

## Proposed NPS for Renewable Electricity Generation (REG) - Board of Inquiry Hearing

### Additional Information Requested during the SEANZ Presentation, Christchurch (Alister Gardiner appeared on behalf of the SEANZ Board Submission #83)

***Question - What wording is suggested to ensure that the special attributes of micro-generation are given sufficient weighting in the NPS on REG and where should this wording appear?***

We suggest the text below, split between a preamble and the Policy 5 sections. It is our view that some wording should be included both in the *Preamble* and in the *Policy 5* section to differentiate the attributes of SSR/DG and in particular roof mounted photovoltaic (PV) generation from the wide range of other distributed generation scales and options that do not offer a small consumer alternative to centralized generation.

#### **Suggested Preamble wording:**

*Add at the end of this section:*

“Particular regard should be paid to the longer term role that new and emerging renewable energy technologies with low environmental impact such as distributed solar PV generation might play in energy systems of the future.”

*Justification for this addition:*

Micro-generation (such as small hydro, PV and wind generators generally <10kW<sub>peak</sub> capacity) is characterised by being located at a general customer or consumer load connection point, and is usually owned by the customer. This generation reduces local energy demand and can also contribute to net generation by exporting power to the grid. While individually small, when thousands of these system are installed in a region, they can have a substantial impact on reducing the import of grid electricity. It is important that the combination of attributes that micro-scale renewable electricity generation offers, which is not present in other distributed or central generation, is recognised and policies supportive to uptake are enacted. These features are:

- Very low environmental impact and high reversibility, particularly for solar PV
- Reduced transmission and distribution (T&D) losses, and deferment of medium and large scale infrastructure
- Highly localised generation, leading to community self sufficiency and sustainability
- Widespread individual consumer access to a fully renewable alternative to grid-mix electricity supply - ie a competitive consumer choice
- Solar PV systems can also be easily mounted on the vast available areas of commercial roof space which is not subject to rigorous aesthetics - ideal for micro generation "islands"
- Through intelligent inverters, metering and batteries (including electric cars) can contribute to the development of smart grid systems required to manage the expected future growth in electricity demand

- The opportunity for regional skills development, job creation and “cleantech” businesses growth.

Solar PV micro-generation is the only high quality renewable electrical energy resource widely available throughout New Zealand. PV technology may be installed at the time of building, or can be readily retrofitted in any built environment. It is generally easier to install and requires fewer penetrations of the building weather proofing than for example retrofitting of solar hot water systems, leading to fewer maintenance issues. While PV generation is currently more costly than current grid sourced power, trends indicate that competitiveness is rapidly improving. It is widely predicted to reach parity with the grid sometime within the next decade or two at the most. For PV technologies to realize their full potential it is also essential that owners get a fair return for any services provided to the network and the grid, and that transaction costs associated with installation are minimized. Improved understanding and active promotion of these technologies is required to realize the benefits.

**Suggested Policy 5 wording:**

*Add at the end of this section:*

“with particular regard to distributed generation that:

- i has low environmental impacts
- ii can be applied in sufficient scale to make an impact on demand in the region
- iii has the greatest potential to reduced T&D losses and defer T&D infrastructure growth”

*Justification for this addition:*

Micro-scale distributed generation has a unique set of attributes not offered in combination by other generation. Solar PV is a particularly attractive renewable micro-generation technology which is widely applicable throughout the populated areas of New Zealand, and with a price differential which is steadily reducing. It is clear that many electricity consumers would consider installing this technology now for reasons other than purely economic, were it a simple, streamlined process to do so.

The guidance document produced for councils by EECA on distributed generation “Domestic scale distributed generation: guidance for local government”<sup>1</sup>, highlights the minimal effects of distributed PV systems and provides further back ground information.

