Number of years to recover the cost of battery systems

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One of the first questions consumers should ask is “How long does it take for the savings from the installation of a battery system take to recover the cost?”. The following seeks to answer this question.

Introduction

The following considers how many years it takes a household to recover the cost of installing a battery system. This involves considering

- lifetime of the battery
- annual savings delivered by the system
- installed cost of the battery system
- lifetime of the electronics

These factors are considered in the following.

Battery lifetime

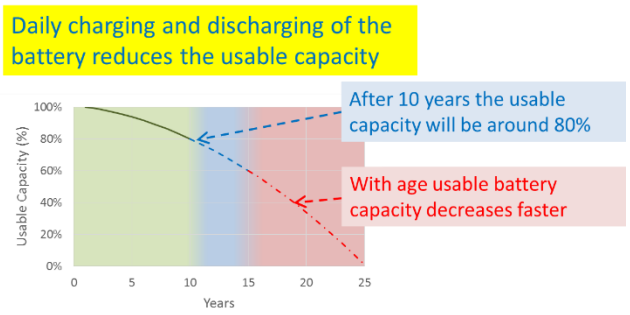
Mobile Phone / Laptop Batteries

When a brand new mobile phone or laptop is used for the first time we are generally amazed at how long the battery lasts (compared to the phone/laptop it replaced). Then only a year or two later we are considering replacing the phone/laptop because the battery does not last anywhere near as long.

This often dramatic decrease in battery lifetime is sometimes blamed on the software, but in most cases it is degradation of the battery which is the primary reason for the reduced run time.

Storage Batteries

Several different battery technologies are currently being proposed for use in household battery storage systems. Similar to mobile phone/laptop batteries the capacity degrades slightly each time they are charged and discharged. The cumulative effect of this gradual degradation is shown in the following figure:

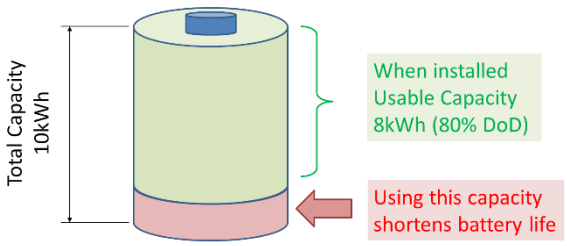


Daily charging and discharging reduces the usable battery capacity

Battery degradation is not linear. As shown in the figure the rate increases with age. This explains why we notice the limited runtime of a 2 year old mobile phone. Once the usable capacity falls below 80% battery degradation is accelerating and the daily runtime becomes noticeably shorter each week.

Usable Capacity

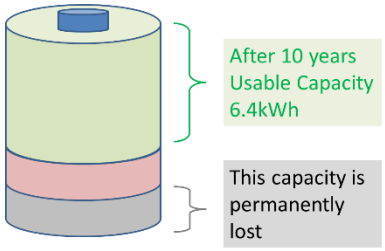
The lifetime of rechargeable batteries is related to the amount of energy removed during each cycle. This is referred to as the depth of discharge (DoD). For example a battery storage system may state its lifetime is 10 years when used at 80% DoD. Exceeding the recommended DoD increases the rate of battery degradation.



Usable battery capacity when battery installed

The above figure depicts a battery storage system with a total capacity of 10kWh. Assuming the recommended DoD is 80% then the usable capacity when the system is first installed is 8kWh. The remaining 2kWh should not be used without increasing the rate of battery degradation.

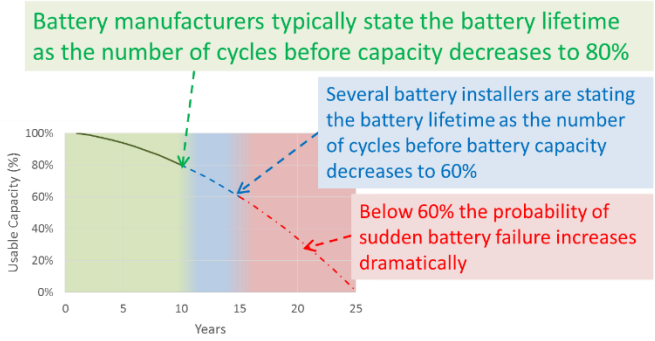
After 10 years of daily charging and discharging the battery capacity will have degraded.



