

Comparing solar with battery storage to solar only

Dr Martin Gill

Households considering the installation of a solar system may be offered the option of adding battery storage. The following considers if the extra cost of adding battery storage to the solar system is justified.

Introduction

Households wishing to lower their electricity bill can choose from multiple options. One option is to install a solar system. Sunlight falling on the solar panels is converted into electricity the household can use to reduce the amount they purchase from the network. The savings contribute to the purchase price of the solar system.

To maximise savings (on unsubsidised solar feed-in tariffs) households should try to use the output of their solar system. This can be difficult because solar systems produce most electricity in the middle of the day, when household consumption is typically low.

A recent innovation adds battery storage to the solar system. Battery storage increases the amount of solar output the household uses, increasing annual savings.

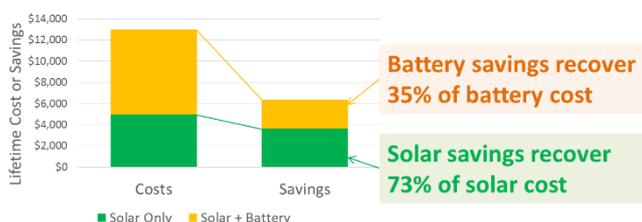
Battery storage solutions are expensive so the following considers if it is better to “install a solar system or to install a solar system with battery storage?”.

Results of the analysis

The installation of a solar system or a solar system with battery storage can lower annual electricity bills. Unfortunately focussing on short term savings risks overlooking the cost to install the systems.

The following compares the cost of the systems with the savings over a lifetime of 10 years.

57% of the total benefits are delivered by the solar system (but it is only 38% of the total cost)



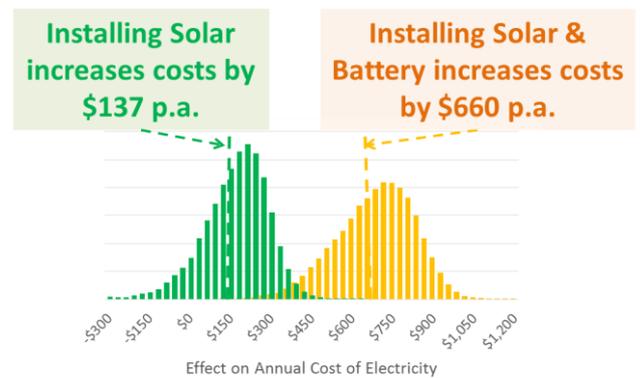
Comparing system cost to lifetime average savings

The figure shows the average household recovers 73% of the cost of the solar system. By comparison the

average household only recovers 57% of the cost of a solar system with battery storage (or just over a 1/3rd the additional cost of the battery storage system).

The average Sydney household considered above was calculated from 300 individual households assumed to have no existing solar system. Further analysis compares benefits from adding a solar system or a solar system with integrated battery storage.

The following figure summarises the effect of adding solar or solar with battery storage to the household's total cost of electricity.



Comparing total annual costs with solar and battery storage

The figure shows adding solar increases the average annual cost of electricity by \$137 p.a. Installing solar with battery storage increases the average annual cost by \$660 p.a..

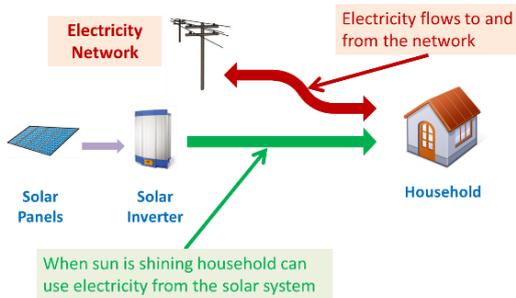
While some of the households receive a financial benefit from installing a solar system, none of the analysed households benefit from adding battery storage to the solar system.

The following sections explore these results in greater detail.

Details of the two systems

Solar System Only

A solar system comprises two main components. The solar panels and a solar inverter.



