INVESTING IN SOLAR PANELS

SUMMARY

The author lives in a large house that has a large reverse cycle air conditioner that uses a significant amount of power to heat and cool the house. Two people live and work from the home. Compared with an average Canberra household with four people, the author's house uses 2.5 times more electricity. With the price of solar panels falling significantly in the past five years, the author believed that if any household was to benefit from installing solar panels, his own would. This paper investigates the financial benefits of investing in solar panels.

In November 2014, three quotes were obtained from ActewAGL to install three different sizes of solar arrays; a 5kWh, 4kWh and a 3kWh system. Although there are many variables that influence the benefits and costs of each installation, there is one variable that dominates all others. This is the ability of a household to consume the power provided by the solar panels when it is generated for 365 days of the year, for 15 years. Every time the household falls short of this ideal consumption pattern they move further away from a viable investment.

As this paper will show most, if not all, Canberra households will not be able to consume anywhere near this ideal pattern so they should hesitate before investing in solar panels. Although the taxpayers are heavily subsidising this investment, it still may not be a good investment for consumers to make.

INITIAL CONSIDERATIONS

To place a boundary around this cost benefit view, the financial benefits of the worst and perfect case were established. Every installation in Canberra would then fall between these two positions.

The cost of electricity in December 2014 was 15.037cents per kWh. A consumer would avoid this cost if he consumed the same power from his solar panels. However, most of the time the solar panels will produce more power than the consumer can use and this excess is fed back into the power grid and will be bought by ActewAGL for 7.5 cents per kWh.

The Worst Case

If the house is empty and all solar electricity is fed back into the electricity grid, the consumer will receive 7.5 cents per kWh.

The table below summarises the results for the three solar systems. Obviously, this is a poor investment and it should not be considered.

Table 1 – Worst Case Summary -15 Year

SOLAR PANEL SIZE	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 15 YRS	IRR FOR 15 YRS
5kWh	$456.00	24 years	-$3,987.87	-3.90%
4kWh	$365.00	26 years	-$3,976.14	-4.94%
3kWh	$274.00	27 years	-$3,078.44	-5.03%

Tables 1 & 2 show the following for all three solar panel systems;

- Average money received each year,
- The approximate time in years it will take to recover the initial investment – a "break even" point, using nominal dollars not present or future dollars.
- The net present value (NPV) of the investment over 15 years. This is what your investment will be worth in today's dollars assuming 3% inflation.
- The internal rate of return (IRR) is for the investment. This is a percentage figure that can be compared with alternative investments – say a fixed interest investment. Unlike the NPV calculation, this calculation does not consider the time value of money (e.g. erosion of the dollar return by price inflation [e.g. CPI]).

The Perfect Case

Although nearly impossible to achieve, the perfect case does show the best return a consumer could obtain. The perfect case occurs when the household uses all the electricity produced by the solar panels, *when it is being produced* throughout the day, for all the years of the investment. Table 2 details the results for this perfect case.

Table 2 –Perfect Case Summary – 15 Year

SOLAR PANEL SIZE	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 15 YRS	IRR FOR 15 YRS
5kWh	$913.00	13 years	$1,434.84	5.11%
4kWh	$730.00	14 years	$281.91	3.47%
3kWh	$548.00	14 years	$115.40	3.35%

It is unlikely for either of these cases to be met but they do give a very clear boundary around the likely investment return on solar panels. In practical terms, a working couple who go to work at 8am and return after 5pm would be closest to the "worst case" as most if not all the electricity produced during the week will be returned to the electricity grid. They would however receive a higher return on the weekend by consuming some of the solar panel electricity during daylight hours.

A retired couple or a family who works from home will be closest to the "perfect case", as they may be able to consume electricity at the same or greater rate while the solar panels are generating electricity during daylight hours. However, this will be very difficult to maintain every day throughout fifteen years.

Both the worst and perfect case figures in Table 1 and 2 are for a 15 year investment period. It was decided to use a 15 year investment period because the system being considered *might* not need any maintenance during this period.

Although the solar panels might work without maintenance for 25 years, the inverter will not and will probably need to be replaced (The inverter only has a 10yr warranty). Any additional expenditure such as this will seriously reduce the investment return. Once estimates of such costs are subtracted from the NPV figures, it can be seen how easily an acceptable return becomes unacceptable.

Calculations for a 10 and 25 year period are given in Annex A These calculations show a better return using a 25 year investment period, but the figures are based on the very fragile assumption that the solar system will work perfectly for all this period without incurring any maintenance costs.

DISCUSSION

To grasp why it is difficult to achieve the perfect case, an understanding of "base load power" is needed. Base load power is the minimum consumption of power that is sustained over a long period of time – in this case the daylight hours when the solar panels are working.

