

## Small-scale renewable energy - two case studies

What would it take for more people to risk some of their hard earned cash in a household renewable energy project? A growing concern about climate change? ..... Possibly. A better than decent return on investment? .... More likely.



Depending on where you live and the type of renewable energy solution chosen, a decent return on investment is now on offer, helped in no small way by generous government rebates and feed-in tariffs<sup>1</sup>. Following are two case studies of a recent personal experience in this area by a member of the investment team.

### 1. Solar Photovoltaic

Spurred on by the rising price of electricity and encouraged by generous incentives, one of us recently investigated the option of putting solar panels on our house. The solar panel system would generate "green" electricity and help offset some of our existing household electricity usage.

<sup>1</sup> Feed-in tariffs are the price your electricity supplier pays you for the green energy you generate and feed back into the power grid – is often much higher than the price paid for grid provided power



## Solar panels on our roof

Our traditional Californian Bungalow house, although pointing in the right direction (i.e. north facing roof), was less than ideal due to its modest size and the affect of earlier alterations. About ten years ago the roof space was converted into a 2<sup>nd</sup> storey attic, creating a large room for general retreat. Unfortunately the 2<sup>nd</sup> storey dormer windows have now reduced the usable north facing roof space that can be devoted to solar panels.



"Google maps" picture of our house roof

Not to be deterred, a couple of solar panel companies were duly called and quotes requested for turning the available roof space into a mini renewable power generator. The system would be connected to the local power grid. Excess energy not used by the house would be fed back into the grid for others to use.

## How photovoltaic's work

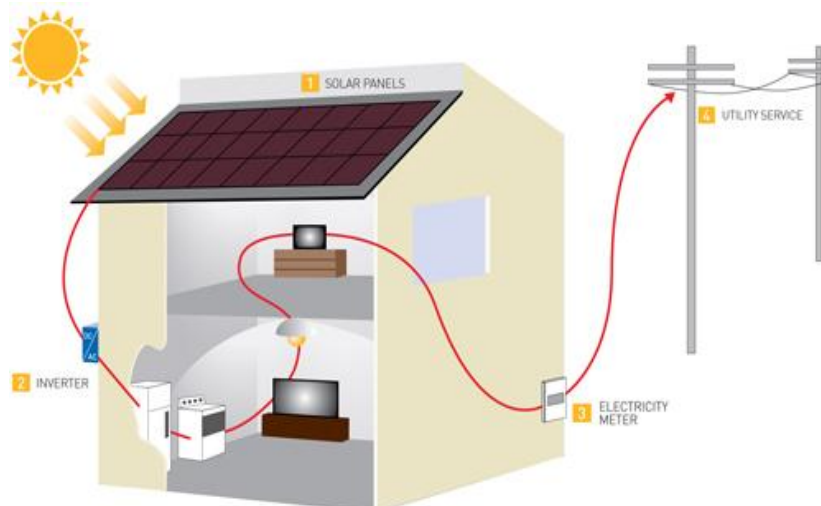


Diagram 5. Solar panels at work



Before we get to the specifics of the roof installation, let's briefly recap on what is a grid connected solar panel system and how photovoltaic (PV) solar panels work. In short, a photovoltaic solar panel consists of an array of individual solar cells made of very pure silicon (the expensive bit) arranged on a panel and sandwiched between toughened glass. Photons (sunlight) hit the panel causing the release of some electrons from the silicon. The electrons start to flow thus generating electrical energy.

PV panels have been around since the early 1940's although the PV effect was first observed during the 1800's. The panels have no moving parts and are long lasting with a typical useful life of 25-40 years (and possibly longer). The average efficiency of current solar panel technology in converting available sunlight into electrical energy is about 10-12%. This has improved from under 5% efficiency when first developed.

The energy available in sunlight at a latitude equivalent to Sydney averages at around 1000 watts (1Kw) per square metre during peak daylight hours (about 5-6 hours per day averaged over a year - a capacity factor of approximately 25%). Solar panels will generate 100-120 watts per square metre at the current 10-12% efficiency levels.

