ASSESSING THE PERFORMANCE OF A 500kWp PV PLANT AFTER FIRST YEAR OF OPERATION

INTRODUCTION

The 500kWp photovoltaic (PV) plant discussed in this article operates in the Northern Cape and has been in operation now for over a year. The aim of this assessment is to provide a simplistic approach to determine the performance which can typically be achieved by a PV plant after a certain period of operation.

The plant was commissioned by specialist electrical contractor, Brand Engineering SA (Pty) Ltd. Brand Engineering has carried out the highest number of utility scale solar Renewable Energy (RE) installations in South Africa. It has become a key construction partner for RE developers, and is responsible for the generation of 360MW of power for Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) projects and other related renewable energy initiatives.

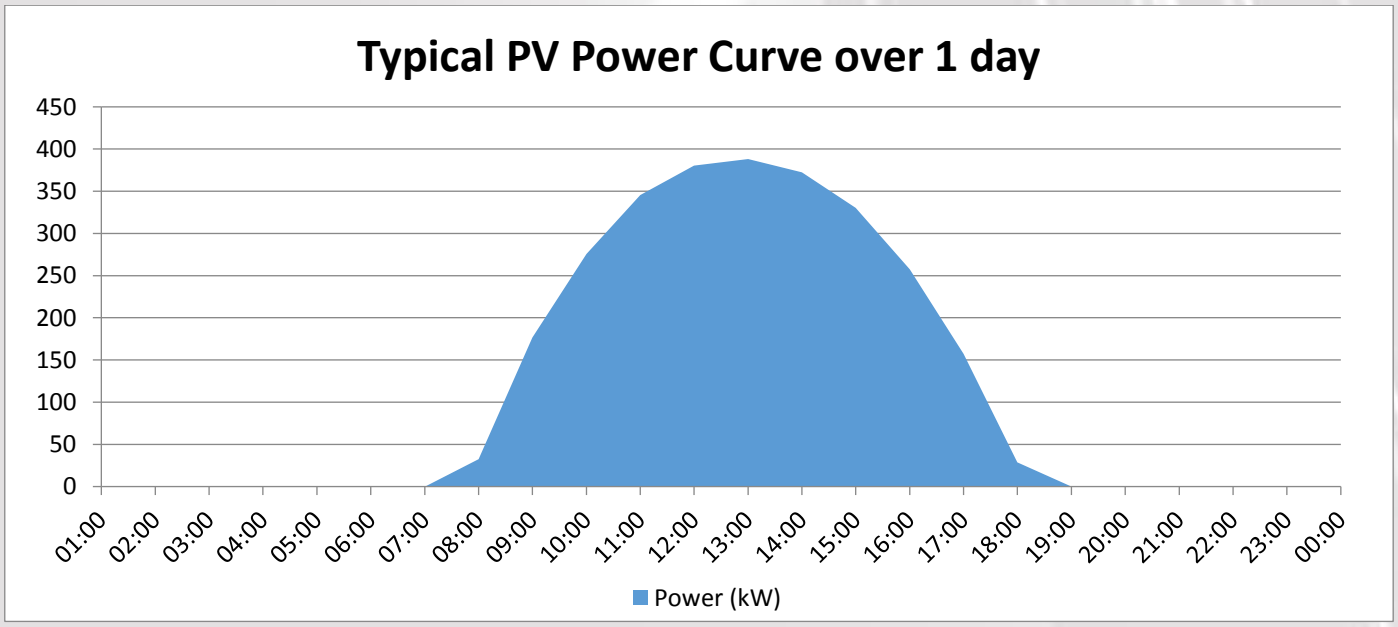
The plant is rated at 450kW/502kWp and therefore an AC to DC ratio of 89.6%. It consists of 18 x 25kW String Inverters which convert DC power from 1620 x 310W PV panels into AC power at 400V and stepped up to 11kV and fed into the client's MV network.

SANS50010-Guidelines for Measurement and Verification of Energy Savings provide guidance for a more complicated approach but in principle use the following core equation: Energy Saving = (baseline period energy use) – (reporting period energy use) +/- adjustments.

In this particular case the energy saving should be equal to or exceed the upfront guaranteed Yield and Performance Ratio value. The baseline period energy use of the client on the network is not discussed in this report but the demand exceeds the output of the PV plant at all times. No +/- adjustments have been taken into account, but an example of this could be network downtime by others.

RESULTS

FIGURE 1: Typical power curve on a clear winter's day.



The plant starts generating at 07:00 in the morning, peak around 13:00 and stops generating at 19:00.

FIGURE 2: Typical daily yield over a period of one month.