***Question: What uptake strategy is recommended for small scale distributed generation:***

This needs engagement with other stakeholders to flesh out, but some suggestions are:

In their plans under Policy 5, local bodies should pay particular regard as to how they can facilitate the growth of rooftop solar PV installations and other micro-generation options, by measures such

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<sup>1</sup> Available from : <http://www.eeca.govt.nz/sites/all/files/guidance-document-for-distributed-generation-05-09.pdf>

as:

- Simplified consenting processes by for example nationwide standardization for small systems and no-cost building and resource consents
- Work with lines companies to identify and disseminate information on areas where best strategic benefit can be obtained from uptake (eg resource availability and network support values)
- Collection and dissemination to the public of solar and other microgeneration resource information and the performance and operation of systems for their region
- Encourage local developers and architects to become competent in solar PV technologies and incorporate them in the design of new buildings (through incentives if necessary)
- Increase public awareness of the benefits of distributed generation and of the available solar PV options, for example the ease of retrofitting rooftop PV generation technologies
- Facilitate access to capital (eg low cost capital) for those wanting to invest in distributed generation

In addition, issues that need to be addressed on a national scale include:

- Develop a national framework or standardized set of requirements and procedures for all parties involved
- Ensure that a financial framework for uptake exists that provides long term investor confidence (for the lifetime of the systems).
- Identify at a national level the most suitable locations for PV uptake to meet strategic electricity supply needs (eg matching to trends in load growth, profiles, commercial, residential, etc)
- Determine the costs and benefits of applying PV to new houses vs retrofit
- Determine which information must be provided by local bodies, (or the supply industry) and which by a central agency, eg EECA (or MED or the Electricity Commission), - for example national/regional maps of solar resource, information on connection procedures, pricing options etc.
- Inclusion of renewable electricity generation in any future implementation of a home energy rating scheme

### **Further Explanatory Notes**

It is not clear to SEANZ how much explanatory text will be provided in the final NPS, or whether guidance notes will be provided. Since micro-scale generation is so unfamiliar to most agencies, we think that more detailed explanation of the technology and its attributes is justified than, for example, large scale hydro. Some of the information contained in the attached market status brief may also be usefully included in NPS guidance documents.

In particular, direction should be provided to local authorities to minimise their contribution to transaction costs and simplify consumer access to installation of these technologies. In comparison with other countries New Zealand has a long way to go in this area. Our focus from hereon is on small scale customer/community-owned solar PV technologies because we believe that these offer tremendous potential for future energy supply in New Zealand.

The present structure of the electricity supply industry makes it difficult to reduce the complexities of connection and supply pricing agreements for customer located micro-generation. At present, the

lowest DG connection class includes plant with up to 10kW capacity, ie capable of generating (and exporting) up to 87,600kWh/yr, or 10 times the typical household demand. The present regulations are designed to address this substantial scale of energy production. There is a case for simplifying the connection and financial transactions associated with very small residential-level PV systems that are designed and installed to acceptable standards (as is the case for other electrical appliances), but which are not intended to deliver net annual energy exports. Central Government leadership is needed to introduce such a simplified connection process and to ensure standardize financial arrangements are in place to remove the current impediments to uptake for smaller systems.

Faster progress in dismantling the many barriers and impediments to uptake might be achieved through a single national agency having the responsibility and authority for streamlining regulatory requirements associated with the installation of micro-generation systems<sup>2</sup>. This would include leading the development of a set of simplified national procedures and standards for (non-notifiable?) resource consents and building permits, electrical permission to connect, supply of ancillary services to the network, charging for applications and principles payments for generation and ancillary services. This work would include addressing the requirements of future smart networks and provision of appropriate smart metering features.

***Question: Sources and validation to support cost curve expectations and timeframes to market competitive uptake of small scale solar PV technology (pre 2020):***

Estimates of future PV costs in New Zealand have generally been based on long term global predictions of market trends by organizations such as the IEA. However the accelerated industry growth resulting from stimulation packages deployed in several major economies over the past decade is likely to dramatically change these earlier predictions.

The following paper summarises this in the New Zealand context under the following topics:

- Abstract - rationale
- Overview of PV attributes
- Barriers to large scale uptake
- Typical costs in New Zealand and trends towards grid parity
- Rate of production learning as a method of validating these assumptions
- Summary and Conclusions

In brief, it is shown that the method of extrapolating technology learning curves against current market growth rates suggests that the past predictions of the date for solar PV “grid parity” are very pessimistic. If current trends continue this event will most likely occur before 2020. Government action is required to prepare a market environment for the substantial uptake of this desirable generation technology and dismantle any remaining barriers.

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2 Note there is already a fairly comprehensive set of standards referenced through the wiring rules for the installation of PV systems. To have this recognized explicitly as a means of compliance under the building code would help, (as would removing the need for consent). An issue is array structures and consenting of these. This area needs further development in the standards and clearer guidance.

