EnergyWatch

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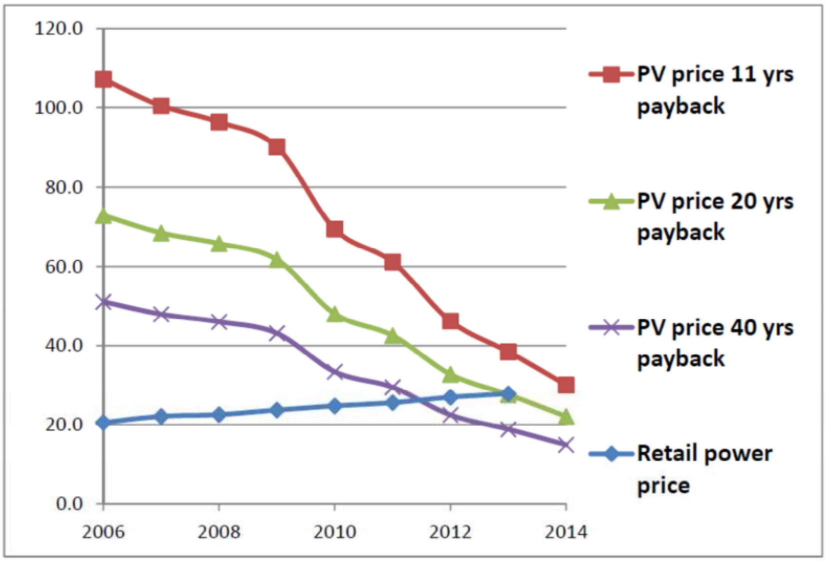
SPECIAL EDITION ON PV PARITY

When does the installation of roof-top PV become the rational choice for a Kiwi householder?

A recent op-ed in the NZ Herald by the head of EECA, reproduced here, has raised more comment on SEFnews than any other topic for some time. I have received 80 emails on the matter. Breaking from the norm, this special supplementary edition of EnergyWatch aims to reflect that discussion and separate the analysis from the politics. It is timed to coincide with NERI's annual NZ energy conference.



Comparison of electricity prices (c/kWh) from roof top PV at various payback periods with retail electricity**

The article by Mike Underhill looks at the generation of electricity with roof top PV at a domestic scale from a supply-side perspective rather than viewing it as a demand reduction technology. He excludes consideration of wider benefits. His estimate of 30 c/kWh for PV clearly can't compete with bulk generation from fossil fuel, geothermal or wind. However, the basis of his analysis and the resulting number has been criticised in many of the SEF members' online posts.

In a rebuttal of that paper, sent to the NZ Herald, which is reproduced in part here, Dean Scanlen estimates that when the cost is spread over the expected 40 years panel life, the effective price of PV electricity from the perspective of the home-owner is about half of the price estimated by EECA. The principal difference between these two estimates could be the payback period used for the assessment. The above chart shows the sensitivity of the cost of PV electricity to the payback period selected. This simplified chart illustrates the impact over the last decade of escalating retail electricity prices and reducing PV panel prices to show when domestic PV becomes a rational choice for homeowners.

**Assumptions:- PV power costs based on adjusted USDOE and German data (see Page 7); Retail electricity prices are from MoBIE quarterly survey; Interest rate = 4.1%; Installed capacity 3kW costing NZ$10,000 in 2014; Replacement inverter at $3,000 in year 20, Annual PV yield 14.65% of installed capacity; PV performance degradation 0.5% p.a.

This chart simplifies the story of domestic PV by presenting the economics on the basis of an interest bearing loan; like a mortgage. Inflation is excluded from the calculations. More sophisticated commercial economic analysis based on Net Present Value, Internal Rate of Return or Levelised Cost of Electricity would be used by commercial entities considering larger scale installations.

A key issue with domestic PV using mains electricity as a backup is the price that would be paid for any surplus power generated and the certainty of that price being contracted for the long term. Such an arrangement is called a Feed-in Tariff (FiT). Certainty about the rate payable for surplus power is as important to the design of a domestic PV system as the rate itself.