The other expensive bit of kit in a solar panel system is the inverter that converts the typically 12-48V DC power from the solar panels into 240V AC power that can be fed back into the local power grid. Lastly we need an extra meter to measure the electricity we generate so we can get paid for it.

### **Renewable Energy Certificates (RECs)**

In Australia, Renewable Energy Certificates (RECs) are electronic certificates that reside on a publicly available Internet database. RECs are generated under the Federal Government's Mandatory Renewable Energy Target (MRET) scheme. Certificates are issued by the government for the generation of renewable energy, which large wholesale buyers of electricity (such as electricity retailers) are then obliged to purchase in order to fulfil their REC liability (see "*demand for RECs*", page 23).

RECs can be created from a range of renewable energy sources including PV solar systems, rooftop household solar hot water systems, small and large wind farms and hydro electric schemes (such as Snowy Hydro).

They are generally created when a megawatt hour of renewable energy displaces an equivalent amount of “black” energy<sup>2</sup>. They are intended to approximate the cost of displacing one ton of CO<sup>2</sup> generated from fossil fuel energy sources. The Australian market for RECs trades on a wholesale basis between registered participants and in parcels sizes of 5,000 or more.



### Supply of RECs

The RECs legislation awards 5 RECs for each megawatt hour of renewable energy generated annually to households installing a PV system of 1.5Kw in size or smaller (i.e. 1 standard REC + 4 bonus RECs per Mwh). This bonus is to be phased out over five years so that by 2016 only 1 REC is received per Mwh of renewable electricity. At our Sydney location a 1Kw PV system will receive 1.382 RECs per annum<sup>3</sup>. Thus a 1.5Kw system is entitled to 2.073 RECs pa (i.e. 1.382 RECs/Kw x 1.5Kw).

Since our system is not greater than 1.5Kw in size, we receive the 4 bonus RECs per Mwh for a total of 10.365 RECs per annum. For PV systems larger than 1.5Kw in size the RECs are received on a 1:1 basis for the excess above 1.5Kw.

Under the RECs legislation, solar panel system owners can forward sell 15 years of RECs in one upfront transaction (i.e. 10.365 RECs x 15 years = 155.475 RECs)

### RECs market in oversupply

The level of bonus RECs being allocated to owners of small household PV systems plus the ability to forward sell 15 years of RECs upfront is adding to the recent oversupply of RECs in the marketplace. Combined with an equally generous Federal

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<sup>2</sup> Electricity generated from fossil fuels such as coal, oil & gas

<sup>3</sup> Figure determined using the Office of the Renewable Energy Regulator’s zone ratings table ([www.orer.gov.au](http://www.orer.gov.au))



Government rebate for solar hot water systems, has seen the market flooded with RECs in the past 12 months.

During this period, REC prices have fallen by about 40% to around \$30 today. The consequences of the price fall are both obvious, in that a lower cost offset to the installation of a PV system is available, but also less obvious in that the project life returns for large scale renewable energy projects being planned are very dependent on the REC prices they receive. The viability of many of these projects is marginal at a \$30 REC price and may lead to project deferral or complete abandonment.

### **Demand for RECs**

The demand side of the RECs market is driven by Australia's commitment to generate 20% of its electricity from renewable sources by 2020 under the MRET scheme described earlier.

To meet this target, buyers of wholesale electricity (e.g. electricity retailers such as AGL and Origin) must purchase up to 20% of their electricity from renewable sources by 2020. They can do this by either generating or buying the renewable electricity directly themselves or alternatively buying RECs to the value of 20% of the electricity they sell. The recent failure to enact an emissions trading scheme in Australia plus the lack of any binding agreement emerging out of the Copenhagen climate conference has seen the demand outlook for RECs soften along with the price for other globally traded emission permits.

