INDUSTRIAL EFFICIENCY IN SOUTH AFRICA

REPORT

Gauteng Department of Economic Development (GDED)

SME Green Support Incentive Program

ENERGY CONSUMPTION ASSESSMENT FOR AQUATRADE

4 Diesel Road, Isando

10 May 2022

Prepared for: **CSIR** National Cleaner Production Centre South Africa
CSIR Pretoria Campus
Pretoria

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REPUBLIC OF SOUTH AFRICA

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Nomenclature

CDD	Cooling Degree Days
CFL	Compact fluorescent lamp/light
CO_{2e}	Carbon dioxide equivalents
CP	Cleaner Production
Deg.C	Degrees Celsius
Hr	Hours
kL	Kilolitres
kVA	Kilovolt Amperes
kW	Kilowatts
kWp	Kilowatt Peak
kWh	Kilowatt-hours
LED	Light-emitting diode
NCPC-SA	National Cleaner Production Centre of South Africa
R	Rands
PV	Photo-voltaic
RECP	Resource Efficient and Cleaner Production
W	Watts

EXECUTIVE SUMMARY

An Energy Assessment was conducted at Aquatrade based in Isando, Johannesburg. This was done to evaluate the company's operation by assessing how much energy they utilize on their site and assist in cost reduction of the consumed energy. The annual Electricity consumption per year is unknown and only based on estimates as there were challenges attaining the total Energy bill from the landlord. The estimates are based on what was seen on the site as well as 4 months data provided to us. Based on the 4 months data provided (April, August, September, and November 2021) the total consumption of R20 675 kWh which amounted to R82 486.

Identified energy efficiency opportunities were identified as follows:

- Opportunity for electrical energy to be sourced from an alternate energy source (saving of 27 114 kWh and 103 643.45)
- Estimated Carbon Dioxide reduction of 16.7 tonnes identified
- Overall identified investment cost of R407 061.78 (Excluding VAT and labour)
- Payback period is 3.93 years

A summary of the material to be purchased is contained below:

Table 1: Solar PV raw material

DESCRIPTION	NO	UNIT	TOTAL
INVERTER (8kW)	1	R87 600.00	R87 600.00
PV MODULES (*540Wp datasheet attached*)	34	R4 042.92	R137 459.28
MOUNTING STRUCTURE	1	R11 961.30	R11 961.30
DC CABLE	200	R15.22	R3 044.00
MC4 CONNECTORS	24	R49.84	R1 196.16
DC ISOLATION (*SANS and NRS compliance*)	1	R10 332.00	R10 332.00
CONSUMABLES	1	R12 640.22	R12 640.22
CABLE TRAYS OUTDOOR	1	R8 843.00	R8 843.00
EARTHING AND LPS	1	R5 761.89	R5 761.89
TRUNKING INDOOR	1	R7 041.21	R7 041.21

AC CABLE AND SWITCHING (C/O, INPUT AND OUTPUT)	1	R38 886.22	R38 886.22
INSTALLATION (PC AMOUNT)	1	R58 892.02	R58 892.02
COMMISSIONING TECHNICIAN (PC AMOUNT)	1	R2 133.00	R2 133.00
GRID PROTECTION ANTI ISLANDING DEVICE (*Ziehl relay*)	1	R14 969.67	R14 969.67
PROFESSIONAL ENGINEER SIGN-OFF	1	R2 979.23	R2 979.23
BI-DIRECTIONAL METER / IF REQUIRED		R3 322.58	R3 322.58
GRAND TOTAL (Exclusive VAT)			**R407 061.78**

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1. INTRODUCTION

Aquatrade is a South African-based company located in Isando, Kempton Park, in Gauteng. Aquatrade supplies a diverse range of speciality chemicals including calcium sulphate removal, chemical raw materials and allied services to industries and specialise in Reverse Osmosis water purification and Reverse Osmosis cleaning. Although primarily manufacturing orientated, Aquatrade provides technology to clients and does its own research and development where necessary. Aquatrade has been operating since 2001. Occupying a factory in Isando, Kempton Park and do manufacturing, toll manufacturing, technical consulting, collections and deliveries for customers. Aquatrade has approximately 30 employees. Administration office and production hours operate from 08h00 to 16h30.The factory consumes electricity supplied by the Ekurhuleni and has no other sources of energy.