Feed-in rates currently range from 3c/kWh up to the full retail electricity price, according to the whims of the power retailers. Industry modelers use 10c/kWh, as the projected long run cost of building new generation. On Page 5, I make a case for surplus PV passed on to neighbours via the local network to be compensated at 80% of the national average retail price.

Historically, New Zealand, being small and technically competent, has tended to be a leader compared with other countries on the implementation of new technologies. However, in the case of PV power, NZ lags well behind other countries. Commentary about the situation in the UK and Germany is on Pages 5 and 6.

Domestic PV has entered the political arena. The Green Party proposes, as an election platform, to *"…amend the Electricity Act to guarantee a fair price to households that feed electricity back into the grid."* and also proposes a financing method via rates. That led some SEF members to suspect that down-playing of domestic PV by others might, in part, be politically motivated.

Finally, there is the climate change benefit of electricity generation from renewable energy sources. My views on this are set out opposite.

Steve Goldthorpe, Editor

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A BIGGER PICTURE ISSUE

Mike Underhill suggests that the altruistic purpose of reducing greenhouse gas emissions motivates some enthusiastic householders to install domestic PV. Whilst undoubtedly true, a sound economic case has to exist first and foremost, so that that significant environmental benefit is a welcome bonus rather than the primary motivator.

If reduction in demand from the grid results in domestic PV displacing natural gas fired power generation at the margin, or reducing the use of coal at Huntly in a dry year, there would be a worthwhile CO_2 emission reduction. However, it is unclear how the established electricity industry will react to the long term impact of PV on the mix of power generation technologies built and used in NZ.

Cost saving also has to be the principal motivator for minor measures to improve vehicle fuel efficiency. The bigger picture global benefit of reducing fossil fuel use would be a bonus.

Measures that provide a feel-good factor whilst sustaining business-as-usual are potentially counterproductive to establishing the profound changes in human behaviour that are needed to significantly impact Climate Change outcomes.

Every little helps - but every big helps more.

Editor

COSTS OVERSHADOW VIRTUES OF SWITCHING TO SOLAR

By Mike Underhill

Many parts of the country enjoy high sunshine hours, making solar power seem like a no-brainer for home owners. Solar power is popular overseas and appeals to many Kiwis wanting to save money and generate their own electricity. EECA's experience is there are four different drivers for the interest in solar power - saving money, independence from the grid, helping the environment and experimenting with new technology.

However, homeowners need to carefully analyse their own situation and to do their sums before making a decision. The price of solar panels has dropped but it still costs about $10,000 to install a grid-tied 3kW system without storage batteries.

Saving money with solar power is harder than people realise. Energy generated by solar power is at its peak around midday in summer, while residential demand is at its highest about 6pm on winter evenings. This means generation and demand are not aligned and electricity retailers generally pay a lot less for buying your surplus solar power than you pay them for electricity.

If people do the maths, including the cost of installation, I suspect they will find solar power won't save their household money overall on their power bills.

Some consumers are more concerned about carbon dioxide emissions and want to act to help the environment. However, solar power mainly replaces one lot of renewable electricity from the national grid with another renewable electricity, so there is generally no reduction in overall emissions.

There are better ways for a householder to reduce greenhouse gas emissions. Forty per cent of energy-related greenhouse gas emissions come from transport, and our vehicle fleet is very inefficient, so that is the best place to start.

Drivers can save fuel, and therefore reduce greenhouse gas emissions by changing their driving behaviour, switching to fuel-efficient tyres, and checking once a month to make sure their tyres are correctly inflated. Every dollar of fuel saved by a motorist avoids about a kilo of CO_2 going into the atmosphere.

Other consumers are attracted to solar power from a desire to be self-sufficient and free of the grid. Off-grid solar power can make good economic sense in situations where connecting to the grid is very expensive - it can cost property owners as much $25,000 per kilometre of power line to connect to the grid and a battery bank can cost anywhere from $10,000 to $30,000. The reality is most solar power is grid-tied and people need to be aware a grid-tied system will stop generating if there is a grid blackout.

