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Gauteng Department of Economic Development (GDED

SME Green Support Incentive Program

ENERGY CONSUMPTION ASSESSMENT FOR AB Farms

R28, Mohlakeng, Westonaria, 1766

10 May 2022

REPORT

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 AB Farms based in Westonoria, 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 energy consumption is 33 543 kWh with a total cost of R 70712.

Identified energy efficiency opportunities were identified as follows:

- Opportunity for approximately 82% electrical energy to be sourced from an alternate energy source (saving of 27 543 kWh and R 57 840.3)
- Estimated Carbon Dioxide reduction of 28.8 tonnes identified
- Overall identified investment cost of **R235 265.10** (Excluding VAT)
- Payback period is 3.3 years

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

Table 1: Solar PV raw material

DESCRIPTION	Power Rating	NO	Units	UNIT Price	TOTAL
INVERTER (8kW)	**8**	1	kW	R43 800.00	R43 800.00
PV MODULES (*540Wp datasheet attached*)	**540**	18	W	R4 042.92	R72 772.56
MOUNTING STRUCTURE		1		R5 980.65	R5 980.65
DC CABLE		100		R15.22	R1 522.00
MC4 CONNECTORS		12		R49.84	R598.08
DC ISOLATION (*SANS and NRS compliance*)		1		R10 332.00	R10 332.00
CONSUMABLES		1		R6 320.11	R6 320.11
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		R19 443.11	R19 443.11
INSTALLATION (PC AMOUNT)		1		R29 446.01	R29 446.01
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		**1**		R3 322.58	R3 322.58
GRAND TOTAL (Exclusive VAT)					**R235 265.10**

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1. INTRODUCTION

AB Farms is a South African based Agricultural Technology Company located in Mohlakeng, Westonaria in Gauteng. AB Farms provides innovative hydroponics solutions to small scale and commercial farmers. They design and manufacture a pipe systems that allows the farming tunnels to have access to water continuously even though the irrigating system is off due to power shortages, pump failure or any other reason. The system essentially allows for plants to be irrigated periodically, as opposed to continuously, thus reducing the amount of energy required per kg produced. AB Farms has been operating since 2015.

AB Farms has approximately 3 employees. Administration office and production hours operate from 08h00 to 16h30.The factory consumes electricity supplied by the municipality and has no other sources of energy.

The Energy Assessment commenced on the 12 May 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	May 2022
Company Name	AB Farms
Physical Address	R28, Mohlakeng, Westonaria
Phone	082 078 9131
Trading Since (year)	2015
No. of Full time Employees	3
Industrial Processes	Pipe Design for Hydroponics Tunnels
Company Contact Person:	
Name:	Tumelo Pule
Designation:	Managing Director
Mobile: **E-mail:**	082 078 9131 tumelop@abfarms.co.za

3. PLANT PROFILE

AB Farms, operates in the agricultural technology industry, as indicated in the introduction. The company is based at Mahlakeng, in the farms of Westonaria and located at (-26.278968, 27.681217). The company operates in a building, which include offices, as well as few green houses that are built with light materials. Their services include providing innovative hydroponics solutions to small scale and commercial farmers. They design and manufacture a pipe system that allows the farming tunnels to have access to water continuously. At the time of the visit however, the irrigating system was off due to pump failure or other hidden reasons. AB Farms services have proven to be invaluable to the society because they provide farming alternative to the farmers as increased levels of climate change is affecting them heavily. Unlike the conventional farming, farming in tunnels gives farmers an advantage to control the production.

Figure 1 shows the Google Earth's Aerial view of AB Farms premises to expose their available roof space. The figure shows that only the building has solid roof space, on which a PV system can be installed if it is feasible.

Figure 1:The Google Earth's Aerial view of AB Farms, both the land mass (left) and the available roof space (right) for possible Solar System Installation capacity.

The online PVWatts® Calculator shows that the total available estimate roof surface 2136 m^2 (left), can be divided into smaller approximately 195 m^2 (right) sections with

the potential system direct current (DC) generation capacities of 320 kW and 29.2 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.