### **1.5Kw PV system size**

So back to our house and the grid connected solar system. The general consensus from the professionals who visited was that it could manage a maximum 1.5Kw system on the roof, needing about 12 sq metres of north facing roof space (9 panels of 170w each at 1.5m x 0.9m per panel). The quotes for supplying and installing the system came in at about \$6,400 net. This roughly breaks out as follows:

<b>Quotes for a 1.5Kw grid connected solar panel system</b>	
Cost of panels, inverter + new meter	\$11,000
Less sale of RECs (155 RECs @ \$30 each)	(\$4,600)
Net cost of 1.5Kw solar panel system	\$6,400

The cost of the system pre any subsidies/RECs is therefore about \$7-8 per watt of generating capacity.



### Chinese imports driving down PV costs

The recent entry into the PV panel manufacturing industry by the Chinese, has seen prices per watt fall by 20-40% in the past year alone (cost was \$11-12 pre price fall) with more likely in the years ahead as improved manufacturing technologies and greater scale efficiencies kick in. Technology advancements are also likely to see the current 10-12% energy efficiency conversion ratios rise strongly, possibly above the 20% levels over the next decade, further reducing the cost per watt.

The tipping point for mass consumer take-up of PV technology appears to be near. Even without subsidies such as the bonus RECs currently on offer, the payback period of a PV system is being quickly shortened by the falling cost of equipment and the rapidly rising cost of electricity.

So turning back to the PV system installed on our house, an average of about 7.2 Kwh per day of renewable electricity would be generated:

Calculation
12 sqm of PV panels
x 1Kw   sqm of energy in sunlight
x 10% efficiency level of PV panels
x 6hrs   day of average peak sunlight
= 7.2Kwh   day
x 365 days
= 2600Kwh or 2.6Mwh pa

### Average Aussie household

The average Australian household uses about 16-18Kwh of electricity per day. Our household is within average at 16 Kwh of electricity consumption per day.

The 1.5Kw solar panel system would therefore be good for a little over one third of our daily energy needs (more in summer, less in winter).

The retail electricity price in NSW is about 20c per Kwh. This makes our annual electricity bill roughly \$1200 per annum, or \$300 per quarter. The grid connected solar system would therefore offset about \$500 of electricity costs for our household

(assuming the same price is received for the solar generated electricity as is paid for grid electricity).



### Attractive feed-in tariffs

But here is where things get interesting. The state of NSW has recently introduced what many regard as the most generous feed-in tariffs in the world. Most other Australian states also have generous feed-in tariffs, but less so than NSW. In NSW, residents with solar or micro wind grid connected systems receive a gross feed-in tariff of 60c/Kwh, about 3 times the rate consumers currently pay for grid power.

What this means is that instead of receiving the same price for renewable electricity fed into the grid as is paid for power drawn from the grid (20c/Kwh), to encourage the take-up of renewable energy technologies, the NSW Government has mandated that energy retailers must pay 60c per Kwh for all gross renewable electricity fed into the power grid regardless of whether there is excess electricity generated or not.

Not only is this rate the highest in Australia, but it pays for renewable electricity on a gross basis rather than on a net basis as is the case in other states<sup>4</sup>. Under a net basis, households will only receive the higher feed-in tariff when more electricity is generated over a billing period than used. To receive this “net” feed-in rate a household would have to install a system that generates more electricity than they consume, and then they only get the high feed-in tariff rate on the surplus electricity generated (the net) with the rest offset against usage on a one for one basis (i.e. at 20c/Kwh).