The Energy Assessment commenced on the 22 April 2022 with a brief introduction meeting with the establishment owner and accompanied by the NCPC-SA representative, followed by the site walk-through and the assessment continuing for the rest of the day on-site.

This review 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. This review report presents the relevant findings contained in the RCEP Assessment Report and information obtained from the site visit relating to energy usage and opportunities for energy performance improvements and renewable energy resources that can supplement grid power. The opportunities are evaluated for technical and financial feasibility. High level investment costs, energy and cost savings and simple payback periods are presented.

2. COMPANY INFORMATION

Table 2:Company Information

Assessment Type	Review of Energy Efficiency and Renewable Energy opportunities
Assessment Period	April 2022
Company Name	Aquatrade
Physical Address	4 Diesel Road, Isando
Phone	011 394 8762
Trading Since (year)	2001
No. of Full time Employees	30
Industrial Processes	Chemicals
Company Contact Person:	
Name:	Mr Hein v Niekerk
Designation:	Managing Director
Telephone: **Mobile:** **E-mail:**	011 394 8762 082 410 5540 hein@manno.co.za

3. PLANT PROFILE

Aquatrade, operates in the chemical and water industry, as indicated in the introduction. The company has relocated to new premises in the industrial zone of Kempton Park, at Isando. Their services are in using chemicals to preserve and purify water, which is the most valuable natural resource. Their services are invaluable to the society because of increased levels of toxins in drinking water. Unlike in their previous location, where they were renting and had limited space, the new location is bigger and they own it. This enables them to widen their scope of services, increase their clientele and expand further.

The company was selected for the Green Incentive program, even though they are in new premises because they are migrating their offerings as they are to the new premises. Since the difference is only space, the energy audit is presented in this report based on their last year's energy consumption in their old premises. The resulting recommendations that are outlined in this report can be implemented in their new site and fulfil their purpose.

Figure 1 shows the Google Earth's Aerial view of the new Aquatrade premises, to expose their available roof space. The Company operates in a large building, which include offices, laboratories, a warehouse, storerooms, and few other processes building. The large building has a large flat surface, on which a PV system can be installed. The online PVWatts® Calculator shows that the total available estimate roof surface 1792 m^2 (left), can be divided into smaller approximately 335 m^2 (right) sections with the potential system direct current (DC) generation capacities of 268.8 kW and 50.2 kW respectively. The orientation of about 35˚ east of north. Since the roof surface is flat, the solar panels will be tilted to harvest most solar energy.
Currently, the company get its electricity from the Municipality, and they pay handsomely. Since the business operates only during the day, the following discussion in this report seeks to lower the electricity bill and investigate whether a grid tied PV system could be ideal and more practical to supplement power supplied by City Power with a PV system.

Figure 1:The roof view of Aquatrade with low and high Solar System Installation capacity.

3.1 Site Solar Energy Resources

The Gauteng Global Irradiation will be used to determine the annual energy yields. The SMA Sunny Design website estimates Gauteng's global annual irradiation at 2046.98 kWh/m²year. The average monthly radiation for each month of the year is reflected in Figure 2 below. The graph shows that the site has a significant component of its radiation that comes from diffuse radiation. This is an indication of notable environmental features such as mist, clouds, smoke and dust.

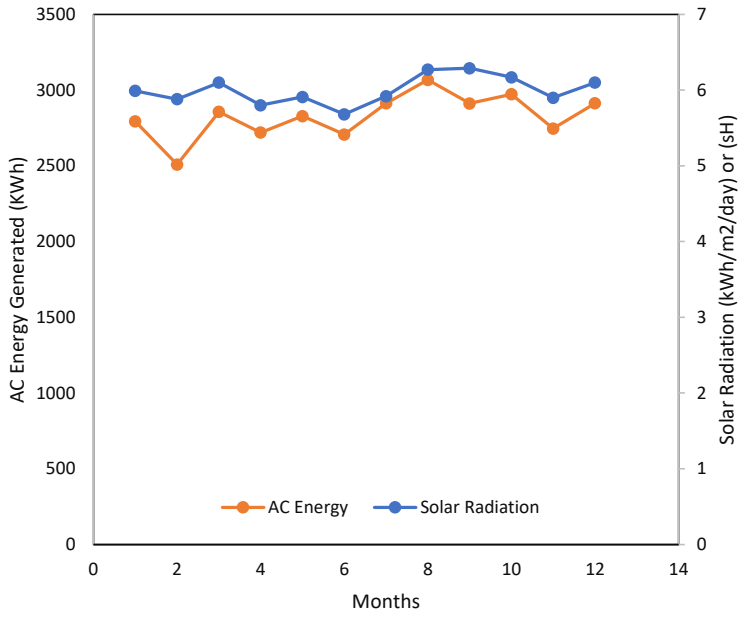


Figure 2: Available average solar radiation per month as well expected AC output are shown together.