Usable battery capacity after 10 years

The above figure shows the effect of battery degradation. After 10 years some of the battery capacity is permanently lost. This reduces the usable battery capacity.

Battery installers should clearly state the battery lifetime and the daily maximum depth of discharge required to ensure this lifetime.



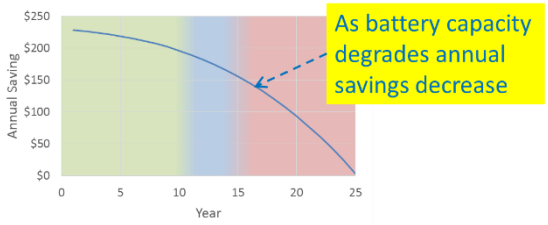
Typical usable battery capacity for quality storage batteries

Battery manufacturers test their batteries and typically state the battery lifetime as the number of charge/discharge cycles for the battery capacity to reduce to 80%. The figure of 80% is not enforced, allowing battery installers to choose different figures. A check of several battery installer websites found some choose to quote the battery lifetime as the number of cycles before battery capacity decreased to 60%. There is nothing wrong with this but it does highlight the need to carefully check the figures being presented.

Below 60% usable capacity the likelihood of sudden battery failure increases dramatically (this is particularly true for battery storage systems using lead acid batteries).

Including the effects of battery degradation

The economic value of a battery storage system depends on the amount of energy it can store. As shown above battery degradation reduces the amount of energy the system can store, decreasing the economic value. This is shown in the following figure:

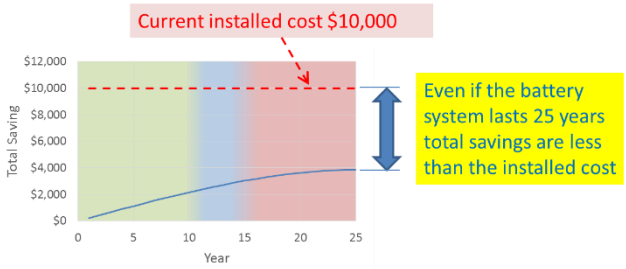


Effect of battery degradation on annual savings

The above figure shows calculated annual savings for a typical Sydney household installing a battery system with a usable capacity when new of 6.5kWh. As battery capacity degrades annual savings also reduce.

Theoretical Years to Recover Cost

Households recover the cost of the battery system when total annual savings equal the cost to install (and maintain) the battery storage system. The following figure therefore plots total savings:



Effect of battery degradation on annual savings

The figure shows on current electricity tariffs and battery system prices this household never recovers the cost of the battery system. This occurs because:

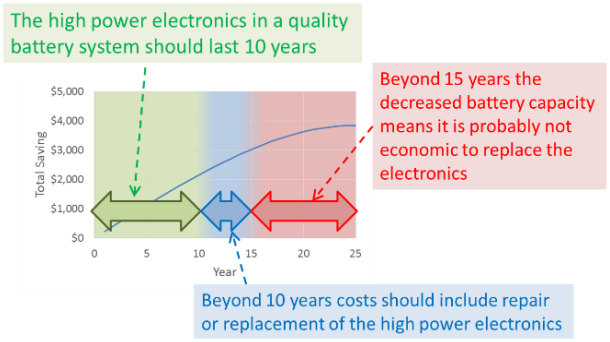
- Battery degradation reduces annual savings in later years
- Battery systems are currently relatively expensive

It is emphasised that the above is a theoretical calculation because it only considers the battery.

