Checking Solar System Performance

Dr Martin Gill
Director OPPM Pty Ltd

The installation of a solar system can reduce the annual electricity bill. Annual savings depend on solar system performance, however most households are unaware of the performance of their solar system. A number of simple checks can be used to verify the performance of solar systems.

Introduction

Over 1 million Australian households have chosen to install a solar system, mainly to reduce their annual electricity bill. The amount households can save depends on the performance of their solar system. Despite this many households are unaware of the performance of their solar system.

Following are some simple checks consumers can perform to verify that their solar system is working satisfactorily. Measuring the actual performance of the solar system is slightly more involved but may be a valuable exercise to ensure the system has been installed correctly.

Why check solar system performance?

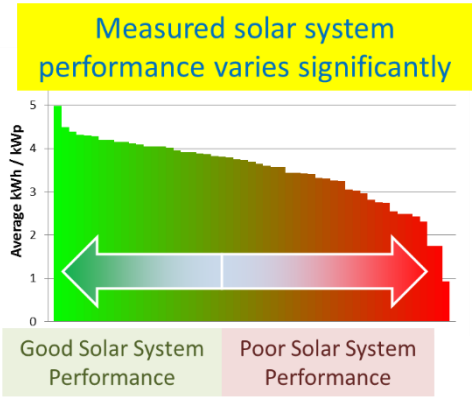
The installation of a solar system is a long term investment. On current tariffs it takes over 10 years for savings from a functional solar system to pay for the installation. Poor solar system performance increases the number of years required to recover the cost of the solar system.

Advertisements for solar systems often state “guaranteed for 25 years”. This results in a popular misconception that solar systems last 25 years. The fine print on these advertisements clarifies that this lifetime is limited to the solar panels and does not cover other essential components.

All solar systems use an electronic inverter to convert the output of the solar panels into electricity. The majority of solar inverters only offer a guaranteed lifetime of up to 5 years. If the inverter fails the household receives no further financial benefit from their solar system. It is therefore important that households regularly check the performance of their inverter and solar system.

Solar System Performance Varies significantly

The following figure shows the performance of 52 households with a domestic solar system.



Despite all the households being located in the same Sydney suburb the figure shows solar system performance varies significantly. Households with poor solar system performance may not recover the cost of their solar system.

Quarterly Checks

The arrival of the quarterly electricity bill is a useful reminder to check solar system performance. Most consumers remember roughly the size of the credit they earn from electricity their solar system sends to the electricity network. A significant decrease probably justifies a more detailed investigation.

The investigation starts by referring to previous bills. Solar feed-in tariffs can change, so rather than looking at the credit, search for the number of kilo-Watt-hours (kWh) of electricity sent to the electricity network. Compare the amount of electricity sent to the network to the figure shown on the bill for the same period last year (some bills will already include this figure). A significant reduction indicates households should check the performance of their solar system.

Households should be aware that credits shown on the electricity bill also depend on the amount of electricity they have used. This dependency is discussed later in the article under "Why not use the new meter?".

Why compare figures to the same period last year?

Solar systems convert sunlight into electricity. The amount of sunlight depends on the season, with longer days in summer and shorter days in winter. This is why it is important to compare figures from the same period last year when there is a similar amount of sunlight.

Other Checks

Solar inverters generally provide a display showing information about the inverter. Owners should familiarise themselves with the normal display. If the display shows any errors or warnings then consult the user manual or contact the installer. Reminder: inverters contain dangerous voltages and should only be serviced by qualified professionals.

Average Daily Electricity Production

The credit shown on the electricity bill only allows households to check their solar system is working. Consumers wanting to calculate the actual performance of their solar system must use different measurements.

The display on most solar inverters includes the total amount of electricity produced by the solar inverter. With a little work this can be used to calculate the average amount of electricity produced each day[1]. The check requires the customer to record both the date and the reading shown on the inverter.

Subtracting the amount of the last reading from the current reading gives the amount of electricity produced. Average daily production is calculated by dividing the number of days as shown in the following example:

Date	Reading (kWh)
12th June 2015	345
14th September 2015	1110

$$\frac{1110 - 345}{90} = 8.5 \text{ kWh / Day}$$

The average daily value depends on the season so the calculated average should be compared to the same period last year. If there is a significant decrease further investigation is justified.

Comparing performance to other solar systems

The above checks provide a simple way to know the installed solar system is continuing to perform correctly. Households wishing to check the performance of a newly installed system need to compare the performance of their solar system to similarly located systems.

Comparing the performance solar systems requires direct measurement of the amount of electricity produced by the solar system. The display on most solar inverters shows a suitable value.

Solar System Size

Calculations use the size of the solar array not the size of the inverter. In most installations the rating of the inverter will be larger than the size of the solar array.

The size of the solar array is determined by the number of solar panels and the rating of each panel. Standard tests are used to measure the peak output of solar panels. Multiplying the number of panels by the rating of each panel gives the solar array size, which is stated in kilo-Watts peak (kWp).

Typical Solar System Output

Typical solar system output depends on where the solar system is installed. It is higher in Northern regions of Australia and lower in Southern regions. The following table was prepared using the online tool PVWatts provided by the National Renewable Energy Laboratory (NREL):

[1] Some inverters display the average daily output, this article assumes a simple inverter only showing total output

City	Average Daily Output (kWh / kWp)
Adelaide	4.13
Brisbane	4.16
Melbourne	3.76
Perth	4.50
Sydney	3.82

The figure in the table represents typical average daily output from a 1 kWpeak solar system. The figure can be used to calculate the amount of electricity produced by multiplying the value in the table by the size of the solar array.