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 daily global irradiation 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.

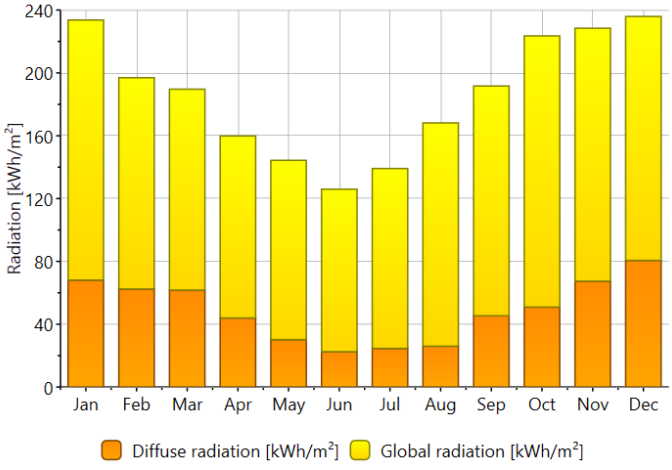


Figure 2: Global and Diffuse Radiations are shown together.

Figure 3: Global and diffuse radiation data

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 AB Farms 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

AB Farms provides Innovative hydroponics solutions to small scale & commercial farmers based on customers' requirements. They design a pipe system that allows the plant to have access to water continuously even though the irrigating system is off due to power shortages, pump failure or any other reason. The system essentially allows for plants to be irrigated periodically, as opposed to continuously, thus reducing the amount of energy required per kg produced.

Figure 4: Process flow diagram

5. ENERGY CONSUMPTION

5.1 Electricity

The following tables shows monthly electricity data. The company is on a land that belongs to the department of agriculture. This land is occupied by other farmers and the landlord pays the total amount to the municipality. Because AB farms are funded by the government, they are only required to pay 15% of what is being consumed on the land.

Table 3: Electricity consumption

Months	Electricity(kWh)	Cost/Month	AB FARMS(kWh)	Cost/kWh (Rands)	
Jan 21	18 130	R 35 567.43	2719.50	R 1.96	
Feb 21	18 119	R 35 545.85	2717.85	R 1.96	
Mar 21	18 091	R 35 490.92	2713.65	R 1.96	
Apr 21	18 113	R 35 534.08	2716.95	R 1.96	
May 21	18 108	R 35 524.27	2716.20	R 1.96	
Jun 21	18 728	R 36 740.59	2809.20	R 1.96	
Jul 21	18 948	R 42 595.10	2842.20	R 2.25	
Aug 21	19 236	R 43 242.52	2885.40	R 2.25	
Sep 21	18 971	R 42 646.80	2845.65	R 2.25	
Oct 21	19 052	R 42 828.89	2857.80	R 2.25	
Nov 21	19 086	R 42 905.32	2862.90	R 2.25	
Dec 21	19 036	R 42 792.92	2855.40	R 2.25	
Total	**223 618.00**	**R 471 414.71**			
Average	**18 634.83**	**R 39 284.56**		**R 2.10**	

5.2 Baseline Establishment

A baseline couldn't be established because there is no available data for production.

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 energy balance and AB Farms energy requirements are as results the machinery being utilised. The irrigation pumps are used to supply water into the hydroponics towers. These pumps operate for 1 hour in the afternoon and 1 hour in the morning. The drainage pump is only used when there is a need to drain any water overflow from irrigation tanks. The drainage pump is only used when there is a need and do not exceed 1 hours of daily use.

Wet wall pumps are used for cooling the hydroponics tunnel temperature. These pumps operate continuously when the environmental temperature is high. The system is automatically operated by a climate controller, meaning the pumps turn off when the temperature is cool.

Cool temperature occurs under the following conditions:

- Winter period
- Cloudy weather periods

- Rainy periods

Therefore, the highest and lowest demand of energy for cooling are in hot and cool weather conditions, respectively.