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. The diffuse radiation follows the same pattern. For Aquatrade site to be suitable for using solar energy as an alternative source of energy and for the PV system installations, the lowest solar radiation must be sufficient to generate enough energy for production.

4. PRODUCTION PROCESS FLOW CHART

Aquatrade provides chemicals based on customers requirements. These chemicals are mainly made of water and chemicals. These chemicals come in form of solids and liquids. When the raw material is received, it is inserted inside the vessels and mixed until homogeneity is established. The product consists of 90% water and its then stored inside drums and placed at the warehouse for dispatch.

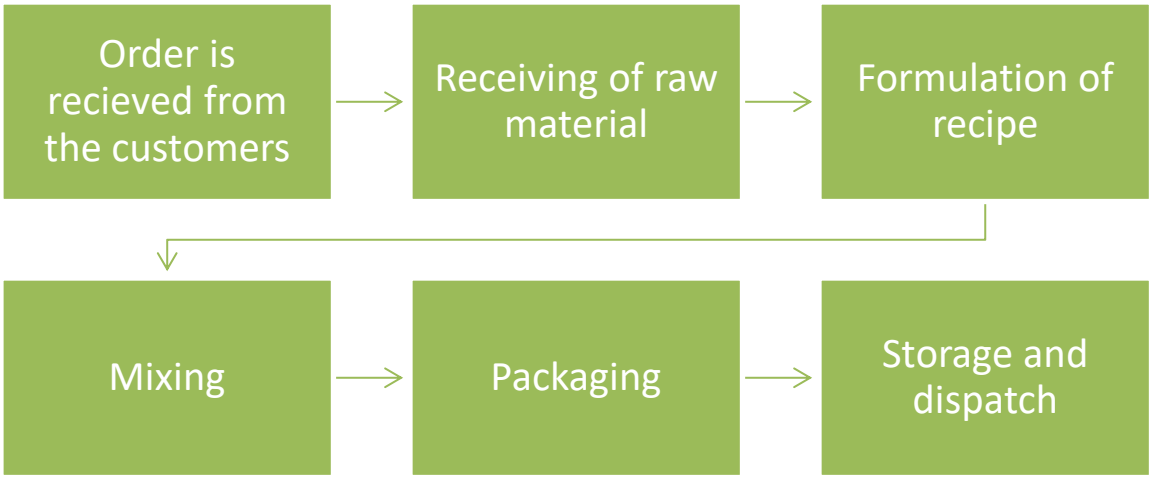


Figure 3: Process flow diagram

5. ENERGY CONSUMPTION

5.1 Electricity

This section provides an analysis of the energy consumption data at the factory, taking into consideration the monthly electricity data as shown in Table 5. The information is not complete as the billing is done by the landlord and there was difficulty attaining other months. This results in having few months reported on this assessment. The recorded months gives an idea of how much electricity is being used but it doesn't complete the total puzzle. Without the data, it is difficult to know the monthly consumption also to understand the trends of electricity monthly. They will be a challenge in establishing an energy balance especially that they are moving into a new site for operations.

Table 3: Electricity consumption, and the only data that was available was from four months.

Months	**Electricity(kWh)**	**Cost/Month**	**Cost/kWh**
Jan 21	-	-	-
Feb 21	-	-	-
Mar 21	-	-	-
Apr 21	3 878.00	R 10 817.42	R 2.79
May 21	-	-	-
Jun 21	-	-	-
Jul 21	-	-	-
Aug 21	6 072.00	R 23 726.63	R 3.91
Sep 21	6 295.00	R 33 431.57	R 5.31
Oct 21	-	-	-
Nov 21	4 430.00	R 14 510.00	R 3.28
Total	**20 675.00**	**R 82 485.62**	**R 15.28**
Averages	**5 168.75**	**R 6 873.80**	**R 3.47**

Table 4 transforms the four months data into 12 months data.

