Electricity Network Regulation Public Inquiry

Submission to the Productivity Commissions' Draft Report

Authors:

Melbourne Energy Institute – Professor Mike Sandiford, Dr Roger Dargaville & Dylan McConnell
School of Social and Political Sciences - Associate Professor Fiona Haines
Melbourne School of Land and Environment - Associate Professor Peter Christoff
Centre for Resources, Energy and Environmental Law - PhD Candidate Anne Kallies

Introduction

We welcome the opportunity to provide written comments to the draft report "Electricity Network Regulatory Frameworks", as part of the public inquiry into Electricity Network Regulation.

This submission focuses on the Draft Reports' findings for distributed generation, and in particular rooftop Solar Photovoltaics (solar PV).

Specifically, we highlight the likelihood of policy failures associated with the current carbon price, and the multiple policy objectives of renewable energy support.

The costs (both installed and implied abatement costs) relied upon with the report, are scrutinized, and placed in the context of the current Australian energy market developments and technology cost reductions.

We find that the cost relied upon within the draft report (both for network extension mitigation and carbon emissions mitigation) are overstated. We also find that due to the multiple policy objectives, and the 'real world' considerations of carbon pricing (which includes but is not limited to an inefficiently low carbon price) justify continuation of renewable energy support schemes. As identified in the draft report, support schemes should also be calibrated (through for example time varying tariffs) to encourage efficient integration of distributed generation in both the electricity market and the electricity network.

Key Findings of our submission include:

- Carbon price is inefficiently low (to correctly internalize carbon emission externalities).
- Additional policy objectives (including addressing additional market failures) also justify renewable energy support schemes.

- The cost-effectiveness of solar to provide distributed peak generation capacity has increased, falling to **$0.8 million / MW peak** (from $1.5 million per MW peak reported)`
- The drop in subsidies implies a current cost of abatement of as low as **$25/tonne** (an order of magnitude smaller than the Commissions figures).
- Time varying tariffs are useful, however considering market value only (for exported energy) does not incorporate the market failures and externalities discussed.

We are happy to elaborate on any of the points made, if required.

Table of Contents

Carbon emissions and other market failures

The draft report is highly critical of government support schemes *"stimulating excessive (and inefficient) investment in some types of DG, especially rooftop PV units"* [1]. The report concludes that *"Commonwealth Government's introduction of a price on carbon should obviate the need for these schemes on abatement grounds*[2]. A large number of critical assumptions are required to meet this conclusion. These assumptions are not reflected in the current reality of carbon pricing and 'real-life' conditions for energy and climate policy, and assume that the single policy objective of renewable energy support schemes is direct emission mitigation.

Carbon emission policy failures

Price inadequacy and political realities

The entire purpose of carbon pricing is to internalize the cost of greenhouse gas emissions from fossil fuel combustion (and extraction) and through this cut pollution. The carbon price should reflect the marginal cost (damage) of a unit of emissions, from a strict economic perspective[3]. However, there is a mismatch between economic theory and political reality

The marginal cost of emissions is highly uncertain, with some estimates as high as €300 per tonne of CO_2[4]. The current carbon price ($23/tonne) and carbon price package has emerged from a complex political negation process. The price is thus a political compromise and below what would be considered "cost reflective". The external costs are therefore not fully internalized, and the price is thus not set at efficient level.

The "best" or most economically efficient solution may be to internalize the full cost of emissions appropriately, but this has not proven to be politically feasible to date. Hence, recommendations that emissions reduction policies should rely on a single instrument alone (i.e. a price on carbon), one associated with a heavily contested political environment, is highly problematic[5]. A carbon price set at an efficient level would place a substantial burden on the Australian industry (as a result of the current high carbon intensity of the economy), which is evidenced by the substantial opposition to the current (low) carbon price. Similar 'real-world' considerations will likely effect the negotiation of an efficient emission cap in the future, and linkage with international markets (as has occurred with the European Union Emissions Trading

---

[1] Productivity Commission, *Electricity Network Regulatory Frameworks, Draft Report, Vol 2*. Pg 450

[2] Ibid pg 455.

[3] Lehmann and Gawel, *Why Should Support Schemes for Renewable Electricity Complement the EU Emissions Trading Scheme? pg 7*.

[4] Downing et al., *Social Cost of Carbon*.

[5] Lehmann and Gawel, *Why Should Support Schemes for Renewable Electricity Complement the EU Emissions Trading Scheme?*.

Scheme). The EU Emissions Trading Scheme (ETS) has also emerged from a political negotiation and has similarly not been set at an 'efficient level'[6].

In contrast to carbon pricing, renewable energy support has proven to be less politically charged and faces (relatively) less political hurdles. The Renewable Energy Target (RET) for example currently has bipartisan support, in stark contrast to the carbon price mechanism. A recent study found that 80% of Australian consumers believe renewable energy is a good solution to the climate change issues (with 7 out of 10 prefer renewable energy over conventional sources)[7]. Further, offering a positive incentive for abatement has been argued to be a pre-condition for implementing tighter caps, through "buying" agreement of stakeholder[8].

