred to as baseload.

Figure 5: Multivariable Regression (Occupancy, HDD & CDD)

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.570626338							
R Square	0.325614417							
Adjusted R Square	-0.079016933							
Standard Error	1371.721928							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	4542526.979	1514175.66	0.804718708	0.542757797			
Residual	5	9408105.243	1881621.049					
Total	8	13950632.22						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2904.392217	3272.556071	0.887499604	0.415455157	-5507.980974	11316.76541	-5507.980974	11316.76541
Occupancy	7.864536677	6.001831617	1.310356101	0.247037995	-7.563662659	23.29273601	-7.563662659	23.29273601
HDD	2.145225429	11.47069805	0.187017862	0.858998483	-27.34114262	31.63159348	-27.34114262	31.63159348
CDD	-12.04137897	25.3359752	-0.475268028	0.654632439	-77.16957661	53.08681866	-77.16957661	53.08681866

The model has 0.57 as multiple R-value, which is lower than the preferred 0.75. The S factor and all P-values are greater than 0.05. A further analysis using the CDD and Occupancy.

Figure 6: Energy vs CDD & Occupancy

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.566477712							
R Square	0.320896998							
Adjusted R Square	0.094529331							
Standard Error	1256.577111							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	2	4476716.002	2238358.001	1.417592017	0.313189325			
Residual	6	9473916.22	1578986.037					
Total	8	13950632.22						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	3436.499442	1481.166786	2.320129964	0.059438395	-187.7851209	7060.784004	-187.7851209	7060.784004
Occupancy	7.589932958	5.330954452	1.423747478	0.204380619	-5.454442669	20.63430858	-5.454442669	20.63430858
CDD	-15.95711447	13.06858265	-1.221028699	0.267875149	-47.93478425	16.0205553	-47.93478425	16.0205553

In this model, the multiple R^2 value is 0.57 and F and P value are above 0.1. These parameters are outside the range. In this model, the CDD driver is eliminated as it has a higher value.

Figure 7: Energy vs Occupancy

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.390064054							
R Square	0.152149966							
Adjusted R Square	0.031028533							
Standard Error	1299.892523							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	2122588.22	2122588.22	1.25617706	0.299349311			
Residual	7	11828044	1689720.572					
Total	8	13950632.22						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2609.478751	1362.638126	1.915019624	0.097038301	-612.648407	5831.605909	-612.648407	5831.605909
Occupancy	5.991635071	5.345888854	1.12079305	0.299349311	-6.649383359	18.6326535	-6.649383359	18.6326535

In this model, the multiple R^2 value is 0.15 and F and P value are above 0.1. The intercept is 2,069.48kWh.

7.2.4 Remarks on regression analysis

The possible conclusion and recommendations are

- The energy use figures are based on estimates. The model cannot be reasonably used on these estimated figures. It was only tried on the 4 months where the readings are actual but didn't yield satisfactory results.

- Note that Eskom is in the process of installing prepaid smart meters in Gauteng[4]. The timeframe for the rollout of smart meters to reach the Rayton area is not known. These meters provide better energy monitoring capabilities.

8. RENEWABLE ENERGY OPTIONS

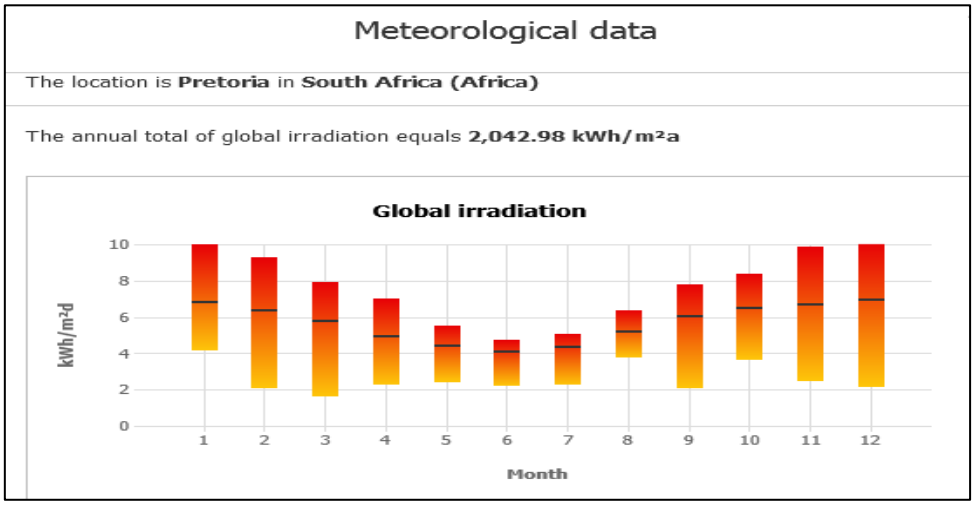
8.1 Description of the renewable energy options