## **Update on the Market Status of Solar PV Technology to Support an Appropriate Emphasis in the NPS on Renewable Electricity Generation**

Alister Gardiner, for SEANZ

### **Abstract**

The factors that affect the market competitiveness of small scale solar PV systems are: the quality of the solar resource, the market conditions faced by system owners, and the relative cost of the PV system when amortised against the cost of grid power. Opposing trends of PV technology cost reductions and grid power price increases are the main factors that will determine the date of “grid parity”. However, because the date-sensitivity to these factors is high, the market conditions also have a substantial influence. It is therefore essential that for earliest uptake any unnecessary barriers to implementation are removed, and that there is opportunity to obtain a fair return for any services offered for network support.

The method of production learning to predict price reductions is validated in many areas of technology introduction, including energy. Until the technology becomes mature, it is possible to predict quite accurately for commercial PV systems the production volume – price reduction curve. The major unknown is how rapidly the production volume will ramp up, and therefore the time-scale to grid price parity for any jurisdiction. The current market Compound Annual Growth Rate (CAGR) of ~45%/yr for PV technology has been deliberately stimulated (particularly by the major economies Germany, Japan and the US) to deliver rapid price reductions that will a) increase their uptake of this renewable technology and b) maintain the technological competitiveness of their industries. China has also already entered the mix as a major player. There is therefore good reason to suggest that the current learning curve trend will continue for several orders of magnitude in production growth. This rationale is used as a basis for the view that (providing that fair pricing arrangements are also implemented) solar PV generation should reach grid parity in New Zealand before 2020.

### **Attributes of Photovoltaic (PV) Electricity Generation relevant to New Zealand**

New Zealand has an excellent widespread solar resource, similar to Melbourne - Australia, Nice - France and Madrid – Spain, and over 1.4 times that of Central Europe (e.g. Germany). The total solar energy intercepted by the New Zealand land mass is approximately  $1.4 \times 10^6$  PJ/yr. New Zealand's total consumer energy demand is 1/3,000 of this. A New Zealand house receives 25 times its occupant's typical energy needs. Because of the wide span in latitude, the solar resource available in Auckland and the north is around 15% higher than Dunedin and Invercargill.

Solar PV is a fully renewable generation technology that offers a widely available alternative to central generation, and without attendant transmission and distribution requirements. It has minimal environmental impact, and on this basis uptake should be strongly encouraged in future energy strategies. In many regions of New Zealand there are few other realistic renewable energy options for local authorities to actively promote and support. Since at grid connected level it is still an embryonic technology, the fact that it is not yet grid competitive on a Cost of Energy (COE) basis alone should not be reason to overlook its future impact. Pricing trends suggest that it may be grid competitive within the next decade.

Like wind and hydro, PV supply is intermittent, but with a different characteristic and timescale. In fact it is easier to manage short term intermittency with energy storage technologies than long term shortfalls such as hydro dry-years. PV intermittency is more consistent and predictable than wind, and offers a better match to diurnal demand profiles. To achieve the most consistent and predictable cumulative PV generation, geographically dispersed grid connected micro-generation is desirable.

It must be acknowledged that PV production is predictably substantially lower during winter months (particularly in the south). When PV becomes an appreciable part of the New Zealand electricity supply this will have to be accounted for through alternative seasonal generation. For example, ocean wave energy flows are substantially higher in winter (and are particularly intense and consistent in the south) and could provide a future balance for PV generation.

Because of its widespread availability, solar PV is recognize a key technology to contribute to the development of future more resilient smart networks that can include autonomous microgrids automatic islanding and self healing capability. It will take many years for sufficiently large clusters of PV generation to build up and become available for this purpose. This is another reason to initiate widespread uptake in pace with the rest of the developed world.

### **Barriers to Large Scale Uptake**

Most PV systems in New Zealand are stand-alone or off-grid. Apart from the current capital cost of the panels and installed systems, there are technical, financial and process barriers to the uptake of this technology at the micro-scale (eg household level), particularly when it is on-grid or network connected. In principle there are no technical reasons why transaction costs should be any higher for connecting small residential or other general electricity customer PV systems than to install for example a heat pump. Standardised small-scale PV generator systems offers less potential power quality problems than many other appliances, including heat pumps. In general, the connection of inverters will improve the power quality in a region, particularly if power factor of the connected load is poor. Voltage rise resulting from the connection of a large number of systems in rural areas with long lines may need to be addressed differently from the effect of additional load, but is most likely to be more advantageous to system management than the additional load.