<b>Average household with a 1.5Kw grid connected PV system</b>		
Annual Electricity (Expense)   Rebate		
<b>Gross feed in tariff @60c</b>		
Electricity use @ 18Kwh day	= (6,600 Kwh) x 20c	(\$1,320)
Electricity generated @ 7Kwh day	= 2,600 Kwh x 60c	\$1560
Net (cost)   rebate for household elect	= (4,000 Kwh)	\$240
<b>Net feed in tariff @ 60c</b>		
Electricity use @ 18Kwh day	= (6,600 Kwh)	
Electricity generated @ 7Kwh day	= 2,600 Kwh	
Net elect used @ 11Kwh	= (4,000 Kwh) x 20c	(\$800)
Net (cost)   rebate of electricity to household		(\$800)
<b>Feed in tariff of 60c is not received under “net” basis as no surplus electricity is generated</b>		

<sup>4</sup> ACT also pays on a gross basis but at a lower rate of 44c/Kwh



As illustrated on page 25 , the “gross” feed-in tariff basis adopted in NSW means that an average household using 18Kwh per day and installing a 1.5Kw solar panel installation effectively eliminates their electricity costs at the current 20c/Kw price of electricity. The same household under a “net” tariff scheme would be paying for a net 11Kwh per day or about \$800 pa.

### **Too good to be true?**

Although the NSW feed-in tariff rate is the highest in Australia, the main limitation is its short duration, being guaranteed at this rate for just 7 years. All other states and Territories have offered longer programs of 15-20 years. There is also a cap on the number of systems that will receive the higher rate, being 50 megawatts of total capacity for the state, or about 33,000 homes with a 1.5Kw system.

### **Very attractive returns**

So what are the returns from our investment in this green energy option?

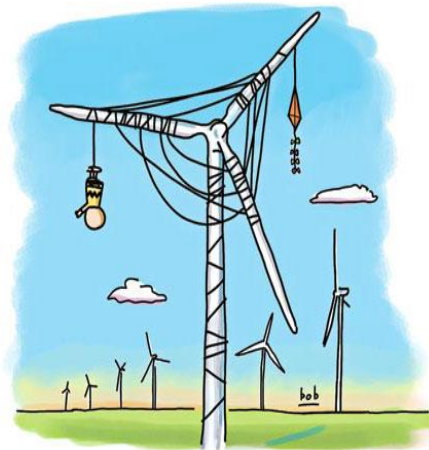
<b>Return calculations</b>	
Net system cost:	\$6,400 installed
Energy generated:	2,600Kwh p.a.
Feed-in rate:	60c Kwh
Returns:	\$1,560 pa

This equates to a return on investment of 24% per annum guaranteed for 7 years. At this rate the system is paid off in 4.5 years. This means that after 4.5 years, the owner gets a free ride with the opportunity to sell another 2.5 years of solar electricity at the very generous rate of 60c/Kwh gross.

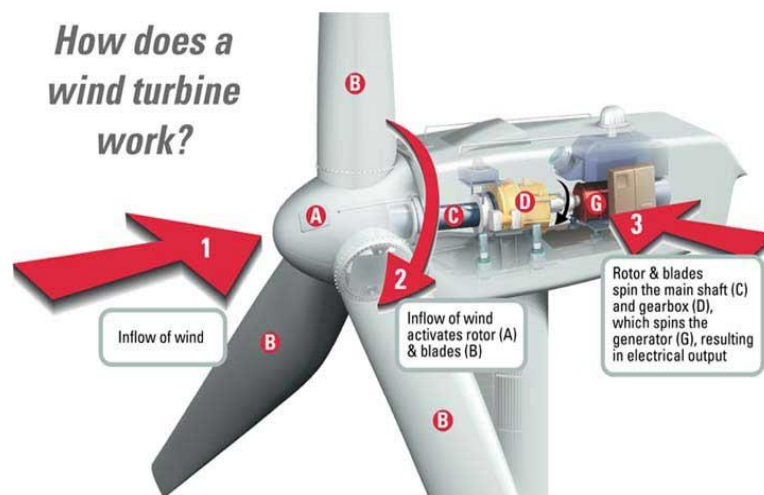
After the initial 7 year program there are possibly another 15-20 years of electricity to be generated by the system. To be sure, the NSW feed-in tariff beyond 7 years is unknown but is unlikely to be less than the prevailing retail price of electricity (which as we know is expected to rise rapidly). Essentially one locks in the electricity price for near enough to a lifetime for more than a third of existing electricity consumption. With some modest efficiency measures one may even be able to reduce household electricity usage further such that the free element is even more than a third of usage.