Two (2) renewable options are considered, i.e., Solar PV system for electricity, including solar lighting and solar thermal for water heating. Three (3) main motivation factors for considering these are (i) abundance of solar radiation and (ii) proven technologies which have been in use for a while and (iii) reasonable payback period for this type of investment.

8.1.1 Solar Energy Resources

The Gauteng Global Irradiation will be used to determine the annual energy yields. SMA Sunny Design website estimates Pretoria's global annual irradiation at **2 046.98kWh/m²year.** The daily global irradiation for each month of the year is reflected in figure 1 below

Figure 8: Global radiation data (Gauteng)



The global irradiation data for Gauteng is shown above. The months with the lowest Irradiation data are June and July and the highest are November, December and January.

[4] https://www.eskom.co.za/distribution/customer-service/energy-saving-smart-energy/eskom-smart-prepaid-split-meters-programme/

8.1.2 Design Criteria

The design concept to be used here is a hybrid solar PV system. It is important to note that during load shedding, when the grid is not available, the hybrid connected PV system will be available to supply the premises until the batteries power stored is 20-40%.

Considering the above points, a distributed design approach was adopted as it offers more benefits from a security point of view (i.e., backup configuration). It also takes advantage of the electrical infrastructure already available, i.e., low voltage electrical panels.

8.2 System Design

From the annual energy usage of 51,079kWh/, the estimated daily energy consumption is 139.94kWh/day (51,079kWh/y/365day/y). The facility has adequate north-facing roof space where solar panels can be installed, and this is about 466m^2 for the main guesthouse and the conference rooms. Had it not been the risk of theft, there is enough ground space to mount roof structures.

Figure 9: Space Availability- Aerial view

8.2.1 Option 1: Whole Facility System Sizing

The sizing of the solar PV system is indicated below. A separate Excel Sheet is available which shows the calculations.

Table 8: Estimated Energy Yield (Grid-tied)

Factory Annual Energy Consumption				**51,079.40**		**kWh**
Canadian Solar 450W Monocrystalline Solar Panel	Size	Performance Factor	Peak Sun Hours	Daily Energy		Annual Energy
	Wp	%	H	Wh	kWh	kWh/y
	450	75%	5.63	1,900.13	1.90	653.64

Energy supply by 80 panels		51,079.40	kWh/y
Required solar PV modules		78.15	
Required solar PV modules (rounded figure)		80.00	
Peak power, kWp		36.00	kWp
Required roof space	2	160	m2
Roof space required (rounded figure)		466	m2
Estimated installation costs		13,500	R/kWp
Total estimated installation costs		486,000	Rands
Estimated energy reduction		51,079	kWh/y
Demand reduction		36.0	kVA
Energy			
Electricity Tariff		R2.3019	R/kWh
Total estimated cost savings		117,580	ZAR/y

The yield calculation is based on a 5.63 Peak Sunshine Hours. In this case the number of panels is 80 and require 160m^2 and this roof space is available.