If a household always left a computer, two lights and say a fan on 24 hours of a day, then the power these items consumed would be the base load power for the household. All other devices that consumed power should be considered as "peak" power devices.

A clothes dryer, oven, hot plates, hot water system, or a reverse cycle air conditioner all use a lot of power but none of these will be going all through the daylight hours. Therefore this electricity consumption cannot be considered as base load power. Even fridges and freezers that "you leave on all the time" are turning themselves on and off throughout the day and, consequently, cannot be considered as base load power devices.

What can be confusing is the knowledge that in some daylight hours you could have used more power than the solar panels have generated. However, much of the solar power has still been returned to the grid. This occurs when the consumption of one or a combination of peak power devices requires more power than the solar panels can provide *when those devices are on*. The excess power not being met by the solar panels *during this time* is provided from the grid. As soon as these devices are off, solar power above the base load power is again being returned to the grid.

Even the smallest solar panel array (i.e. 3kWh system) will produce significantly more power than the base load power requirements for most, if not all, of Canberra's households. If peak load power devices do not capture all the remaining power produced by the solar panels during daylight hours, the investment in the solar panels progressively becomes sub-optimal.

The ratio between how much solar power is used by the consumer and how much of the solar power is returned to the grid determines where a household sits on the investment continuum between the "worst case" and "perfect case" outcomes. Most households in Canberra whatever the size of the solar panel system will have difficulty exceeding a 50:50 ratio – 50% solar power used by the consumer: 50% solar power fed into the grid.

There will be a tendency to be optimistic in gauging how high this ratio might be. However, it should be remembered the investment is for every day over many years (e.g. 15 years) and, although on some days a household might have a high ratio there will be other days when most if not all power will be returned to the grid. For example, every time you go on holidays or leave the house for most of the daylight hours (e.g. going to work), there will be a very low ratio. Or in autumn and spring when you do not need power "hungry" cooling or warming, there will be a low ratio. Even on the days you don't use your washing machine, clothes dryer, or oven the ratio will fall.

In the author's house in November, the three solar systems would produce between 13-22 kWh yet, on a 25 degree day, daylight consumption (both base and peak) only averaged 7kWh. When temperatures rose to 33 degrees daylight consumption rose to average 15kWh as the air conditioner was used. However, that air conditioner was going on and off automatically throughout the day and consequently was only using solar power for approximately 50% of the time.

In contrast, on a very cold weekend day with everyone at home in the middle of winter when solar power generation is low, consumption will be high which might give a high ratio (say approximately 90%). However, this situation does not happen all year, for 15 years.

MORE DETAILED CALCULATIONS

This section will summarise the investment performance of each system showing different usage ratios so the reader can grasp the sensitivity of this ratio as it changes. The first column in each table lists five ratios of Consumer use to Grid use (i.e. 50:50 up to 90:10) and compares these with the perfect case detailed in the last row. The remaining columns are the same as in Table 1 & 2.

The 5kWh System

Table 3 –5kWh system with different ratios – 15 Year

5kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 15 YRS	IRR FOR 15 YRS
(Consumer : Grid)				
50:50	$731.89	17 years	-$1226.44	1.07%
60:40	$780.84	16 years	-$694.18	1.92%
70:30	$585.99	14 years	-$161.93	2.75%
80:20	$878.75	13 years	$370.33	3.56%
90:10	$927.70	12 years	$1,388.70	5.03%
Perfect Case	$976.65	11 years	$1,434.84	5.11%

The 4kWh System

Table 4 –4kWh system with different ratios – 15 Year

4kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 15 YRS	IRR FOR 15 YRS
(Consumer : Grid)				
50:50	$585.51	23 years	-$1,847.11	-0.34%
60:40	$624.67	20 years	-$1,421.31	0.47%
70:30	$663.84	17 years	-$995.50	1.25%
80:20	$703.00	16 years	-$569.70	2.01%
90:10	$742.16	14 years	$245.00	3.41%
Perfect Case	$781.32	14 years	$281.91	3.47%

The 3kWh System

Table 5 –3kWh system with different ratios – 15 Year

3kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 15 YRS	IRR FOR 15 YRS
(Consumer : Grid)				
50:50	$411.00	20 years	-$1,481.37	-0.51%%
60:40	$439.00	18 years	-$1,162.02	0.29%
70:30	$466.00	17 years	-$842.67	1.06%
80:20	$494.00	16 years	-$523.31	1.81%
90:10	$548.00	15 years	$87.71	3.19%
Perfect Case	$550.00	14 years	$115.40	3.25%

Discussion

Both the above tables and those in Annex A show that the best investment requires the largest solar panel system and preferably the longest maintenance free investment period.