Table 5: Estimated energy usage

Product	Power rating (kW)	Max daily time	Daily energy consumption (kWh)	Annual Energy Consumption (kWh)	% Energy Consumed
Irrigation Pumps	3.7	12	22.2	5328	34
Drainage Pump	0.75	2	1.5	360	2
Wet Wall Submergible Pump	0.74	24	8.88	2131.2	14
Extraction Fans	2.2	24	26.4	6336	41
Water Urn	1.6	1	1.6	384	2
Sundry Appliances*	2	2	4	960	6
Total	10.99	65	64.58	15499.2	100%

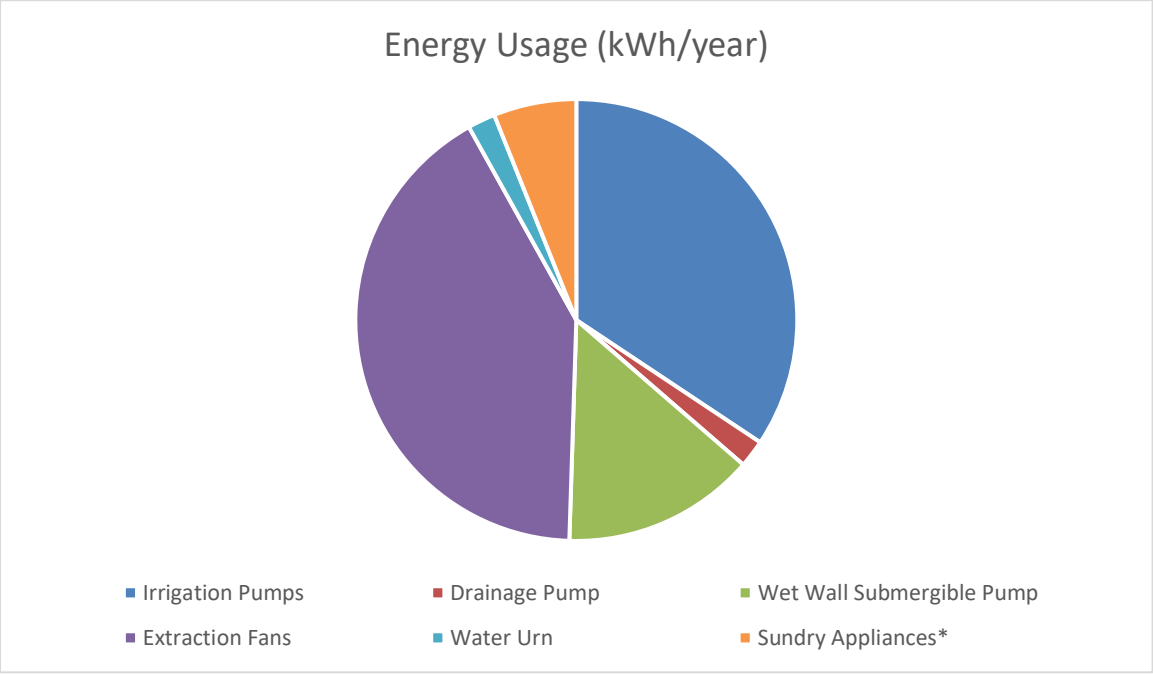


Figure 5: Significant Energy Users

6. DETAILED ASSESSMENT FINDINGS AND RECOMMENDATIONS

6.1 Installation of a Solar PV System

Rationale

AB Farms operates from 08h00 to 17h00 and can benefit from installing a Solar system on their roof to generate electricity for their plant operations. However, the company does not have enough roof space, on which a solar system can be installed. Figure 6 the building of AB Farms with the total PV installation capacity on the available roof space, together with the potential PV installation.