Table 9: Bill of Quantities – Including Back Up Batteries

PRODUCT DESCRIPTION	QTY	Unit Cost	Total Cost
SOLAR COMPONENTS			
Solar Panels - Canadian Solar 450W Monocrystalline Solar Panel	80	R3,015.00	R241,200.00
Solar Bracket Mounting Kit (IBR Roof)	80	R500.00	R40,000.00
Dc Combiners / Surge Arrestors / Panel fusing	4	R4,950.00	R19,800.00
Cabling & connectors	1500	R21.19	R31,785.00
Consumables, trunking / cable securing	4	R16,923.75	R67,695.00
Earthing cable, fittings, etc	80	R21.35	R1,708.00
Sub-total Solar Components			R402,188.00
INVERTER & AC COMPONENTS			
ABB PRO-33.0-TL-OUTD-SX400 including VSN logger Card	1	R82,124.25	R82,124.25
3 Phase Board / Cabling % Isolators	1	R11,001.25	R11,001.25
Sub-total for Inverter & Ac components			R93,125.50
METERING & REMOTE ADMINISTRATION			
Anti - Reflux with shine web box	1	R17,924.00	R17,924.00
Wireless Router	1	R3,500.00	R3,500.00
Network Cabling provision	120	R11.33	R1,359.60
Sub-total for remote metering			R22,783.60
Battery back			
Freedom Won Lite 10/8 LiFePO4 Battery	2	R64,900.00	R129,800.00
Accessories	2	R5,933.13	R11,866.26
Sub-total for battery back-up			R141,666.26
Installing & Commissioning			
Installation of PV Mounting Rails and Panels	80	R850.00	R68,000.00
Mounting Inverters, enclosures and AC wiring	1	R9,577.50	R9,577.50
Plant hire provision / Sundries	1	R15,000.00	R15,000.00
Applications / COC	1	R15,000.00	R15,000.00
Sub-total for installation			R107,577.50
Total, excluding VAT			**R767,340.86**

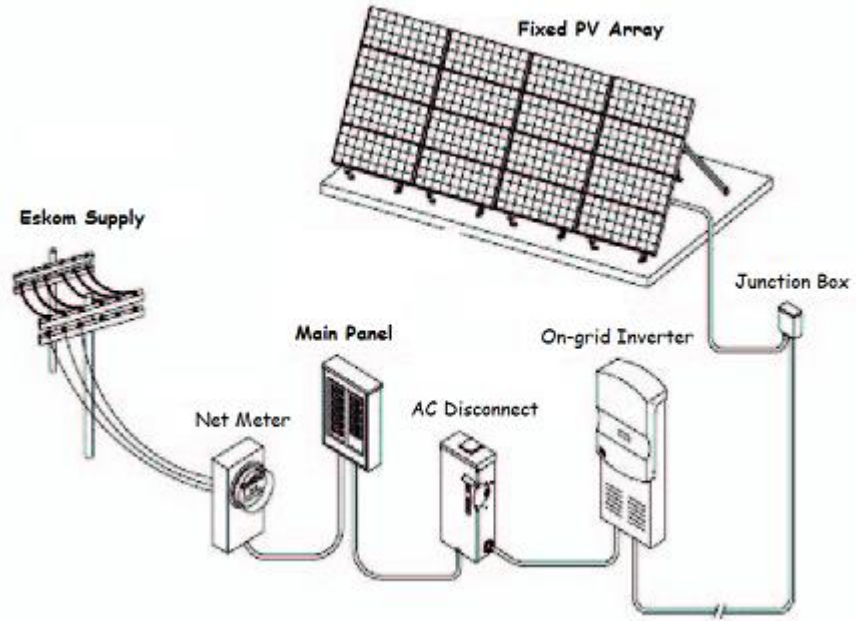
The system will have 2 x Freedom Won Lite 10/8 LiFePO4 battery.

8.2.2 System compatibility – metering the Solar PV System

After installation, it is expected that the system is measured and metered for a period of 1 to 2 weeks. This is to measure exactly how much energy is generated from the system and if it aligns to the initial

specification of the system. The schematic below is generic for the main components of the system, including net metering.

Figure 10: PV System Configuration



Such a meter is actually permanently installed.

8.2.3 System Operation & Maintenance

Solar PV System requires little maintenance. The following are generic points to consider in maintaining the system.

- Solar panels require very little maintenance, especially if they are on a tilt, as rain can wash away any debris.
- It is generally recommended that you perform solar panel cleaning between two and four times per year.
- Using a monitoring app can help you keep track of the amount of energy your panels produce. If you notice a dip in production, it might be time to clean your panels.
- Solar panel maintenance and cleaning is not covered under panel warranties, but if your solar panels are damaged, they will usually be covered.

9. CLEANER PRODUCTION RECOMMENDATIONS

9.1 Other Resource Efficiency Opportunities

9.1.1 Retrofit Electric Geysers with Solar Water Heaters

Based on the electrical load distribution, the electrical geysers consume about 21,450kWh/y. If these are retrofitted with Solar Water Heaters, these can potentially reduce energy consumption by between 40 and 60%.

The calculations show a potential savings of 7,873.17kWh/y out of the estimated annual energy usage of 21,453.35kWh. This corresponds to 37% potential savings. The lower figure is due to the occupancy rate which is 32%. However, since the facility is primarily a functions venue, the critical days of Fridays and Saturdays are always fully booked. See also Annexure 02: Table of Solar Water Heater Calculations

The estimated savings are summarised below.