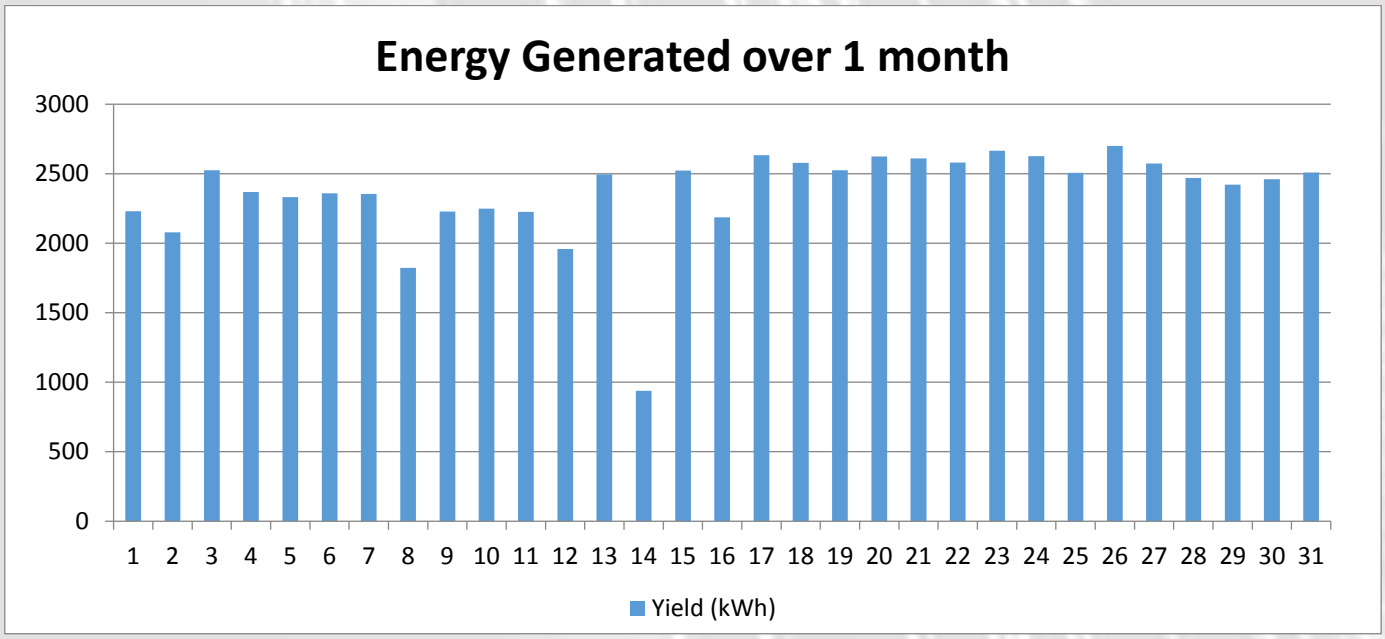
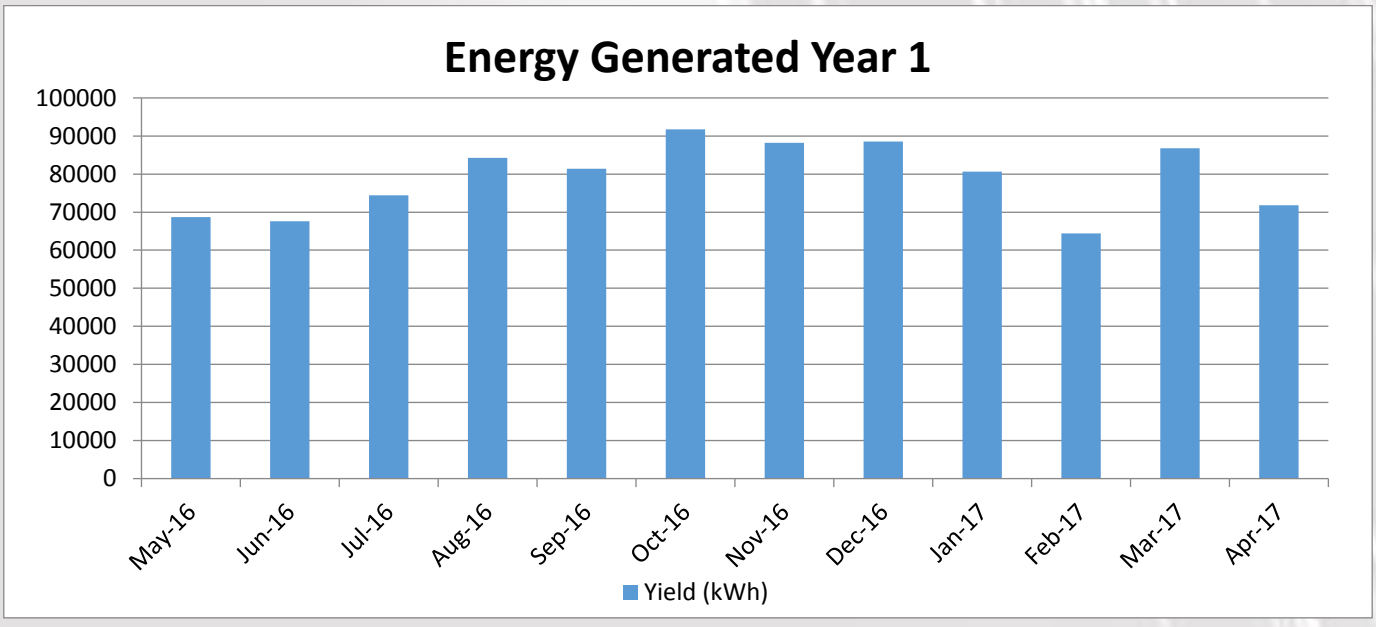