From a national perspective the economics of solar power are questionable. New Zealand would be investing in solar generation at a cost of about 30c/kWh, which will displace cheaper renewable generation like geothermal and wind, costing about 8-9 c/kWh.

By world standards, New Zealand is in an enviable position where we already generate more than 70% of our electricity from renewables like hydro and wind. We have a target of achieving 90% renewable electricity by 2025.

I welcome the fact that energy, greenhouse gas emissions and innovative technologies are generating so much public discussion and debate. Solar power is an exciting technology. I believe it will play an important role in the future but we need to have the debate about whether its time has come for New Zealand.

Mike Underhill
Chief executive of the Energy Efficiency and Conservation Authority
NZ Herald - 7th March 2014.

REBUTTAL IN DEFENCE OF DOMESTIC PV POWER

By Dean Scanlen

Opinion writer Mike Underhill, the CEO of the Energy Efficiency and Conservation Authority, says that "New Zealand would be investing in solar generation at a cost of about 30c/kWh".

Solar generation has the potential to be a lot cheaper than Mr Underhill suggests. In fact, his figure of 30c/kWh is misleading. Here is why.

An average 3kW grid-tied solar plant generates nearly 4,000 kWh (units) of electricity each year and currently costs around $10,000. If that is paid off over the (expected minimum) 40 year life of the system at the Crown's current sovereign interest rate of 4.1% per annum, then the cost works out to only 15c per unit. This allows for one replacement of a major component, like the inverter, after 20 years.

At the interest rate paid by most mortgagees (6% per annum at present) the unit cost increases, but only to 18 cents per unit. For the unit cost to be 30 cents as claimed by Mr Underhill, long-term interest rates would have to run at more than 11 per cent per annum.

Much more significant, and relevant, are the potential savings. If the owner receives the average retail cost of grid electricity for all the electricity they generate (currently 29c per unit according to the Ministry of Business Innovation and Employment) and electricity prices continue to increase at the same rate as that of the last 13 years (1.1 cents per unit per annum), then an average 3kW grid-tied solar system would completely pay itself off in only 11 years. After that, the system will continue generating electricity at virtually no cost to its owner. For example, by owning a 3kW solar system, 20 years after installing the system the owner would be nearly $16,000 better off. When the system is nearing the end of its life after 40 years, the owner would be nearly $100,000 better off.

At 6% annual interest, these results would be 12 years, $15,000 and more than $120,000 respectively. At an interest rate of 1% per annum (a typical after-tax rate for investments) the payback period reduces to only 9 years.

In the highly unlikely, probably fanciful, event that grid electricity prices are static in future then the payback periods only increase by 1 to 2 years and a grid-tied solar system is still financially very viable.

Mr Underhill correctly says "…electricity retailers generally pay a lot less for buying your surplus solar power than you pay them for electricity." While this is true, it reflects a failure of Government policy that makes the future earnings of solar systems uncertain for the owners. This, in turn significantly reduces the uptake of solar systems. A guaranteed "feed-in tariff" will not alter the overall benefits of solar systems. Because of this, many countries have legislated and guaranteed such a tariff and New Zealand should too. It is worth noting here that a policy of the Greens, in addition to making low-interest loans available for solar generation systems, is to put such a tariff in place.

Mr Underhill also dredges up an old and very tired criticism of solar power that the sun doesn't shine when most people need the power. Tying to the grid completely addresses this because the grid acts as a giant storage system. In fact, the effect of more grid-tied solar systems in this country will be to improve the reliability of our hydro power generation for everyone.

It is vital that we harness our abundant renewable energy resources fully and eliminate our addiction to fossil energy. The necessary transition will be made less likely by the most senior member of our only Government-funded advocate for energy efficiency and renewable energy using such misleading numbers.

Dean Scanlen, Engineering Outcomes Ltd.
Letter (truncated) sent to NZ Herald

WHAT PRICE PV SURPLUS?

A key issue for householders considering roof top PV is the value of the electricity that is generated. Obviously, that portion of the electricity that meets instantaneous use in the home displaces consumption at full retail prices.