- Energy reduction 7,873.17kWh/y
- Energy cost savings R18,054.20/y
- Investment R118,000
- Payback period 6.5y
- Carbon dioxide reduction 8.1ton/y

9.1.2 Security Lighting

To increase the security at the property, it is recommended that additional solar lighting strategically placed on the property. The primary purpose is to increase security and reduce potential loss of property. There is no energy savings from existing lighting, but the proposed lights are LED solar lighting, which will not require additional electricity from the electricity supply.

Table 10: Solar lighting

Typical solar lighting fixture.	Specifications
	Rated Power: 300 Watt Lumens: 10000+ Solar panel: 10V 42W Beaming angle: 120° Colour Temperature: 6000k - 6500K Charging time: ≥6 hours Material: ABS+Die-Cast-Aluminum Waterproof: Yes-IP65 Diameter: 400mm x210mm x 100mm Battery Specifications: Lithium Battery 32650 20000 mAh Feature: Remote + Light sensor + Time swich + Dimmable

If Eskom power is used, the estimated energy usage is 12,045kWh/y for 10 units, operating for 11hours a day for the whole year. The estimated savings of installing solar LED lights are summarised below

- Energy 12,045kWh/y
- Energy cost reduction @ R2.3019/kWh R27,726.39/y
- Investment @ R2,850 each for 10 LED lights R28,500.00
- Payback 1.03y
- Carbon dioxide CO_2 reduction 12.6ton/y

9.2 Evaluation & Feasibility of the Opportunities

Each of the identified opportunities was evaluated for technical, environmental and economic feasibility. These are summarised under each of the opportunities.

10. IMPLEMENTATION PLAN

No	Description of savings opportunities / recommendations	Required resources	Estimated investment (Rand)	Timeframe	Priority
1	Install solar powered lights.	Supplied in modular form and an electrician should mount these easily.	28,500.00	Immediately	High
2	Retrofit the existing electric geysers with solar water heaters	Qualified electrician/ solar installers. Most of the resources are available locally.	146,500.00	Short term: less than 3 months	High
3	Install a Solar PV system with battery backup.	Qualified electrician/ solar installers. Most of the resources are available locally.	767,340.00	Short term: less than 3 months	High
4	Install a two (2) electricity submeters to account for internal energy usage	Qualified electrician	3,500.00	Immediately	High
Total			**945,840.00**		

11. ANNEXURES

11.1 Annexure 01 Freedom-Won-Spec-sheet_LiTE-Home-10_8

11.2 Annexure 02: Estimated Savings & Investment

Electric Geyser	Geyser Capacity	Qty	Existing Geyser Element Size (kW)	Water Usage per geyser (L/day)[1]	Energy usage kWh/L[2]	kWh Consumed per geyser/day	Recommended Action[3]	Total Savings			Cost to Install (R)	Payback (y)
								(kWh/yr)[4]	(kVA)[5]	(R/yr)[6]		
150L, 3kW	150	7	3	150	0.090	13.4	150L Solar+2.0kW element	6,588.27		15,165.53	101,500	6.69
200L, 4kW	200	1	4	200	0.090	17.9	200L Solar+2.0kW element	1,254.91		2,888.67	16,500	5.71
Notes:								**7,843.17**		**18,054.20**	**118,000**	**6.54**
1. Water usage is assumed to be 150 & 200 per day from the 150 & 200L hybrid solar geysers. The occupancy rate of 32% was factored in, that is why the potential savings are low												
2. Energy consumption by electric geyser is assumed to be 0.09kWh per Litre. This is based on calculation of heating from 23°C to 100°C boiling point												
3. The 150L & 200L geysers are replaced by a 150L & 200 solar geyser with 2.0kW back up element												
4. Calculation assumes a solar fraction of 60% for potential energy savings												
5. A power factor of 0.94 is used, based on assumption												
6. Cost Savings calculated based on average cost of electricity as shown in the table below.												
General Note: If the daily usage is more than what is reflected in the table above then the savings will increase resulting in a lower payback period.												

Item	Value	Unit	Source
Energy charge	2.3019	R/kWh	Based on energy bills

150L Solar water heater	R14,500	R/Unit	Estimated based on a quotation
200L Solar water heater	R16,500	R/Unit	Estimated based on a quotation

11.3 List of Tables

11.4 List of Figures