Network connected domestic solar system

When sunlight falls on the solar panels they produce electricity. The solar inverter converts the output of the solar panels into electricity which can be used by household appliances.

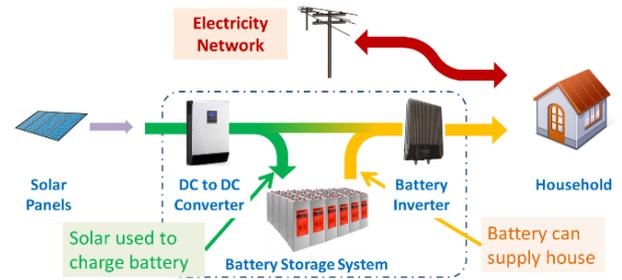
The amount of electricity produced by a solar system is determined by the total size of the solar panels, which is stated in kilo-Watts peak (kWp). This is the maximum amount of electricity the panels can produce under ideal test conditions. Various practical considerations mean the actual output of a solar system is always lower than the kWp rating.

After installing a solar system most households choose to remain connected to the electricity network. This is because solar systems only produce electricity when sunlight is falling on the panels. When the solar system is not producing enough electricity the household continues to purchase electricity from the network.

If the household does not use all the electricity produced by their solar panels the excess flows to the electricity network. On unsubsidised feed-in tariffs they receive a credit equivalent to the wholesale price of electricity, currently around 5c/kWh.

Solar with Battery Storage System

Adding battery storage to a solar system allows the household to store excess electricity produced by their solar system. The stored energy can be used to reduce the amount of electricity the household purchases from the network.



Domestic solar system with battery storage

The above figure shows a solar system with battery storage. In this system the output of the solar panels is connected directly to the battery system. An advantage of installing the battery system at the same time as the solar panels is the system can use one inverter. Using one inverter reduces the cost of the combined system by several thousand dollars (compared to installing the systems separately).

Important clarification: After installing the solar and battery storage system the household remains connected to the electricity network. Households considering using solar battery storage systems to disconnect from the electricity network should be aware they require a larger solar array and usable battery capacity than considered here. They should also consider installing an alternative onsite generator able to provide power when several days of cloudy weather reduce solar output.

Installed System Costs

Solar systems are available in a wide range of different sizes. This analysis considers the installation of 3kWp of solar panels.

Combined solar and battery systems are also available with a wide range of solar panel sizes and usable battery capacities. This analysis has considered a system using a solar panel size of 3kWp in combination with 6.5kWh of usable battery storage.

The details are summarised in the following table:

Summary of the two systems

Details	Solar Only	Solar + Battery
Installed Price	\$5,000	\$13,990
Solar Panel size	3kWp	3kWp
Usable Battery Capacity	-	6.5kWh

The prices were obtained from relevant websites. These indicate the price includes standard installation and assumes the household qualifies for Government solar rebates (currently around \$2400).

Current Electricity Costs (tariffs)

Choosing the cheapest electricity tariff is a simple way of reducing annual electricity costs. The Energy Made Easy website was used to select a fixed and time of use (ToU) tariff offered to Sydney households.

Single Rate Tariff used for the analysis (including GST)

Tariff	Price (cents per kWh)
First 10.9589kWh/day	22.24376
Second 10.9589kWh/day	21.94016
Remainder	21.6568
Daily Supply Charge	72.6

Time of Use Tariff used for the analysis (including GST)

Tariff	Price (cents per kWh)
Peak (2pm to 8pm weekdays)	38.29
Shoulder (all other times)	16.03
Off-Peak (10pm to 6am daily)	9.04
Credit for excess solar	5.0
Daily Supply Charge	82.72

After installing the solar system or solar system with battery storage the analysis assumes the household chooses a ToU tariff.