The tricky question is what price should be paid for surplus electricity generated by roof top PV and delivered into the local distribution network?

Simple negative flow through the domestic electricity meter would yield the full retail price for surplus PV electricity. However, that arrangement would mean that the homeowner would pay nothing for the storage function being provided by virtue of being grid-connected.

In contrast, the generator/retailer companies in New Zealand generally only offer the price at which power can be generated in bulk at remote power plants, which is well less than half of the retail price. That arrangement assumes that all the costs of transmission; distribution etc. should be applied equally to roof top PV generation and, say, mountain top wind generation.

It would seem more reasonable for surplus PV power to be paid for at the retail price less a charge for the service provided by the local lines companies, which would accept the surplus PV power and distribute it to other consumers in the local area. Since the variable component of the lines companies' charges range from 1/6 to 1/3 of retail prices, a service charge of 1/5 of retail price would seem reasonable. Hence the surplus PV price could be standardized at 80% of the national average retail price.

The present electricity market structure in NZ has the transmission by Transpower and the local distribution by 29 lines companies bundled into retail packages. Doug Heffernan, CEO of Mighty River Power makes a case for unbundling the lines companies in http://www.hivenews.co.nz/articles/398-heffernan-calls-for-debate-on-separate-lines-and-power-bills.

In addition to improving transparency, that would assist the rational pricing of PV power that is created at the point of use.

Editor

A UK PERSPECTIVE

I recently hosted old university friends from the UK who were visiting New Zealand. They were astonished by the dearth of solar energy gathering equipment on kiwi rooftops. I struggled to explain why that was the case.

Their eldest son founded and runs a small family business designing and installing high quality domestic scale solar PV and hot water systems. See www.leeds-solar.co.uk. That business now employs several people and is one of many such small well regulated UK companies comprising a thriving solar energy industry in the UK.

A look at the credentials on the Leeds-solar website indicates that good certification and compliance with regulations is a vital part of doing business in the UK solar industry.

The creation of that fledgling industry was a consequence of the UK feed-in tariff (FiT) arrangements. The intent of a FiT scheme is to promote development of such an industry with planned gradual backing out of the level of support. However, a couple of years ago the Conservative Government halved the FiT rates at very short notice. Despite that upset to their business plan, the family business was able to weather the storm and I am told that my friends' three sons in the business are still doing well.

Editor

NUMBERS FROM GERMANY

By Stephan Heubeck

In the debate about PV and other (small scale) renewable electricity generation technologies, as well as associated legislation, Germany is often referenced as an example. Initially the German Energiewende or "energy revolution" was viewed as a brave step towards a more sustainable energy future, but in recent months negative reporting, and even blatant propaganda, against the German approach seems to dominate the news. Here are some up to date numbers that indicate that things are not as grim in Germany as the media would have us believe: -

- German PV electricity is not expensive. The feed-in tariff rates (long term fixed prices received for exporting PV electricity to the grid) will be between 9.28 and 13.41 Eurocents/kWh (depending on size) for installations commissioned in March 2014[1].

- In 2013 Germany had 1.4 million PV installations, which generated 29.7 TWh of electricity and avoided 21 $MtCO_{2eq}$ GHG emissions. The PV industry provided employment for 50,000 to 65,000 people.[2]

- Distributed generation such as PV does not compromise grid reliability. Managing millions of small scale generators, Germany still has the second most reliable grid of all major countries in Europe (<30min/y outages), just behind wind heavy Denmark.[3]

- In 2012, 23.5% of the electricity demand in Germany was met with generation from renewables, up from 6.2% in 2000. Of this 8.4% was from wind, 7.2% from biomass and 4.4% PV.[4] Wind and solar generation complement each other seasonally.