From a financial viewpoint micro-generation systems offset demand the customer would otherwise draw – accordingly full savings associated with demand avoidance should accrue to the owner. When the embedded system delivers electricity to the network, payments that represents the full time of generation and location value of that electricity should accrue to the owner. Power quality benefits, if any, should be accounted for.

The factors that discourage the uptake of small-scale PV generation systems are often complex and interactive, and while on an individual basis can be relatively small, in combination they represent a substantial hurdle to any small consumer wishing to invest in their own generation system. In summary, they include:

- Market structure and existing tariff arrangements
- Complex and varied “permission to connect” procedures and other transaction processes and costs
- Complex and varied local body environmental and building requirements and regulations

- Lack of ability for the owner to recover value from supply of ancillary network services (network support, power quality, reserves)
- Lack of government initiatives to encourage uptake (eg in comparison to the “call-in” provisions available for fast tracking large-scale energy infrastructure)
- Capital cost
- Awareness of technology
- Recognition of the value of the electricity generated

### The Cost of PV Generation Technology

Because of a current COE disadvantage in comparison with centralized grid power, the potential for solar PV to contribute to New Zealand's energy future has been underrated. An example of this is the view expressed in the Proposed NPS that SSR/DG will only be relevant “primarily to service remote rural villages”<sup>3</sup>.

Internationally, this cost barrier has not prevented many developed nations (many with a much poorer solar resource than New Zealand) from planning for a substantial large scale near-future (2015-2020) uptake of rooftop PV. This planning is being undertaken on the basis of projections of cost reductions alongside the benefits of PV generation, and the steady increase in the cost of deliver of central generation. For more information on the global status of solar PV it is recommended that the recently published (April 2009) MED report *Assessment of the Future Costs and Performance of Solar Photovoltaic Technologies in New Zealand* referenced in footnote 4 be consulted.

### Present Solar PV System Costs in New Zealand

The MED report (footnote 4) estimates installed grid connected system costs in New Zealand as:

<b>Small (&lt;2kW)</b>	<b>Medium (&lt;10kW)</b>	<b>Large (&gt;100kW)</b>
NZD/W 13.50 – 15.40	NZD/W 11.74 – 13.65	NZD/W 10.32 – 12.70

Since for solar energy the “fuel” is free, capital costs are the major determinant of the cost of energy (COE) for PV systems. Present capital costs are a well recognized barrier to uptake. Numbers such as these can however be misleading as neither the inverter (which is rated in W) nor the PV array (which is rated in Wp) have a universal relationship to the output of an installed PV system. A more appropriate way to look at the cost for PV is to evaluate the installed cost per kWh of energy generated annually. These cost are currently (for a small system) in the range of NZD7.15 to NZD12/ kWh/annum generation.

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3 MED <http://www.mfe.govt.nz/publications/rma/nps-renewable-electricity-generation/index.html>  
(5.2.5.4, p47)