Other components in the battery system

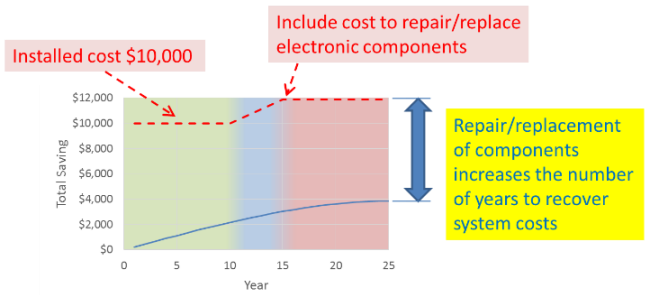
A battery storage system comprises several other critical components. Of relevance to this discussion is the electronics, especially the high power electronics used in the battery charger and battery inverter.

A quick review of several battery installer websites suggests warranty periods for the electronics is between 5 and 10 years.



Lifetime of other battery system components

As noted on the above figure beyond 10 years financial calculations should include the cost to repair or replace the high power electronics (estimated to be around 20% of the system cost). These costs are included in the following figure:



Including the cost of repair/replacement

The above figure shows including the cost to repair or replace the high power electronics increases the number of years required to recover the total system cost.

Beyond 15 years the probability of a system failure becomes increasingly likely. With battery system prices anticipated to continue decreasing it raises the financial question of whether it is worth repairing an old system (with decreased battery capacity and aged electronics) or completely replacing the entire system? Most households will probably choose to replace the entire system suggesting financial returns should be limited to a maximum of 15 years.

A final thought

It is noted the average Australian homeowner moves every 7 to 8 years. This suggests unless households recover the cost of installing a battery system in less than 7 to 8 years they do not receive a financial benefit. (Possible Capital Improvement value is considered in the Points of Clarification at the end of this article)

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Conclusion

Daily charging and discharging of batteries reduces their available capacity. Over short periods this gradual degradation does not significantly affect economic calculations.

Battery storage systems are currently a long term investment and beyond 10 years the effects of battery degradation begins to significantly reduce financial benefits.

Using current battery technologies and current battery storage system prices analysis suggests households never recover the cost of the battery system.

The batteries are only one component of the storage system. Other components also affect the economic life of the system and calculations beyond 10 years should factor in the costs to repair or replace these components.

Citation

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.

Comments or Questions?

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

Points of Clarification

Annual Savings shown above

The annual savings shown above are taken from the article "Adding Battery Storage to Solar Systems". The presents analysis of the economics for 300 Sydney households with an existing solar system of 2.5kWp choosing to install a battery system with a usable capacity of 6.5kWh. The selected household achieved the highest return on investment over 25 years. The full article is available from www.drmartingill.com.au

New Battery Technologies

Battery manufacturers continue to improve the endurance of their batteries. The use of new materials can reduce the rate of electrode degradation (mainly oxidisation) and extend the usable battery lifetime.

Research into alternate battery technologies is currently underway. Some preliminary announcements suggest new designs may provide usable lifetimes beyond what has been presented.

Capital Improvement

It has been suggested a household installing a battery storage system can recover the cost through capital improvement of the property. Assigning a value to capital improvement is extremely difficult, especially when buyers may not want the hassle of annual maintenance of the battery system (analogous to new owners not wanting the hassle of maintain a domestic swimming pool).

Once the hype around battery storage systems settles buyers are likely to consider the economic value they may receive from the battery storage system. As the above analysis shows old battery systems provide very little value. This situation has already been observed, with the price of second hand hybrid cars remaining high while the car's battery pack remains in warranty, but decreasing rapidly as the age of the battery pack approaches end of life.

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While the price of domestic battery storage systems is currently high, prices are expected to continue decreasing (Some sources have predicted prices will halve in less than 10 years).

The above two factors combine suggesting the real value of an installed battery system is lower than its original purchase price.

There might be some residual value in the cost of household wiring modifications undertaken during the original installation. Even here continuing improvements to household wiring standards may require further wiring upgrades when a new battery storage system is installed.