FIGURE 3: Yield generated in the first year of operation:



The plant generated approximately 950 000kWh (950MWh) during the first year of operation with a performance ratio in excess of 83%.

DISCUSSION OF RESULTS

Yield assessed in this report is measured at the output terminals of the Inverters. Energy for this particular plant is also metered at LVac (input of transformer) and MVac (point of connection).

The plant outperformed the guaranteed yield by approximately 10%. The guaranteed yield at the time was calculated by a software package against a P90 (90%) probability. The yield output was even higher than the predicted P50 probability.

It can furthermore be calculated that this plant generated on average 5.2kWh per day for every kWp (DC) installed power. The plant achieved an average Performance Ratio in excess of 83% in its first year of operation. Performance Ratio is the ability of the plant to convert the available Solar Irradiation at any given time into usable energy (yield). Performance Ratio is affected by PV panel efficiency, shading, reflection, angle of PV panel, dust, temperature, AC & DC cable losses, inverter efficiency, connector losses, self-consumption and down time. Irradiation of the sun is measured with a pyranometer and together with measured AC energy and plant information put into a formula to calculate Performance Ratio.

Good Solar Irradiance on a clear day is in excess of 1000W/m². Of this only approximately 16% can be harnessed by a PV panel and converted into DC energy which is further converted into AC energy with losses along the way.

The good yield could possibly be attributed to good weather, but the Performance Ratio serves as confirmation that the plant performed above expectations for the first year of operation. Most tenders stipulate required Performance Ratios of 78 to 79% where-as this plant achieved in excess of 83%.

Where plant availability is reflected within Performance Ratio as discussed above, this can also be measured separately for some clients. 98% plant availability is a common requirement among clients, therefore a maximum of only 2% downtime is allowed during the day, typically for irradiance values of 200W/m² and higher.

The annual degradation value of the plant is guaranteed at 0.4% therefore the targeted yield and Performance Ratio for each year will be adjusted accordingly.

Plant maintenance and monitoring plays a vital role in achieving good performance. The plant referred to is monitored remotely from Cape Town on a daily basis and abnormalities are attended to and followed up swiftly. Quarterly, annual and bi-annual maintenance is carried out on the plant. Every month a performance report for the plant is submitted to the client, and every three months this is accompanied by a maintenance report. It is important to note that the pyranometer should only be cleaned when the PV panels are cleaned otherwise it will affect the Performance Ratio calculation.

COMPARISONS

The generated green power in year 1 of the plant equates to a saving of approximately 600 tons of CO2, 75000L of fuel oil and 110 tons of coal. The saved CO2 equates to approximately 6.1 million kilometres covered by car.

IN CONCLUSION

The PV plant discussed in this article meets and exceeds requirements and expectations. Analysing the data assists in planning, designing, pricing and operating PV plants in the future.

RE in the form of Solar is the answer to future energy requirements, especially when taking into account that costs for commercial scale installations have dropped to below R15/kWp. Under the REIPPP, producers now tender for as low as 60c/kWh selling electricity to Eskom under a 20 year contract. This is definitely cheaper than power from a new coal or nuclear power station.

There is naturally the issue of base power and therefore in the foreseeable future renewable energy will still have to be mixed with other forms of energy to make financial sense. Supplementing ones existing supply with PV results in very favourable payback periods from six years and up on initial investment.

Although the output from PV panels degrades over the years, installations last for 20 years and longer. Saving in the short term by using an inferior installation will be a let-down in the long term, and compliance with regulations, bi-laws and quality of products are vital.

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