Data used for the analysis

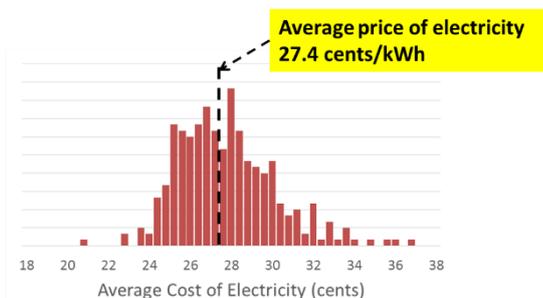
The analysis is based on actual measurements taken at 300 Sydney households over a period of three years. The data provides separate 30 minute measurements of household electricity consumption and solar system output.

Average Price of Electricity

Before

The analysis starts by using actual household consumption to calculate the total annual cost of electricity on the fixed and ToU tariff. The lowest annual cost is selected as the baseline.

The lowest annual cost is divided by the total amount of electricity used by the household giving the average price of electricity.



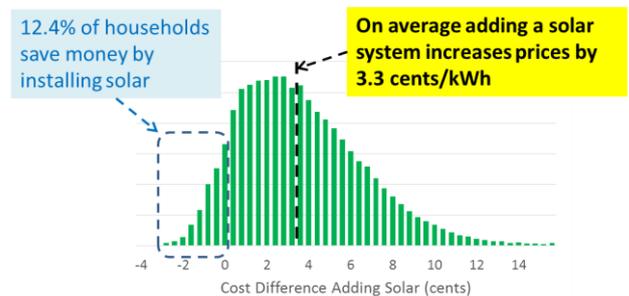
Average Cost of electricity (no solar system)

The following sections compare how adding solar or adding solar with battery storage affects the average price of electricity.

Adding Solar (Only)

After installing a solar system the household continues to use the same amount of electricity. The difference is some of the electricity is produced by the solar system. Purchasing less electricity from the network reduces their annual electricity bill.

Savings are offset by the cost to purchase the solar system. The cost of the solar system is included in the calculation of the average price. To highlight the benefit of installing the solar system the following figure plots the difference between the average price for each household with and without a solar system.



Comparing benefit of adding a solar system

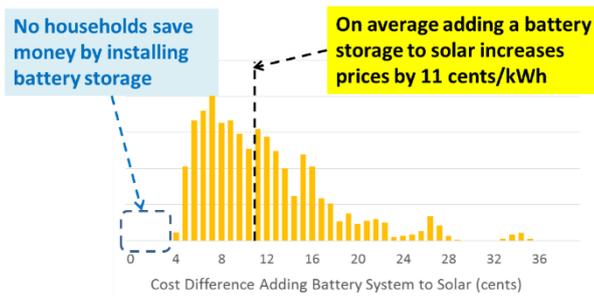
The analysis shows the installation of a solar system lowers the price of electricity for 12.4% of the analysed households. For the remaining households installing a solar system increases the price of electricity.

On average adding a solar system increases the cost of electricity by 3.3 cents/kWh. As an alternative to installing their own solar system consumers can pay a premium for electricity from renewable sources. The premium for 100% GreenPower is currently around 5 to 6 cents/kWh. The analysis reveals GreenPower is a lower cost option for around 20% of households wishing to support renewable energy.

Adding Solar with Battery Storage

On unsubsidised feed-in tariffs excess electricity generated by the solar system earns a credit of 5 cents/kWh. The peak rate on the ToU tariff is 38.29 cents/kWh. On this ToU tariff each kWh stored in the battery and used during peak times saves the household approximately 33 cents.

The following figure shows the average price difference of adding 6.5kWh of usable battery storage to a 3kWp solar system.