Table 4: Translation of the four months data to the annual estimates.

Energy Usage Data	4 months data	Monthly average	Annual Estimate	Units
Energy	20 675.00	5168.75	62025 kWh	kWh
Energy Cost	R82 485.62	20621.405	R 247456.86	

5.2 Baseline Establishment

A baseline couldn't be established because there is no available data for production. The production data is not recorded. The electricity data has some months that are missing.

5.3 Identification of Significant Energy Users

An energy balance was done on site accounting everything that utilises electricity on site. The total on the balance would tie up with the total from their electricity balance. It is purely based on estimates and simply highlights where the electricity on site is going to. This aids in establishing the Significant energy users on the site.

The above table shows an estimate of energy consumption on site. Because the electricity data is incomplete, the balance will be based on the average of the given months. As it can be seen the biggest user of electricity is the Mixing tanks. They utilize 87% of the energy on site as there are mainly used to mix chemicals as per order received. The second use would be gysers followed by the lighting present are the old fluorescent lights which are present in both factory and offices. The other users of energy are the day to day

Table 5: Installed capacity & estimated energy usage

Equipment	**Estimated kWh/year**	**%Energy Consumed**
Mixing tanks	5 070	87%
Gyser,150L	312	5%
Lighting	242	4%
Fridge	32	1%
Microwave	1	0.01%
Desktop	35	0.59%
Printer	0	0.00%
Air-conditioner	168	2.88%
Total	**5860**	**100%**

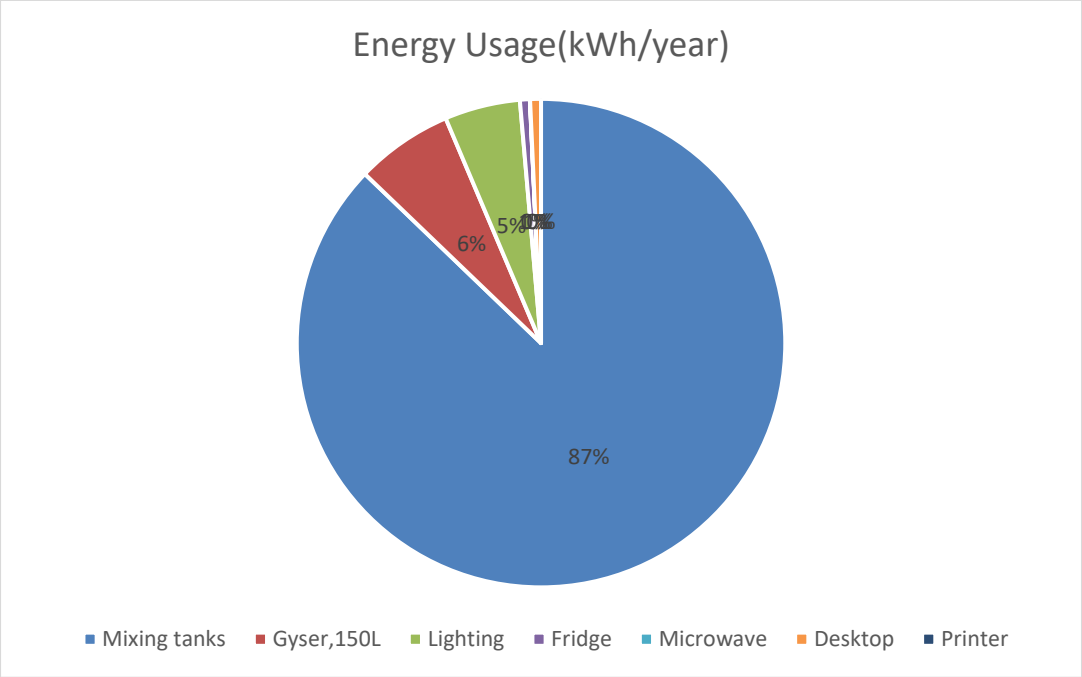


Figure 4: Significant Energy Users

6. DETAILED ASSESSMENT FINDINGS AND RECOMMENDATIONS

6.1 Installation of a Solar PV System

Rationale

Aquatrade has a large roof space, on which a solar system can be installed as shown in Figure 5. When fully utilised, it can give them a huge energy resource. shows the buildings of Aquatrade together with its maximum PV installation capacity.