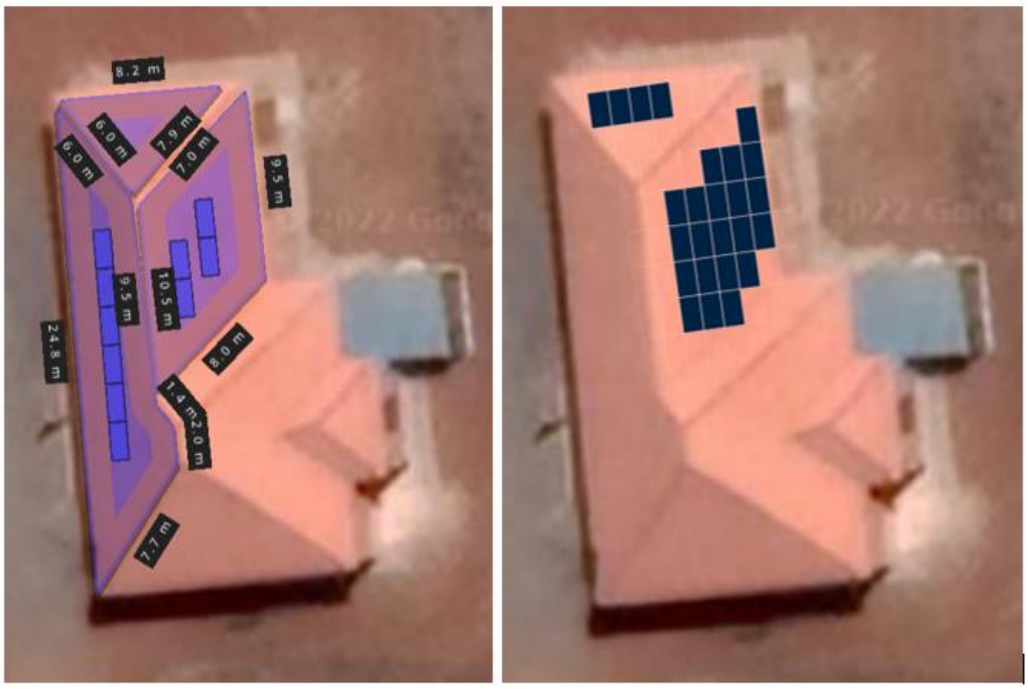


Figure 6: The available AB Farms roof space showing the PV system installing capacity (left), possible installation (right).

In the figure, 25 Canadian Solar modules were fitted using the https://powercalculator.ibc-solar.com/ website. The figure shows that the company building is oriented such that the roof spaces face almost East and West and can accommodate only few solar panels. This will make the East and West facing roof spaces to separately generate power in the morning and afternoon respectively.

Using data that was generated through the PV Watts website, Figure 7 predicts the energy that a 10 kWp solar system that is installed on the East facing roof space can generate in relation to the available monthly average peak sun-hours. The minimum (in June) and the average

sun-hours that the system is exposed to was found to be 3.85 and 5.22 hours respectively. The figure shows that the predicted energy generation follows the available sun hours.