## Solar PV Generation Cost Trends and Implications

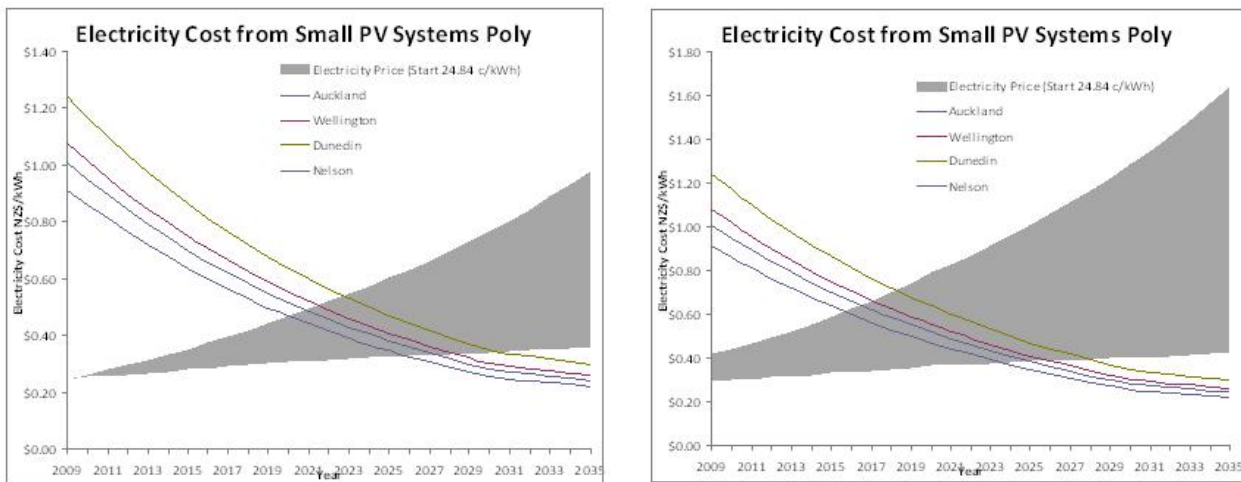


Figure 1: PV cost trends a) current grid price b) levelised grid price

The graph in Fig.1a has been taken from the IT Power MED<sup>4</sup> commissioned report. This shows a reducing levelised cost of PV compared with an increasing estimated grid electricity cost – the electricity cost not being levelised. It indicates grid parity sometime between 2020-2030, depending on region and grid price trends.

The second graph<sup>5</sup> (Fig.1b) presents an alternative analysis using the same data, in which the levelised cost of PV is compared with the levelised cost of grid electricity - for the next 20 years or the duration of the life of a typical PV system. This second analysis shows a substantially earlier grid parity, ranging from 2016 to 2020. The same sensitivities for grid price trends and solar intensity are present. It can be argued that this is a more realistic way of making the comparison, since both costs are represented in the same levelised form. If consumers accept this rationale, they will be prepared to invest in solar power alternatives much earlier than the analysis of Fig. 1a suggests.

All predictions such as these are however based on assumed price trends and can only be indicative. The PV cost curves in 1a and 1b above are based on data produced by the IEA (footnote10). It is worth noting here that from the modeling on page 75 of the IT Power MED report (footnote 4), which used the IEA data, fringe-of-grid and off-grid applications are already cost effective in New Zealand.

Let us examine these graphs in Fig. 1 in more detail. For PV, the downward price trend is now primarily dependent on production volume – a more rapid global uptake will advance the grid parity date, a reduced uptake rate will delay it (although there will be supply-demand perturbations that affect short term pricing). For the grid electricity price, a wide range of factors are involved, which include future carbon costs and the cost of renewable energy from increasingly less desirable sites. The exact slopes and therefore date of “grid parity” cannot be known until reached, but the analysis illustrates the basic point of this brief - that network connected PV is close to commercial viability.

4 IT Power report to MED [http://www.med.govt.nz/templates/MultipageDocumentTOC\\_40501.aspx](http://www.med.govt.nz/templates/MultipageDocumentTOC_40501.aspx)

5 Brazier, 2009 (analysis undertaken by Shay Brazier, Southern Perspectives and SEANZ, 2009)

The following can also be noted:

- This analysis only considers averaged cost of energy, not added value that can accrue through supply of ancillary services such as peak capacity support, VARs etc.
- There is a high sensitivity to the date for “parity” and it would only take a small improvement in PV performance or cost, or a small increase in grid costs to substantially accelerate the date.
- Because of the high date-sensitivity a small increase in returns to the owner through say on-peak export pricing or other grid support values could also make a significant difference to uptake

This high sensitivity to a combination of increasing grid prices and reducing PV costs has not been appreciated in earlier reports predicting potential New Zealand uptake, leading to somewhat misleading conclusions (eg Grid Connected Domestic and Small Scale Renewables in New Zealand, commissioned by EECA in 2007). These reports have also not included consideration of any financial value other than the supply of energy. The market in New Zealand does not currently recognize these additional values at the small generator level, but there is no reason why it should not be required to do so – many would argue that to provide fair access to small scale generation it must.