For example the table shows a solar system in Sydney should produce 3.82 kWh/kWp. A solar array of 2.5kWp should produce an average of 9.55kWh / day (2.5kWp x 3.82).

The calculated value is the daily average calculated over a full year. Seasonal variations including the number of daylight hours, temperature and cloud cover will heavily affect daily figures.

Comparing the figures

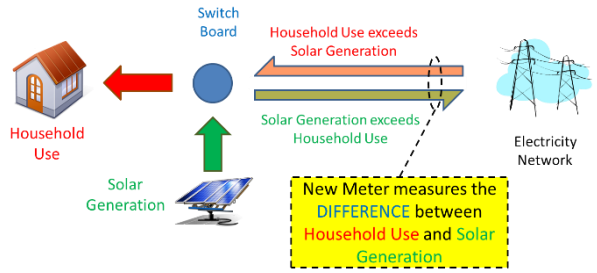
Using the PVWatts online tool households can calculate the average daily output for a solar system at their location (or if appropriate use the above table). Multiplying by the installed solar array size the household can calculate the typical average daily output they should expect.

The typical average daily output is compared to the measured daily average output obtained from values shown on the inverter display. If the measured inverter value is significantly lower than the calculated typical value then further investigation is probably warranted.

Why not use the new meter?

Households with solar receive a credit for the electricity their solar system sends to the electricity network. Households installing a solar system are often required to install a new meter able to measure electricity flowing both to and from the network. Unfortunately readings from this new meter cannot be used (directly) to check solar system performance.

The reason is that the new meter measures the *difference* between the output of the solar system and household use as shown in the following figure:



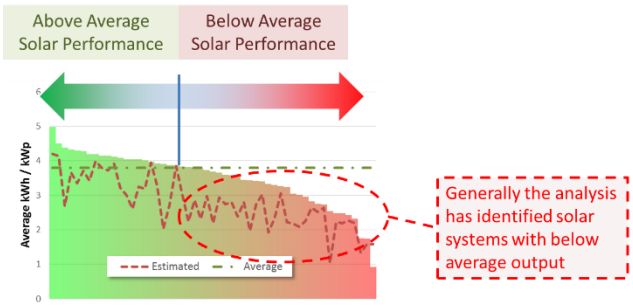
The figure shows the meter does not measure the output of the solar system. Instead it measures the amount of electricity used by the household LESS the amount produced by the solar system. This is why it is not possible to use the new meter to check the performance of the solar system.

Estimating Solar Performance using meter data

Realistically most households are unlikely to manually read the solar inverter. This means they are unaware when the performance of their solar system is below what might be possible. This presents an opportunity for third parties to offer a service to check (and possibly restore) solar system performance.

The daily output of solar systems depends on the amount of sunshine falling on the solar panels. Local weather patterns, including cloud cover, means the amount of electricity produced by solar systems located within a few kilometres of each other have similar outputs. Software programs can use this similarity to estimate solar system performance.

To demonstrate this possibility the author developed a software algorithm and applied it to a sample of 52 households located in the same Sydney suburb. The result is shown in the following figure:



This figure shows that the algorithm has (generally) identified solar systems with below average performance. While the result is encouraging the author acknowledges that more work is required and that the results are based on a small sample of meter data.

Conclusion

The installation of a domestic solar system represents a significant financial investment. Annual savings, used to recover the cost of the system, depend on solar system performance. This article has presented a number of simple checks households should perform to ensure their solar system continues to deliver annual savings.

More involved checks have also been described. These allow consumers to compare the actual performance of their solar system against a typical value for systems at their location. If issues are detected then the system should probably be checked by a qualified professional.

Unfortunately while the credit households receive from their solar system is calculated from meter readings, these meter readings cannot be readily used to check solar system performance.

Comments or Questions?

The author is happy to receive comments or questions about this article. He can be contacted at martin@drmartingill.com.au

References

PVWatts online solar tool provided by the National Renewable Energy Laboratory (pvwatts.nrel.gov)

Optimum Solar System Size in Sydney available from www.drmartin.gill.com.au

Citation

Clarifications

Source of Solar Data

The solar data used in this article was downloaded from the Smart Grid Smart City Information Clearing House. Only 52 installations were found with 12 months of data containing no missing readings.

Actual Solar System Performance

Several factors can decrease the solar system performance. These include shading and orientation of the solar array and inverter over voltage trips and efficiency.

Warning: Accuracy of inverter energy measurements

The accuracy of utility electricity meters is controlled by government legislation. This legislation does not include the accuracy of measurements made by the solar inverter. Calculations based on inverter measurements should only be considered estimates of solar system performance. Over time they can still be used to detect degraded performance.

About Dr Martin Gill

Dr Gill specialises in the provision of advice and data analysis to the energy industry. As a consultant he has prepared advice for government regulators, distributors, retailers, consumers, asset operators and equipment vendors.

Dr Gill has lead teams researching and developing new products across a broad range of industries, including advanced communication modems, burglar alarms, high voltage fault monitors and power quality analysers. One of his teams developed the first in home display and web-portal providing Australian customers the ability to view their electricity use. This innovation was recognised with the Green Globe Award, NSW Government's Premier's Award and Best New Product by the Australian Electrical and Electronics Manufacturers Association.