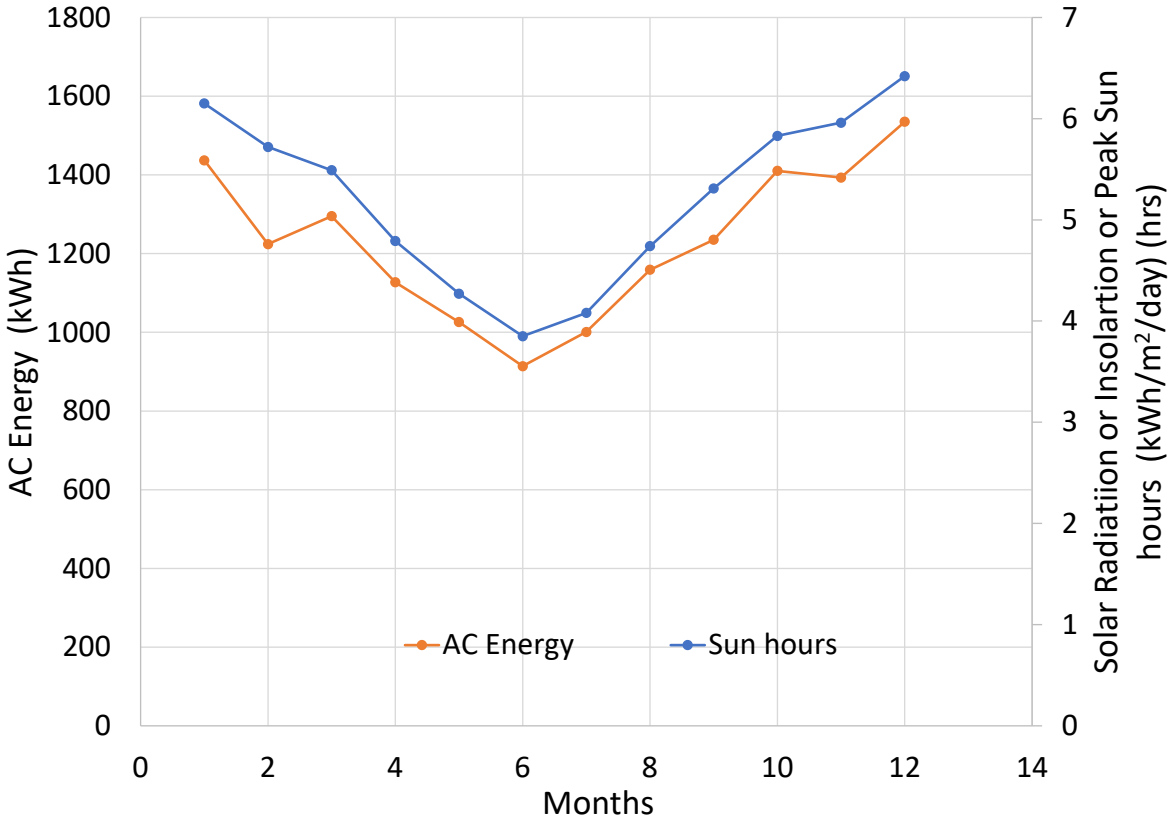


Figure 7: Predicted energy generating (orange) in relation to the available peak sun hours (blue).

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

The company will strongly benefit from the installation of a solar system that has a battery back-up bank, in their premises. The recommendation is a hybrid system to cater for the never-ending load shedding. Table 3 shows the background information that is required to size the PV system and recommended for installation on the newly acquired roof space at AB Farms. Such information includes the hours, days, weeks, and months the company operates in a year as well as the PV system size that budgeted for.

Table 3: AB Farms PV System background

Item	**RESULTS**			
Operating hours, days, weeks, and months	9 hrs	5 days	4.33 weeks	12 months
Total Annual Consumption (kWh)	223618.00	kWh		
AB Farms' 15% share of annual energy consumption	33 543	kWh		
Average Monthly consumption	2795.23	kWh		
Average Daily consumption (5 Days a week)	129.0	kWh		
Blended Tariff (R/kWh)	R2.10			
PV Module Wattage (Wp)	540	Wp		
PV System Size according to the Budget	9.72	kWp		
Number of Solar Panels	18			

Table 4 gives the PV system size based on the plant's 15% share of consumption and cost-benefit calculations as well as the minimum and average peak sun hours.

Table 4: The PV system sizing and cost-benefit analysis

Solar Insolation (Worst: winter and Average) or peak sun hours	Minimum (hrs)	Average (hrs)	
	5.69	6.01	hrs
PV System Size that matches consumption	29	28	kWp
Estimated Annual production	14 380	15 197	kWh
Percentage annual savings	42.87%	45.31%	
Value of annual PV production	R30 267.97	R31 987.94	
The cost of the system	R235 265.10		
Average annual total bill	R42 905.32		
Percentage Savings on Total Bill	70.55%		
Payback period	7.77	7.35	years
Carbon Dioxide Reduction		Ton/y	

Figure 8 presents the actual proposed solar system model. The diagram was created using the Helioscope.