- Small scale renewable electricity generation is a citizen's affair. Over 1/3 of installed renewables capacity in Germany is owned by private individuals, while another quarter is in the hands of farmers and small businesses. The "big 4" generators own less than 7% of installed renewables capacity.[5]

- The legislative framework in Germany, in particular the feed-in tariff system, encourages co-operative structures. In 2013 there were 888 energy cooperatives, 142 more than the previous year.[6] These numbers indicate that the claim that *"small scale renewable generation technologies are toys for the upper class that the poorer members of society have to pay for"* are simply wrong. For sure it will take many more years to rectify the wrongs of the 1990's privatization excesses, but Germany is well on the way.

- Small scale renewables can make up for the gap left by the nuclear phase out. Renewables were not only able to compensate for the ~40 TWh/y shortfall left by the German nuclear phase out so far, Germany was even able to achieve a net export of electricity of 33TWh in 2013[7]. That achievement disproved all the dire predictions of big and long lasting black-outs made just a few years ago.

- Germany is not burning more fossil fuels to make small scale renewable generation work. Comparing the latest figures from Dec13 to Feb 14 to the previous year shows a reduction of 5.5%, 15.2% and 20.6% in the generation output from lignite coal, hard coal and natural gas fuelled generation stations, respectively[8]. Industry associations, scientist and politicians agree that this is due to steadily increasing renewables generation, rather than increased electricity imports or a recession.

In summary it can be said that the Energiewende in Germany is continuing. Citizen's support for this big task is still strong, and many of the problems reported in the international media are exaggerated. Germany's progress with PV and other small scale renewable generation technologies can teach New Zealand, and indeed the world, many lessons. The most important one being that the main challenges with making our energy supply more sustainable are not technical or economical ones, but societal and political in nature, and it requires vision, foresight and a balanced approach to overcome these.

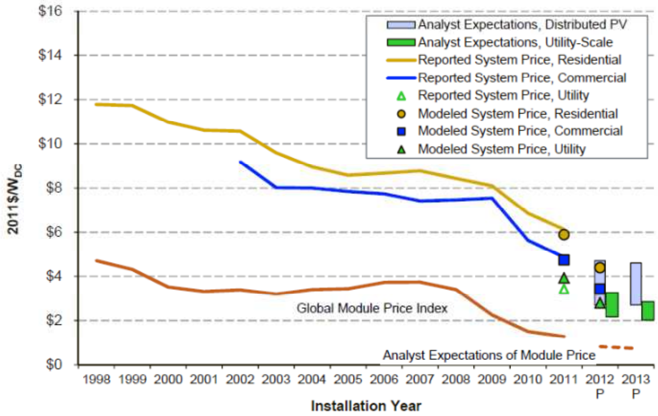
Stephan Heubeck

[1] http://www.photovoltaiksolarstrom.de/einspeiseverguetung
[2] http://www.solarwirtschaft.de/fileadmin/media/pdf/2013_2_BSW_Solar_Faktenblatt_Photovoltaik.pdf
[3] http://www.renewablesinternational.net/overview-of-grid-reliability-in-eu/150/537/75716/
4 http://www.erneuerbare-energien.de/fileadmin/Daten_EE/Dokumente__PDFs_/ee_in_zahlen_en_bf.pdf
5 http://www.stromtip.de/News/28723/Erneuerbare-Energien-in-Buergerhand.html
[6] http://www.goeppel.de

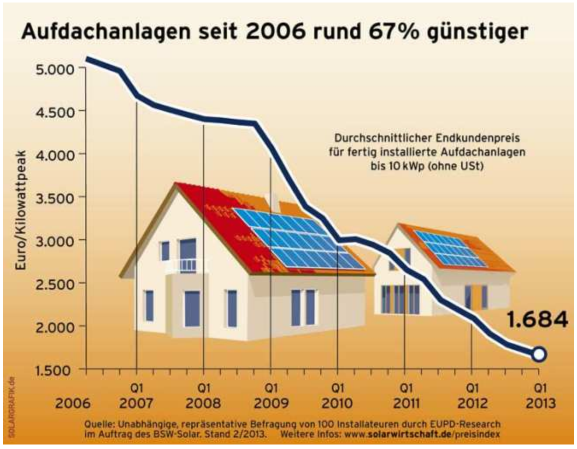
7 http://www.heise.de/tp/news/Strom-Neuer-Export-Rekord-2102640.html
8http://www.spiegel.de/wirtschaft/unternehmen/kohle-milder-winter-drosselt-produktion-von-kohlestrom-a-957960.html