When using a 15 year investment period and the 5kWh solar system, households will still need to achieve a greater usage ratio than 70:30 to make the investment viable.

All the sub-optimal investment figures in the tables above have a red font.

LESS THAN IDEAL

All the calculations made so far have been ideal or optimistic figures. This section will discuss "What can go wrong?", or the less than ideal situation.

Price of Power Returned to the Grid

In December 2014, ActewAGL paid consumers 7.5 cents per kWh when electricity was returned to the grid. ActewAGL makes it very clear that it is not compelled to do this (i.e. there is no contractual obligation) and it will determine the price that households will receive in the future. Presently, the company is purchasing power at one of the lowest prices in the World and, consequently, has no incentive to increase this price. They are more likely to reduce this price rather than increase it.

If too many people continue installing solar panels, ActewAGL will face the same problem that households are facing. They could be receiving more power in the daylight hours that they can use. No energy company will pay anything for power they cannot use. One way that ActewAGL can prevent this oversupply problem is by reducing the price paid for power being returned to the grid as a disincentive.

If the amount of cheap electricity from solar panels increases, then it is conceivable the 15.037 cents per kWh cost will also drop.

Consequently, consumers cannot assume that the two prices used in the calculations will be maintained for the full 15 years of the investment.

Maintenance Costs

The calculations have assumed cost free maintenance.

Dirty solar panels or trees shading just a small part of the solar array can cause a significant degradation in the solar power output. The calculations assume the consumer is not only maintaining the panels perfectly but his time undertaking such maintenance is costing nothing.

As discussed earlier, any hardware failures or problems during the investment period will undermine the investment return. For example ActewAGL warn that during installation, additional costs for modifying the meter box may be necessary. Also, the inverter may not last for 15 years and will need to be replaced.

Any such additional costs should be deducted from the NPV figure for the investment. Since most of these NPV figures are less than $2,000, such maintenance costs could quickly degrade an investment by 40-100%.

At the end of the investment period, the calculations have assumed that the solar panels are removed and sold, and the roof has been returned to its original condition. The calculations have optimistically assumed that the net costs of these activities have been a profit of $750 for a 10yr investment, a profit of $100 for a 15yr investment, and $0 for a 25yr investment. Any shortfall from these figures should also be deducted from the NPV figure which will reduce the investment return.

Assumptions

Most of the assumptions made for these calculations have been provided by ActewAGL and are listed in Annex B. These assumptions have been accepted at face value. If they are neutral assumptions (i.e. neither optimistic nor pessimistic), then there will be half the customers who may receive better performance from their panels, and half that receive worse performance. For the latter group their investment return will be lower than shown in these calculations.

If the assumptions are optimistic, then all will receive a lower investment return.

House Occupancy

The calculations assume that you will own your house for the whole of the investment period. This is unlikely for most people as they leave Canberra or buy another house. In this situation it is unlikely that owners will be compensated for their investment in solar panels. However, the new occupants, who have not contributed to the investment, will benefit significantly.

CONCLUSION

Although every person and situation will differ, investing in solar panels in Canberra in December 2014 is not a good investment. Better returns with lower risks can be achieved with many other investments.

Annex A – 10 & 25 Year Investment Period

The 5kWh System - 10 Year

Table 1 –5kWh system with different ratios – 10 Year

5kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 10 YRS	IRR FOR 10 YRS
(Consumer : Grid)				
50:50	$700.00	15 years	-$2,908.73	-3.31%
60:40	$747.00	14 years	-$2,520.13	-2.41%
70:30	$794.00	13 years	-$2,131.53	-1.53%
80:20	$841.00	13 years	-$1,742.93	-0.67%
90:10	$910.00	12 years	-$1,011.88	0.91%
Perfect Case	$930.00	11 years	-$965.73	1.0%

The 4kWh System - 10 Year

Table 2 –4kWh system with different ratios – 10 Year

4kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 10 YRS	IRR FOR 10 YRS
(Consumer : Grid)				
50:50	$561.00	16 years	-$3,099.83	-4.55%
60:40	$598.00	15 years	-$2,788.95	-3.73%
70:30	$635.00	14 years	-$2,478.07	-2.93%
80:20	$673.00	14 years	-$2,167.20	-2.14%
90:10	$728.00	13 years	-$1,582.35	-0.68%
Perfect Case	$747.00	12 years	-$1,545.44	-0.60%