Figure 5. The available roof Aquatrade roof space and it maximum PV Installation capacity

The figure shows that the company's roof can accommodate quite several solar panels. In the figure, 328 Canadian Solar modules with the peak wattage of 149.2 kW were fitted using the Helioscope software. This can power much of their processes.

The company operates from 08h00 to 17h00, which places them in a position to exploit solar energy to generate electricity for their plant operations, almost maximally because the building orientation is only about 10˚ west of north and its roof is flat. This brings another benefit, clients will

This enables installers to tilt the panels to the optimum tilt angle. In this case, the number of sun hours are not reduced.

Solar PV System deployment

Table 5 illustrates the electricity consumption and site information of the PV system that is for installation on the large roof of Aquatrade. The recommendation is a hybrid system to cater for the never-ending load shedding. With the 20675-kWh annual electrical energy consumption, which translates to 79.58 kWh, daily, the size of the PV system that is budgeted for is estimated to be 18.36 kWp, 34 solar panels and without storage.

Table 5: PV System sizing background information

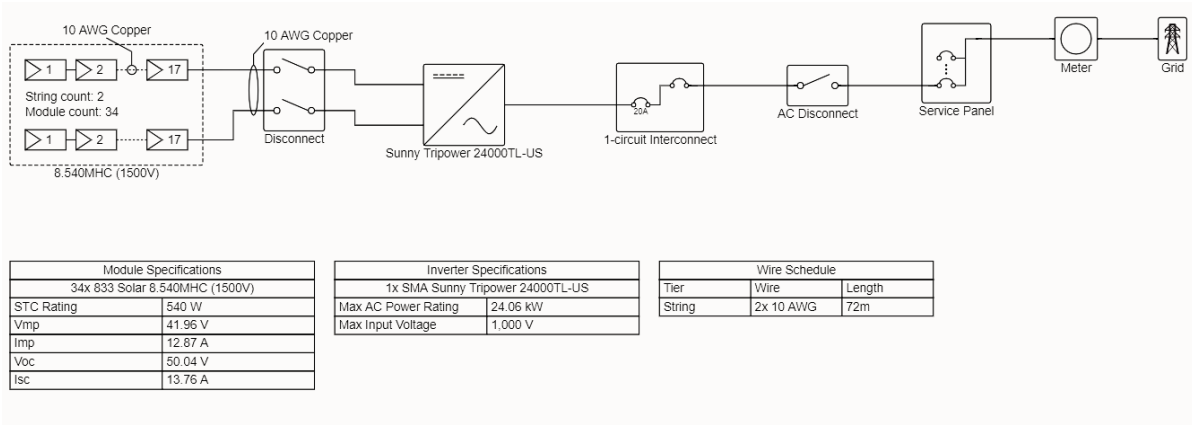
Item	Quantity	Units
Operating hours (Only 8 to 5)	9	h
Operating days a week	5	days
Operating Weeks in a month	4.33	weeks
Operating month in a year	12	months
Estimated Day vs Night Consumption split	100%	Day
Total Annual Consumption (kWh)	20675.00	kWh
Average Monthly consumption over 4 months	5168.75	kWh
Average Daily consumption (5 Days a week)	238.6	kWh
Blended Tariff (R/kWh)	R3.82	
Is Tariff Correct & the Best Option?	YES	
PV Module Wattage (Wp)	540	W
PV System Size according to the Budget	18.36	kWp
Number of Solar Panels	34	

Table 6 predicts that a PV system of 18.36 kWp size can be installed, considering the shortest period (peak sun hours) insolation is available in a year, which occurs in winter.

Table 6: PV System sizing and the costs

Table 10 The cost-benefit analysis of the PV system, day time			
Solar Insolation (Worst: winter and Average) or peak sun hours	Minimum (hrs)	Average (hrs)	
	5.68	6.00	
PV System Size that match consumption	55	52	kWp
Required numberof solar panels	101	96	
Estimated Annual production	27 114	28 646	kWh
Percentage annual savings	131.14%	138.55%	
Value of annual PV production	R103 643.45	R109 497.72	
The cost of the system	R407 061.78		
Average annual total bill	R82 517.99		
Percentage Savings on Total Bill	125.60%		
Payback period	3.93	3.72	years

Figure 6 shows the line diagram of the system, with components connections, the module and inverter specifications and wires dimensions highlighted.