There are a number of reasons why potential uptake could be rapid when, or before grid parity is reached. At the forefront is a strong desire by many people to seek an alternative to centralised generation of electricity, which is perceived as devoid of real competition. In addition, if Government ensures that ancillary services provided by micro-generation are fairly rewarded, this will accelerate economic viability. Smart metering can play a role in this. For example a minimum national standard for general customer smart meters should include the ability to adjust TOU (or time of generation) export pricing, as this would for example help incentivise uptake of network-compatible micro-generation technologies.

## **PV Technology Improvements and the Rate of Production Learning**

A key indicator of the market entry pathway for any emerging technology is the rate of production learning. From this comes the reduction in unit cost. Cost savings can be achieved by improvements in efficiency and lifetime, lower cost materials, better production processes, etc. Monocrystalline panels for example are predicted by some sources to drop from around 3 Euro/Wp in 2008 to below 1.3 Euro/Wp by 2015<sup>6</sup>. The efficiency and durability of various commercial PV technologies have steadily increased over the past 2 decades and are expected to continue to improve. At the same time, costs are being decreased due to application of large scale production techniques. Silicon is now produced in foundries specifically designed for solar substrates, rather than the much higher quality silicon required for producing ICT semiconductor devices.

This incremental reduction in cost of a technology as the production volume rises is called the production learning rate. It is characterized by a remarkably consistent drop in unit cost over many orders of magnitude of production growth. For many energy technologies the cost has been found to reduce to between 75% and 85% for each doubling of cumulative production.

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6 Sun & Wind Energy, 2/2009

The learning rate for PV panels has been plotted by many researchers over several orders of magnitude production growth, and is shown to be close to 20%<sup>7</sup>, ie, a 20% reduction in cost occurs for each doubling of cumulative production. The same type of curve is experienced for inverter systems, the other main component of a grid connected PV system. An example from one study for PV modules is reproduced below.

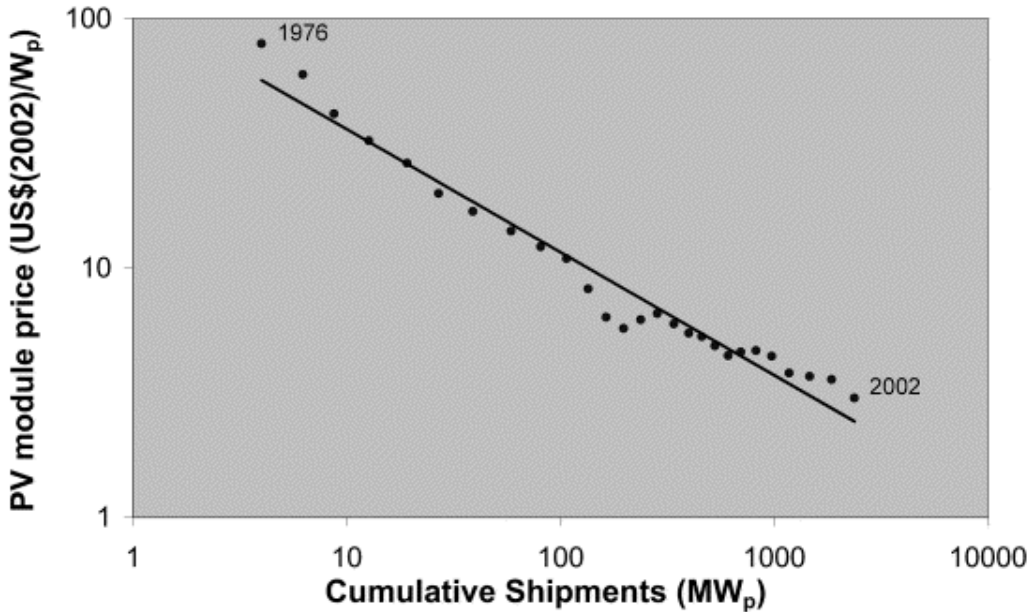


Figure 2: PV module experience curve, 1976–2002 ([[Maycock, 2002](#) and [Maycock, 2003](#)]).

The production learning rate can be used to estimate the production volume at which a PV technology becomes grid competitive, based on the cost of energy in any market, and the annual PV energy production for the technology in the region. The problem is rather to predict the rate of production growth, and from this the date of grid price parity.