PV POWER COST REDUCTION

These two charts show historical trends in PV costs in the USA (principally California) over the period 1998 to 2011:-



and in Germany from 2006 to 2013.



www.solarwirtschaft.de

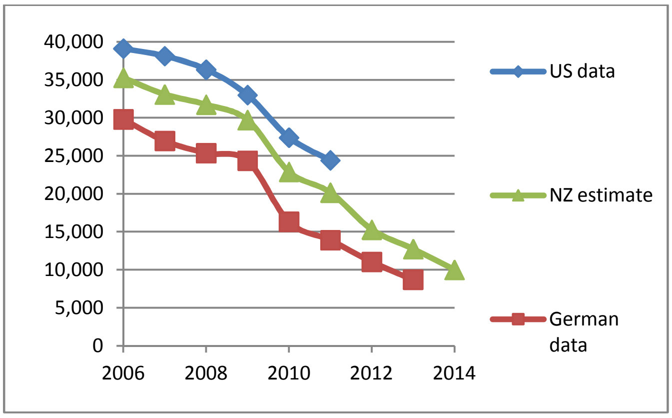
Both charts show dramatic reductions in the cost of domestic PV installations in recent years.

The US data shows a 4-fold reduction in global PV module prices from 1998 to 2011, but only a halving of the corresponding prices of total installed systems. According to the USDOE data the cost of PV panels reduced from 40% to 20% of the reported prices of the total installed systems. This might be explained by overheads, labour costs and legal and compliance costs being relatively high in the USA. In contrast, the total installed cost of systems in Germany has tracked more closely to the reported dramatic reduction in PV module costs. The German cost reductions might also be partly due to volume.

When the two sets of total installed costs for domestic PV systems are converted to a common NZ$ basis using smoothed exchange rates the installed costs of PV in Germany are seen to be substantially lower than in California. I have assumed that the non-panel component of installed systems costs in NZ are intermediate between the US and German costs.

The US data shows predictions of module costs in 2013 corresponding to about NZ$1/W$_{peak}$. Current panel prices in NZ are about NZ$1.25/W$_{peak}$. So I have assumed that historical panel prices in New Zealand were 25c/W$_{peak}$ more expensive than the global price.

On the basis of these data and assumptions, a historical profile for the installed cost of domestic 3kW$_{peak}$ PV systems is estimated, based on EECA's anchor point of $10,000 in 2014. The resulting estimated historical capital cost profile in NZ$ is shown in this chart in comparison with converted US and German data.



This estimated historical system capital cost profile for NZ is used to determine the electricity production cost curves presented on Page 1.

The actual system costs will depend on many case-specific factors, which would be evaluated by system design and installation professionals. Obviously, a DIY system would be cheaper.

Furthermore, if the payable FiT is low, or is uncertain, then the system designer might reduce sensitivity to that factor by including a small amount of battery storage to even out the time-of-day variability of domestic electricity demands; thus reducing both imports and exports of power through the meter. Such a capability could provide resilience to grid power outages.

Editor

Join our sustainable energy news & discussion group

SEF Membership provides a copy of our quarterly EnergyWatch magazine. In addition, many members find the SEFnews email news and discussion facility an easy way to keep up to date with news as it happens and views of members. The discussion by the group of sustainable energy "experts" who have joined the SEFnews service offers an interesting perspective.

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EnergyWatch

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Readers are invited to submit material for consideration for publication.

Contributions can be either in the form of Letters to the Editor or short articles addressing any energy-related matter (and especially on any topics which have recently been covered in EnergyWatch or SEFnews).

Material can be sent to the SEF Office, PO Box 11-152, Wellington 6142, or by email to editor@sef.org.nz, or by directly contacting the editor, Steve Goldthorpe, at PO Box 96, Waipu 0545.

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