Module Specifications	
34x 833 Solar 8.540MHC (1500V)	
STC Rating	540 W
Vmp	41.96 V
Imp	12.87 A
Voc	50.04 V
Isc	13.76 A

Inverter Specifications	
1x SMA Sunny Tripower 24000TL-US	
Max AC Power Rating	24.06 kW
Max Input Voltage	1,000 V

Wire Schedule		
Tier	Wire	Length
String	2x 10 AWG	72m

Figure 6. Line diagram for the space budgeted for.

Figure 7 presents the actual solar system model. The diagram was created using the Helioscope. The system has one inverter.

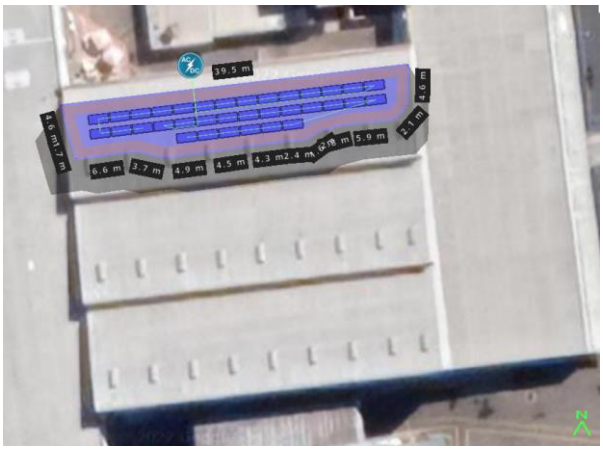


Figure 7: The actual setup of the PV system that is budgeted for and will be deployed. The model places it at the recommended space.

Figure 8 presents the predicted grid power output in relation to the plane of array irradiance and the global horizontal irradiance. The grid performance is in line with plane of array irradiance, especially in March and April as well as September and October. This can be attributed to the equinox impact. On the other hand, the GHI is high in summer and low in winter

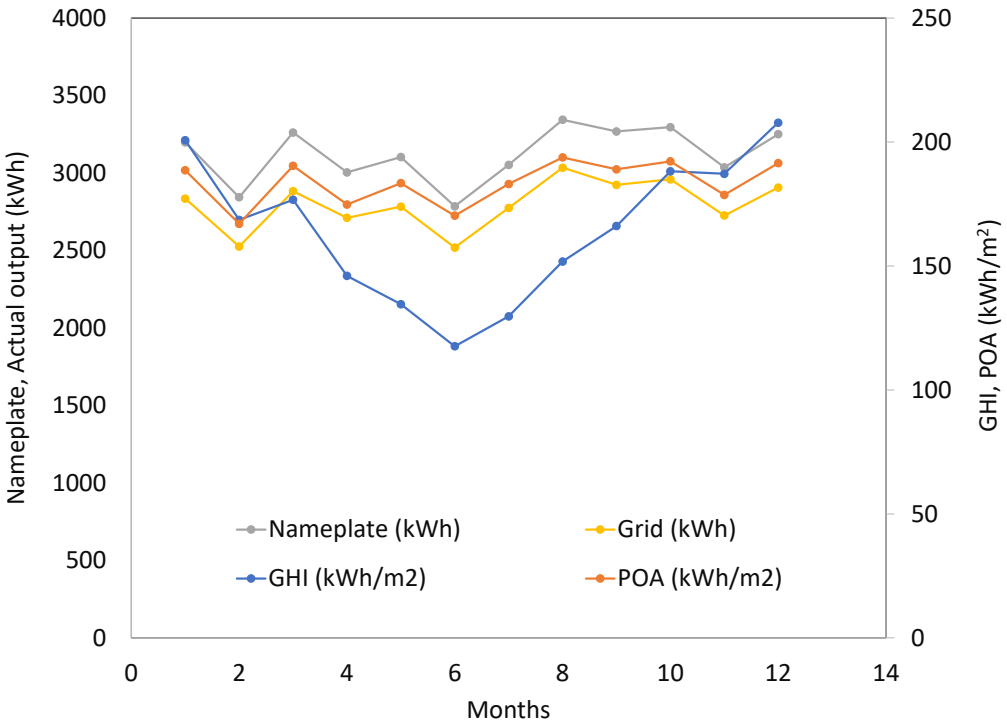


Figure 8 Monthly Electricity generation relative to the plane of array and global horizontal irradiance.