### Global PV Production Growth Predictions

We have shown that the production growth rate defines the cost reduction rate. There are many short term predictions for global PV market growth. Fig.3 indicates estimates of production capacity, while Table 1 reports some other industry statistics for shipments, production capacity and estimates of market growth. These suggest ongoing growth will continue to be very high - but since it is strongly subject to governments’ policies, uncertain. Continuation at an average compound annual growth rate (CAGR) of between 20 to 40% is realistic.

7 There has been a recent blip in this figure due to the massive production growth (>50%/yr) over the past few years resulting from large scale government incentive programmes. This has exacerbated the already extreme shortage of silicon, and temporarily maintained higher prices. Silicon fabrication investment has now caught up. Coupled with the current economic downturn and rejigged support schemes (eg Spain), panel prices are now readjusting downwards, restoring the production learning ratio.

### Solar PV, Existing World Capacity, 1995–2008

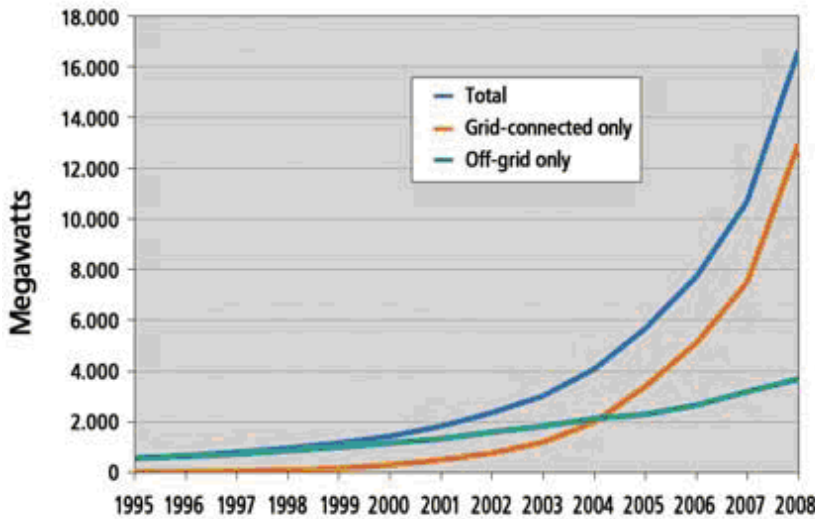


Figure 3: International PV market growth (IEA-PVPS)

Table 1: Growth rate of the solar PV market

<i>GW/Yr</i>	<i>2008</i>	<i>2010</i>	<i>2012</i>	<i>2020</i>	<i>Notes</i>
Sarasin & Cie <sup>8</sup> (2009)	4.2	13.3	19	125	Market predictions
Frost & Sullivan <sup>9</sup> (2007)	6.9	10.5	16.7	-	Market predictions (Av. CAGR 24%)
Photon (2009)	7.9	-	-	-	Production capacity growth (85% in 2008)
Production Capacity CAGR <sup>10</sup>	53%	-	-	-	Averaged 2002-07
Market CAGR <sup>11</sup>	44%	-	-	-	Averaged 2002-07

In Fig.1a the current levelised PV COE was estimated to be between \$0.9/kWh and more than \$1.2/kWh, depending on locality, although there are questions raised as to how up-to-date this data (based on IEA projections) really is<sup>12</sup>. This cost estimate is now relatively high by present world standards, where lower installed costs having been achieved through economies of scale following large volume market stimulation. A similar overall installation cost reduction will be expected to also occur in New Zealand in the early years of market growth. For COE grid parity in the Auckland region by 2015 based on these figures, the PV electricity cost using this data would have to reduce from \$0.90/kWh to below \$0.35, a reduction ratio of 2.57 or greater. Under the Fig. 1b analysis, still using this basic data, the cost would only have to reduce to below \$0.60/kWh, a reduction ratio of just 1.5 or greater.

8 Annual analysis by respected Swiss bank - reported in Sun & Wind Energy, 2009/2

9 A benchmark global market research group with wide experience in energy technologies

10 IEA-PVPS

11 Renewable energy focus, March April 2008, p30

12 One supplier in New Zealand currently offers small systems for NZD9300+GST installed that will generate 1300kWh/annum (based on Auckland, optimum pitch/orientation). At 25 year system life and allowing for module output degradation, this is estimated to represent a COE of about NZD 0.31/kWh.