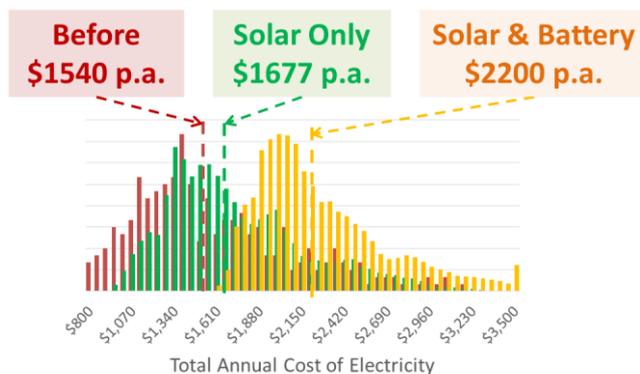


Cost difference adding battery storage to solar

The figure shows no households benefit from adding battery storage to the solar system. In all cases adding battery storage increases the cost of electricity. On average adding a battery storage system increases electricity prices by 11 cents/kWh.

Annual Cost of Electricity

The following figure compares the annual cost of electricity for the three options.



Comparing total annual costs with solar and battery storage

The figure shows across the 300 households the annual electricity bill varies from \$680 to \$3100. This wide variation makes it difficult to observe the effect of adding solar or solar with battery storage. For example this view does not show the 12% of households who receive a financial benefit from installing a solar system. The figure is only included for completeness.

Conclusion

The installation of a solar system or a solar system with battery storage can lower annual electricity bills. Unfortunately focussing on short term savings risks overlooking the cost to install the systems.

When the current costs to install the system is included in the calculations the analysis reveals just over 10% of the households received a financial benefit from the installation of a solar system.

The analysis also reveals none of the households receive a financial benefit from installing a battery storage in addition to the solar system.

Comments or Questions?

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

Citation

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About Dr Martin Gill

Dr Gill is an independent consultant specialising in the provision of advice and data analysis to the energy industry. He has provided this advice to government regulators, distributors, retailers, consumers, asset operators and equipment vendors.

Dr Gill has a broad technical background having personally developed advanced communication modems, burglar alarms, electricity meters, high voltage fault monitors and power quality analysers.

Dr Gill is a metering expert. His innovative products have been recognised with the Green Globe Award, NSW Government's Premier's Award and Best New Product by the Australian Electrical and Electronics Manufacturers Association.

Analysis using Interval Data

The modelling uses 30 minute interval data. For each half hour the difference between household consumption and solar system output is calculated.

- When solar system output exceeds household consumption the battery is checked to determine if it can store the excess. If the battery is already fully charged the excess is sent to the network.
- During non-peak periods: When solar system output is less than required the shortfall is purchased from the network.
- During peak periods: When solar system output is less than required the battery is checked to determine if it can meet the short fall. This is limited to the nominal output power and maximum depth of discharge. If the battery is unable to supply all of the shortfall the remainder is purchased from the network.

Three years of household use and solar system output are used to calculate each point. The calculation is repeated twice, once for the first year with 100% Usable battery capacity and again for the 10th year with the battery capacity reduced to 80%. Linear battery degradation is assumed between the two values.

References

Source of Interval Data : ausgrid.com.au

Source of current tariffs: Energy Made Easy (energymadeeasy.gov.au)

Solar and Battery System Prices : (aglsolar.com.au/energy-storage/)

Solar System Price: (solarchoice.net.au)

Points of Clarification

Years to recover system costs

This article considers financial results over a period of 10 years. None of the households recover the cost of the battery system even after 10 years (as indicated by increased electricity costs). Only 12% of the households recover the cost of a solar system within 10 years.

Solar and solar with battery storage systems are rarely guaranteed beyond 10 years. Calculations beyond 10 years must include additional costs to repair or replace the system.

The calculations assume after 10 years usable battery capacity has decreased to 80%. Beyond 10 years the usable battery capacity begins to decrease rapidly reducing potential savings.

Cost of Capital

The analysis does not include interest rate payments on loans taken out to pay for the systems. Interest paid on any loan increases the average price per kWh for both solar and solar with battery storage.

Maintenance

Experts recommend annual inspection of battery storage systems to ensure continued safe operation. The cost of these inspections has not been included in the calculations.