## 2. Small Scale Wind

Although the price of renewable solar has fallen dramatically over the past couple of years, the same economic and technological forces have also been at work with wind power, such that the capital cost is still below that of PV at \$6-7 per Kw of generating capacity (pre-subsidies) for small scale systems.



In addition, in a strong wind resource area, wind has the potential to generate more energy over a year than is available from solar. Most wind farms are struck on a capacity factor of 30-40%, meaning the wind is only blowing 30-40% of the time, allowing electricity to be generated. As explained earlier, the same capacity factor for solar is lower at about 25-30%.





## **Windy Jamberoo**

Having bought some rural land in Jamberoo a few years back (a relatively windy area on the south coast of NSW), we also looked at the economics of a wind turbine installation based on the generous 60c/Kwh gross feed-in tariff on this land.

Unlike suburban Sydney, we were under no size constraints on this rural land. Our aim was to put in the biggest system we could afford and one that would still qualify us for the gross feed-in tariffs. The NSW Government has limited individual installation system sizes to 10Kw under their scheme. We therefore looked at what would be the cost and returns from a 10Kw wind turbine system installed on a windy ridge of our rural south coast land.

4.9 Kw wind turbine on an 8m pole



## **Local supplier**

Coincidentally, we found a supplier of this size of system only a few kilometres away at nearby Gerringong. They had recently installed a demonstration unit on a farm nearby that was attracting a reasonable amount of media interest.

There is no development approval required to install these systems on land zoned as rural. This eliminates any red tape in the process. When installed in built-up suburban locations, wind turbines require development approval. They are more problematic as a suburban renewable energy source because of their visual and noise impact on surrounding residents.

The local supplier had recently started up his business of selling a range of fully installed grid connected wind turbine systems (5Kw, 10Kw and 30KW systems) to farmers and other rural energy users.

9.8Kw turbine – Princes Hwy Gerringong



### **Phones are running hot**

The recent change in the NSW feed-in tariffs has been a boon to his business. Before the change in the NSW tariff structure, provisional orders were on hand for about 10 turbines located across rural NSW with only a handful of systems installed to date. In the weeks following the new feed-in tariffs announcement in early November, the phone has not stopped ringing.

### **The Chinese again**

The turbine offered was a Chinese manufactured 9.8Kw generating unit mounted on a locally made 12m galvanised tilt tower and connected to the grid via two German-made 5Kw Windyboy inverters. Total cost was \$70,000 for the system. As with solar, system sizes larger than 1.5Kw only receive the bonus 4 RECs on the first 1.5Kw of capacity. The excess system capacity above 1.5Kw receives only 1 REC per Mwh of annual generating capacity. Further, unlike solar, the RECs can only be sold upfront for 5 year periods. As a consequence the REC's offset on the installation cost is only about \$6,000 (first 5 yrs of RECs).

There were a number of other possible installation cost offsets available including GST rebate for small businesses (\$6,300), the RECs produced in the following two five year periods and accessible in year 6 (\$3,600) and year 11 (\$3,600), and the 50%



small business investment allowance that was offered until 31 December 2009 (value depends on owner's tax rate but at 30% is worth about \$10,000).

### **Attractive returns ....again**

Unlike solar, wind turbines have a number of moving parts that need maintenance and replacement. The turbine has a 5 year maintenance interval costing about \$300 per service. The blades may need to be replaced after 10-20 years at a cost of about \$3,000 per set. The generator unit has an estimated life of 15-25 years and a replacement cost of \$5,000.

So for a 25 year service life comparison to the Solar PV system (and ignoring the small business investment allowance and minor servicing costs) we have the following net present value capital costs.