Based on the current production learning rate for PV technology, this level of cost reduction should occur with some certainty when the annual global installation rate reaches about twenty five times the present level of ~5GW for 1a ie 125GW, and five times for 1b, ie 25GW. This illustrates the extreme sensitivity of “grid parity” to predicted production volume. From the Sarasin & Cie prediction in the table above, these annual production rates required to achieve competitive module prices will be reached by 2020 for 1a, and before 2015 for 1b.

It is worth noting from the IT Power MED report (footnote 4) that the International Energy Agency’s Scenarios and Strategies to 2050 does identify PV as a significant player in the longer term, with the Blue Map scenario including 1400 GW of PV generating 3000 Terrawatt hours of electricity by 2050, about 300 times the current production volume. The IEA’s view is that market growth (and cost reductions) won’t ( or wouldn’t) continue at the rate currently being experienced. This must now be questioned, and if these trends do continue, the graph in fig. 4 below gives some indication of the likely effect.

Fig. 4 plots the price steps that occur within each year for constant CAGRs of 30% and 50% and production Learning Ratios (LR) of 0.8 and 0.85. The two upper curves represent LR=0.85 and the two lower curves are for LR=0.8. It is evident that the LR has a greater effect on the rate of cost reduction than the CAGR. A CAGR of 30-50%/yr (which has occurred over the past decade) with a production learning ratio of 0.8 will result in a cost reduction to below 40% by 2015, which on current market growth predictions is quite achievable (and probably grid competitive in New Zealand). With a production learning ratio of 0.85 the cost reduction by 2015 is significantly less (down to about 60%), and requiring around 10 years to reach 40% of current cost (still reaching grid parity before 2020).

The conclusion is that the assumptions leading to the COE predictions in figure 1a are somewhat pessimistic, and probably do not represent the last few years of industry performance. Unfortunately no recent updates on learning ratio have been found to validate the 0.8 ratio reported in fig 2. There is some evidence of a modest leveling out in the last part of this curve, in which case 0.85 may be a better ratio to use. A lower learning rate is certainly expected by the IEA, but the question is whether the recent explosion in market growth has already provided the impetus necessary for prices to reach grid parity in many large markets.

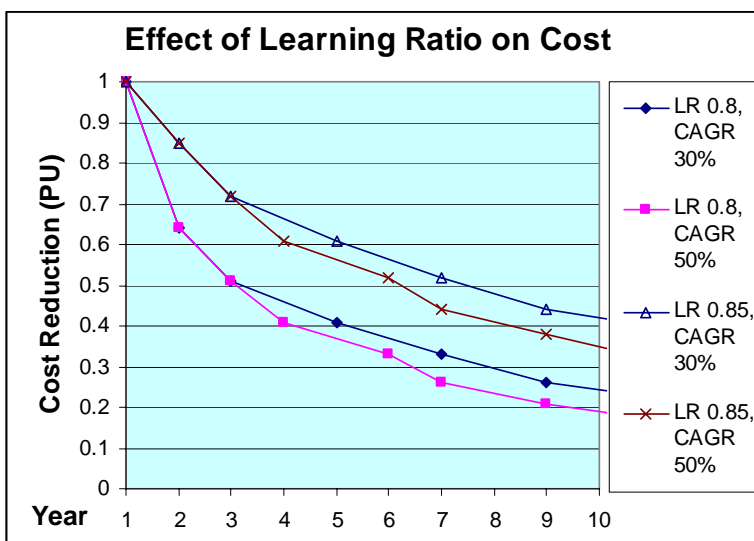


Figure 4: Cost reductions for different production learning ratios

As for any projection there are many unknowns, but the message is clear – PV technology costs will continue to decline while grid electricity prices continue to increase. On present trends PV is likely to become grid-competitive in New Zealand within the next decade, and possibly as early as 2015 at good sites, particularly if values other than energy alone are recovered by the owner.

## Summary

Micro-scale (localized) PV generation should be given recognition in a 2020 time frame Renewable Energy Generation policy for New Zealand because it is:

- likely to make a substantial impact globally and grid parity may be reached in the coming decade
- currently poorly understood in New Zealand and therefore undervalued
- currently subjected to a wide range of cumulative barriers to uptake
- capable of improving power supply security within a future smart grid framework
- uniquely able to offer a widely available alternative choice to consumers
- highly relevant to regional authority energy policies due to the large number of potential implementations in urban areas