The 3kWh System - 10 Year

Table 5 –3kWh system with different ratios – 10 Year

3kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 10 YRS	IRR FOR 10 YRS
(Consumer : Grid)				
50:50	$411.00	17 years	-$2,304.53	-4.12%
60:40	$439.00	16 years	-$2,071.37	-3.35%
70:30	$466.00	15 years	-$1,838.21	-2.59%
80:20	$494.00	14 years	-$1,605.05	-1.85%
90:10	$548.00	14 years	-$1,166.42	-0.46%
Perfect Case	$550.00	13 years	-$1,138.74	-0.39%

The 5kWh System - 25 Year

Table 1 –5kWh system with different ratios – 25 Year

5kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 25 YRS	IRR FOR 25 YRS
(Consumer : Grid)				
50:50	$654.00	22 years	$1.920.35	4.86%
60:40	$698.00	21 years	$2,667.12	5.55%
70:30	$745.00	20 years	$3,413.90	6.21%
80:20	$788.00	19 years	$4,160.68	6.86%
90:10	$828.00	19 years	$4,907.46	7.50%
Perfect Case	$872.00	18 years	$5,654.24	8.13%

The 4kWh System - 25 Year

Table 2 –4kWh system with different ratios – 25 Year

4kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 25 YRS	IRR FOR 25 YRS
(Consumer : Grid)				
50:50	$523.00	23 years	$658.22	3.73%
60:40	$558.00	22 years	$1,255.64	4.38%
70:30	$593.00	21 years	$1,853.06	5.00%
80:20	$628.00	21 years	$2,450.49	5.61%
90:10	$663.00	20 years	$3,047.91	6.20%
Perfect Case	$698.00	19 years	$3,645.33	6.79%

The 3kWh System - 25 Year

Table 5 –3kWh system with different ratios – 25 Year

3kWh System Different Ratios	$ RETURN (avg.) EACH YEAR	BREAK EVEN POINT YRS	NPV FOR 25 YRS	IRR FOR 25 YRS
(Consumer : Grid)				
50:50	$392.00	24 years	$382.50	3.56%
60:40	$418.00	23 years	$830.57	4.20%
70:30	$445.00	22 years	$1,278.63	4.82%
80:20	$471.00	21 years	$1,726.70	5.42%
90:10	$497.00	20 years	$2,174.77	6.10%
Perfect Case	$523.00	19 years	$2,622.83	6.58%

Annex B - ASSUMPTIONS

ACTEWAGL Assumptions:

These have been taken from an ACTEWAGL quote.

"We've prepared this on the basis of:

1. Panels installed in 3 arrays with size, direction & tilt (degrees) - 8 panels (2kW) 290 & 30, 5 panels (1.25kW) 20 & 30 and 3 panels 0.75kW) 20 30
2. Your most recent 12 months electricity consumption data 19659 kWh p.a.)
3. The Australian Energy Market Operator's profile of an average customer in the ActewAGL Distribution network area
4. The Clean Energy Regulator's Zone 3 rating (which means 1,382kWh of annual solar production for each 1kW of solar generating capacity)
5. Our 2014/15 ACT electricity prices for our 'Home Saver+ plan'
6. Our current rate for exports (7.5c/kWh) under the 'ActewAGL ACT Small Generator Buyback scheme' tariff. This is not a government mandated scheme; it is offered by us on a voluntary basis. We may at any time vary the rate or withdraw the scheme without notice. [qtv103-70]

NB. The performance of a PV System is subject to a number of variable factors beyond ActewAGL's control. These include, but are not limited to the available hours of sunlight, cloud cover and other weather occurrences, the location of the PV System, and the location of any other trees, plants and structures on Your or neighbouring Premises.

Except to the extent to which we are required by law, ActewAGL does not guarantee the performance of, and accepts no responsibility whatsoever, in the event that the performance of the PV System is lower than predicted."

Author's Assumptions

1. Performance of the Trina solar cells will fall 1% per annum for 25 years.
2. NPV Calculations: a 3% CPI figure was used to discount future cash flows.
3. NPV Calculations: The positive cash flow assumed at the end of the investment period was: $750 for 10 year investment period, $100 for 15 year investment period, $0 for 25 year investment period.
4. IRR Calculations: No "hurdle" figure (e.g. inflation rate) was used in the calculation.
5. Electricity used costs 15.037 cents per kWh. Electricity returned to the grid earned 7.5 cents per kWh.
6. Red font is used in the Tables to indicate a poor investment. For example: breakeven points that exceed the investment period, negative NPV values, and IRR values less than 3%, which could be less than inflation.
7. Costs of each solar system and their annual output are: 5kWh $9,522 and 6494 kWh per annum; 4kWh $8,522 and 5196 kWh per annum; 3kWh $6,506 and 3897 kWh per annum.