Figure 9 shows several losses that the system can incur from both the environment and the system itself.

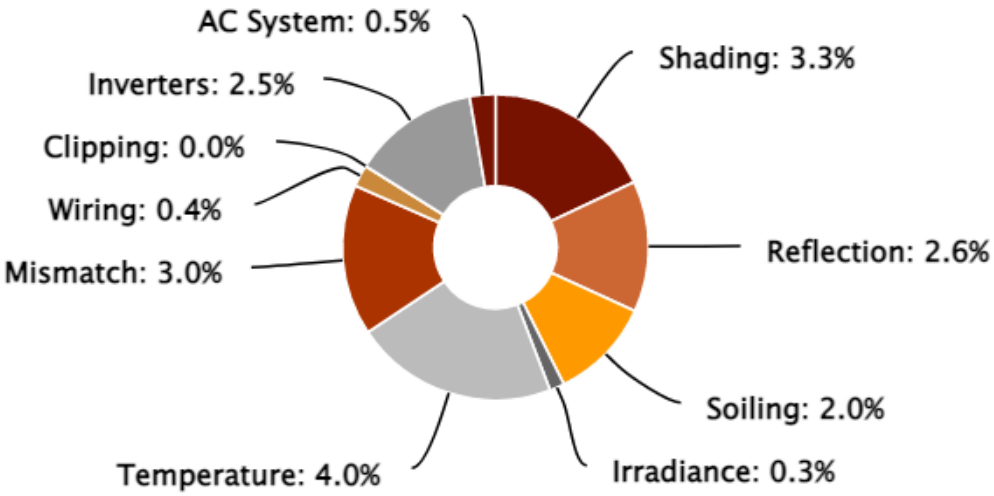


Figure 9. Sources of System Loss

The major power losses can be seen with module temperature, mismatch, shading, reflection, inverters, and soiling. which occur at environmental high temperatures.

Losses due to high temperatures can be minimised by selecting modules with low temperature coefficients. Losses due to mismatch, even though it is not specified, they can be attributed to a wrong tilt angle, and less sensitivity of one module technology to the properties of the spectral irradiance. PV module surfaces are also reflective and this adds some power losses. Soiling also brings about losses on the solar panels. This can be minimised by cleaning the modules at some scheduled and unscheduled times. By minimising these losses, higher outputs can be achieved. It therefore recommended that contractors include a maintenance/ training agreement with the recipient of the Green Incentive.

Solar PV System Cost of Investment

Table 7: Bill of Quantities for the Aquatrade

DESCRIPTION	NO	UNIT	TOTAL
INVERTER (8kW)	1	R87 600.00	R87 600.00
PV MODULES (*540Wp datasheet attached*)	34	R4 042.92	R137 459.28
MOUNTING STRUCTURE	1	R11 961.30	R11 961.30
DC CABLE	200	R15.22	R3 044.00
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BI-DIRECTIONAL METER / IF REQUIRED		R3 322.58	R3 322.58
GRAND TOTAL (Exclusive VAT)			**R407 061.78**

Summary of Electricity and Cost Savings

Total Electricity saved per year: 27 114 kWh

Total Cost savings: R103 643.45

Investment Cost: R407 061.78 (excluding labour)

Payback period: 3.93 years.

7. IMPLEMENTATION PLAN

The objective of the implementation plan is to provide Aquatrade Solution with the confidence that all the energy saving opportunities will be considered when implementing the project, and make sure a to-do list for tasks is done. Activities and processes involved in producing deliverables are highlighted. It is also to make decison on the allocaton of resources and specifying the project priority levels. This plan will enable the track down of implemented opportunity and the savings they bring about.

8. CONCLUSION

Aquatrade sees the importance of being energy efficient in their operations. Due to being charged high amounts of access charge, implementation of Energy Efficiency projects is of high importance. And the company is in the process of enlarging its facility by addition of other operations. They will be able to adopt what has been done on the current operations and implement this on the new facility. Because of the Energy Audit, they have seen the importance of understanding more about Energy and would like to do courses at the NCPC to know and understand more on this topic.