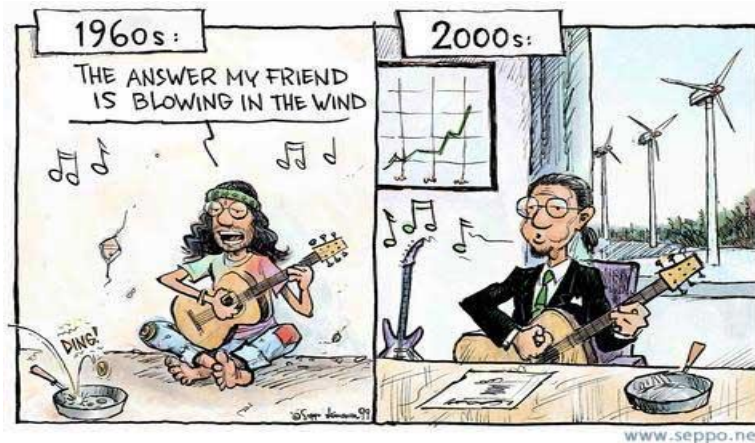
<b>Capital cost of 9.8Kw wind turbine system</b>	
Initial system installation	\$70,000
Less REC's for years 1 – 5 (@\$30)	(\$5,800)
Less GST rebated	(\$6,300)
Less REC's for years 6 – 10 (NPV@10%)	(\$2,000)
Less REC's for years 11 – 15 (NPV@10%)	(\$1,300)
Plus blade replacement year 15 (10% NPV)	\$800
Plus new generator year 20 (10% NPV)	\$800
<b>TOTAL capital cost wind turbine system</b>	<b>\$56,200</b>

The windy spot where the turbine is to be located has an average annual wind speed of about 6 metres per second (21.6km/h).

In this wind resource, the system supplier estimates the turbine should generate about 30,000Kwh per annum of renewable electricity which equates to revenue of about \$18,000 pa using the 60c/Kwh feed-in tariff. There are expected to be minimal running costs other than the 5 year servicing. The return on investment for this wind turbine is therefore estimated to be about 32%.

The risks are that the wind doesn't blow as much as expected, that the unit performs below its specification or that the feed-in tariff beyond 7 years is very low. Nonetheless, the guaranteed feed-in tariff over 7 years and the calculated payback of a little over 3 years do provide some buffer for underperformance. In any case a return north of 20% even allowing for some performance slippage is not too shabby at all.

Even if one was to be very conservative and assume a wind speed of say 4.5m/s (the historical average wind speed across NSW) and a 20c/Kwh feed-in electricity price, the turbine would generate 18,600 Kwh per annum @ 20c = \$3,720 pa. This represents a 6.6% return on investment with utility-like risk.



This modest level of return on investment will only rise with any increase in the electricity price over the prospective 25 year life of the turbine. One would have to say this is a high probability outcome as reflected in recent regulator pricing reviews, even if one assumes no cost for carbon emissions.

### 3. Concluding Thoughts

Not wanting to burden readers further given the liberty we have already taken in exploring this topic there are nonetheless a number of other issues not covered which are worthy of a passing mention;

1. **Debt funding:** The strong level of ungeared project returns combined with government guaranteed tariffs would easily lend themselves to some level of project debt funding. Debt has the potential to significantly enhance equity returns within manageable risk parameters.
2. **Federal Government green loans:** These are four year interest free loans available for such projects, which further improve returns.
3. **Mass take-up economics :** Household solar or wind technologies appear to be nearing the point of mass take-up given the near utility type returns (6-8% pa) available even before non-REC subsidies and high feed-in tariffs are factored in.



4. **Retail price of electricity.** If there is one certainty in the current investment climate, it is that electricity prices are going up in the years ahead. You need to look no further than some recent regulatory pricing decisions for evidence of this. The key factor here is the years of underinvestment in electricity generation and distribution by industry and governments alike that now must be caught up. The future costs of climate change and emissions trading, if any, will be a further burden on the electricity price beyond this.

There are now clear examples of where being green no longer requires one to suspend their desire for a reasonable return on investment. To the contrary, these investments can in some cases deliver very handsome returns indeed. **SFM**

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