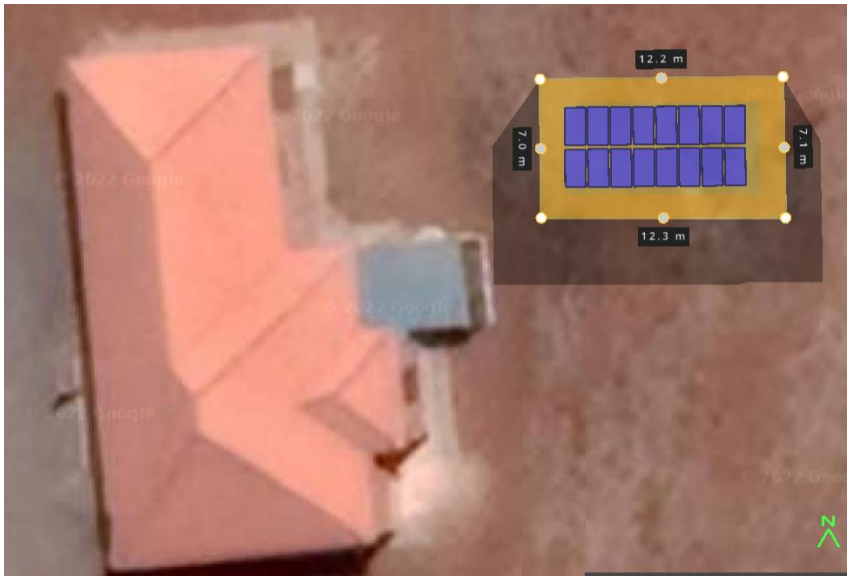
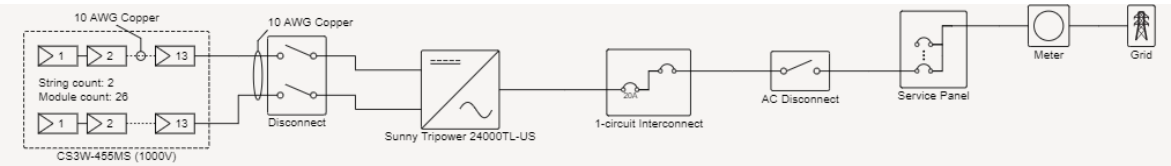


Figure 8: A strong mobile structure, a shipping container, as an alternative.

Figure 9 shows the line diagram of the system, with components connections, the module and inverter specifications and wires dimensions highlighted. The system has one inverter.



Module Specifications	
30x CanadianSolar CS3W-455MS (1000V)	
STC Rating	455 W
Vmp	41.3 V
Imp	11.02 A
Voc	49.3 V
Isc	11.66 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	89m

Figure 9. Line diagram for the space budgeted for.

Figure 10 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

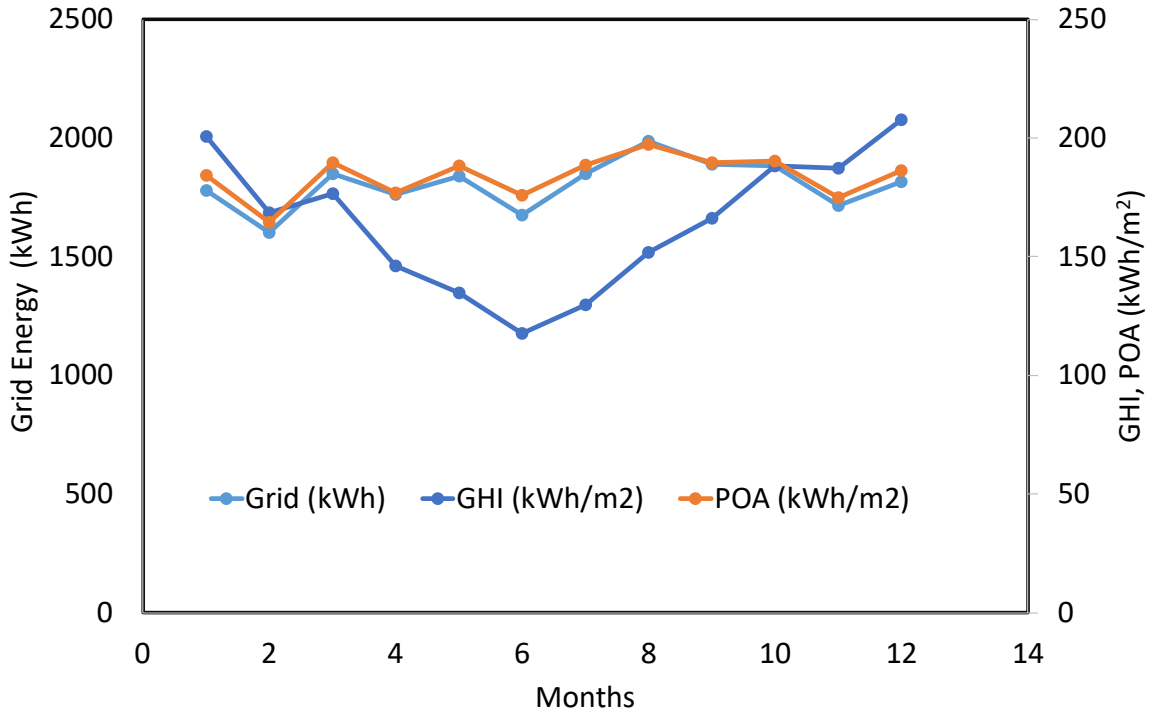


Figure 10 Monthly Electricity generation relative to the plane of array and global horizontal irradiance.

Figure 11 shows several losses that the system can incur from both the environment and the system itself.

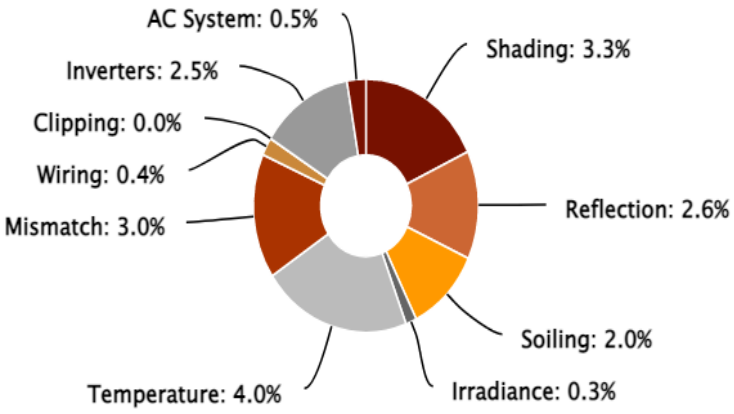


Figure 11. Sources of System Losses

Major power losses can be seen with the module temperature, mismatch, shading, reflection, inverters, and soiling. First, losses due to high temperatures, which occur at high environmental temperatures, can be minimised by selecting modules with low temperature coefficients. This will make the rise in module temperature to be slower

than the rise of ambient temperature. Next, the losses due to mismatch, even though they are not verified, they can be attributed to wrong tilt angles, and low sensitivity of one module technology to the properties of the spectral irradiance. Next, PV module surfaces are also reflective, and thus add some power losses. Also, soiling 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.

Summary of Electricity and Cost Savings

Total Electricity saved per year: 27 543 kWh (Excluding winter days)

Total Cost savings: R 57 840

Investment Cost:

Table 5: Bill of Quantities for AB Farms.

DESCRIPTION	Power Rating	NO	Units	UNIT Price	TOTAL
INVERTER (8kW)	**8**	1	kW	R43 800.00	R43 800.00
PV MODULES (*540Wp datasheet attached*)	**540**	18	W	R4 042.92	R72 772.56
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BI-DIRECTIONAL METER / IF REQUIRED		**1**		R3 322.58	R3 322.58
GRAND TOTAL (Exclusive VAT)					**R235 265.10**

Payback period: 7.7 years.

7. IMPLEMENTATION PLAN

The objective of the implementation plan is to provide AB Farms 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. The main recommendation is that the intervention in the company should be in the form of installing a solar system that power several of their processes. However, to ensure that quality service is rendered and the performance of the PV system can be monitored after installation, it will be prudent to take a sample of the modules under a reliability test.

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.The two identified opportunities are ranked as high, meaning that they are of high priority and they should be impemented quickly to bring about an energy saving.

8. CONCLUSION

AB Farms 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.