Subsidization of carbon emitting technologies

Fossil fuels have been and still are promoted by substantial direct subsidies in Australia. This serves the function of making such fossil technologies inefficiently cheap, further undermining the attempt to internalize the external cost of fossil based fuels. On a global level, the International Energy Agency reports that fossil fuel subsidies have increased to $538 billion annually (compared with $88 billion for renewable technologies)[9]. In Australia, the subsidies contradictory to climate policies are have been reported in the order of $10 billion annually[10]. In another example of fossil fuel subsidization, the NSW state government developed a coal mine (Cobbora mine) to secured supplies of coal for electricity generators at a subsidies price (due to concerns about the impact of export demand). The NSW treasurer explained that[11]:

> *"..We have acted in the interests of electricity users to address the fuel cost issue … Our rationale for the Cobbora resource is simple: to provide a secure and long-term supply of fuel for our generators at prices that are less distorted by booming export demand."*

The difference between a market offer (from a private company) for domestic supply of the same coal mine and the subsidized price reportedly amounts to over $4 billion over the lifetime of the project[12]. Compared to the export value of the coal, the implied subsidy was reported as $3-3.6 billion per year[13].

---

[6] Matthes, *Greenhouse Gas Emissions Trading and Complementary Policies. Developing a Smart Mix for Ambitious Climate Policies*.
[7] TNS Gallup and Vestas, *Global Consumer Wind Study*.
[8] Lehmann and Gawel, *Why Should Support Schemes for Renewable Electricity Complement the EU Emissions Trading Scheme?*.
[9] IEA, *World Energy Outlook 2012*.
[10] Denniss and Macintosh, "Complementary or Contradictory? An Analysis of the Design of Climate Policies in Australia."
[11] New South Wales. Parliament. Legislative Council. General Purpose Standing Committee No. 1 and Nile, *The gentrader transactions*.
[12] "NSW's Great Big Coal Subsidy Scandal | Climate Spectator."
[13] Ibid.

Further to the direct subsidization to fossil fuel industries is the partial exemption from the carbon price mechanism. The current carbon price package incorporates implicit subsidies (which further undermine the internalization of the carbon cost, and indeed the point of the carbon price), due to socio-political considerations. The "Energy Security Fund" ($5.5 billion) includes support to electricity generators that are strongly affected by a carbon price through the provision of cash payments and free carbon unit[14]. Whilst it is early days in the Australian scheme, in the EU the allocation of free permits has resulted in windfall profits with particular benefits to large fossil fuel electricity generators[15].

Multiple Policy Objectives & Other Market Failure

The draft report assumes that the objective of renewable energy support is to directly abate emissions, ignoring the fact renewable energy support policies typical have multiple objectives. These other objectives typically include other market failures that are not (and should not) be covered by a carbon pricing mechanism.

Learning Effects & Cost Reductions

A widely acknowledged market failure is knowledge 'spill over', where knowledge generated through innovation or learning effects may 'spill over' to other companies[16]. This 'spill over' represents a positive externality, which companies are unable to capitalize on. This results in reduced incentive to invest in knowledge generation and reduced levels of technology innovation and adaption[17]. For innovation related spillovers, direct subsidy to research and development (R&D) are suitable. However learning effects ("learning by doing"), separate to direct R&D innovation (and the related expenditure), have been found to be significant for renewable energy technology[18] and are not covered by direct R&D expenditure. Several studies have shown that support schemes based on output subsidy per unit input are justified in the presence of learning effects[19,20,21]. The carbon price (and R&D measures) alone does not address the externalized benefits associated with learning effects (and nor is it designed to), which justifies the existence of additional support schemes.

---

[14] Australian Treasury, *Strong growth, low pollution*.
[15] Keppler and Cruciani, "Rents in the European Power Sector Due to Carbon Trading."
[16] Arrow, "The Economic Implications of Learning by Doing."
[17] Jaffe, *Technological Opportunity and Spillovers of R&D*.
[18] Isoard and Soria, "Technical Change Dynamics: Evidence from the Emerging Renewable Energy Technologies."
[19] Fischer and Newell, "Environmental and Technology Policies for Climate Mitigation."
[20] Kverndokk and Rosendahl, "Climate Policies and Learning by Doing."
[21] Lehmann, *Climate Policies with Pollution Externalities and Learning Spillovers*.

The key consideration for current investments and support for renewable energy is the necessity to quickly achieve reductions in cost (through "learning by doing"). The International Energy Agency's modelling scenarios show that renewables will play a critical role in this century if climate change is to be mitigated[22]. Immediate CO2 reductions driven by the early deployment of RE may cost more than other options today, but will reduce the costs of mitigating climate change in the future[23]. According to the IEA the required *"cost reductions are expected to come, in a large part, from an early deployment of these technologies"*[24]. Solar PV in particular has experienced consistent and predictable cost reductions as a function of capacity deployed (see figure below), with a "learning rate" of 22% (22% cost reductions for every doubling of deployed capacity)[25,26].

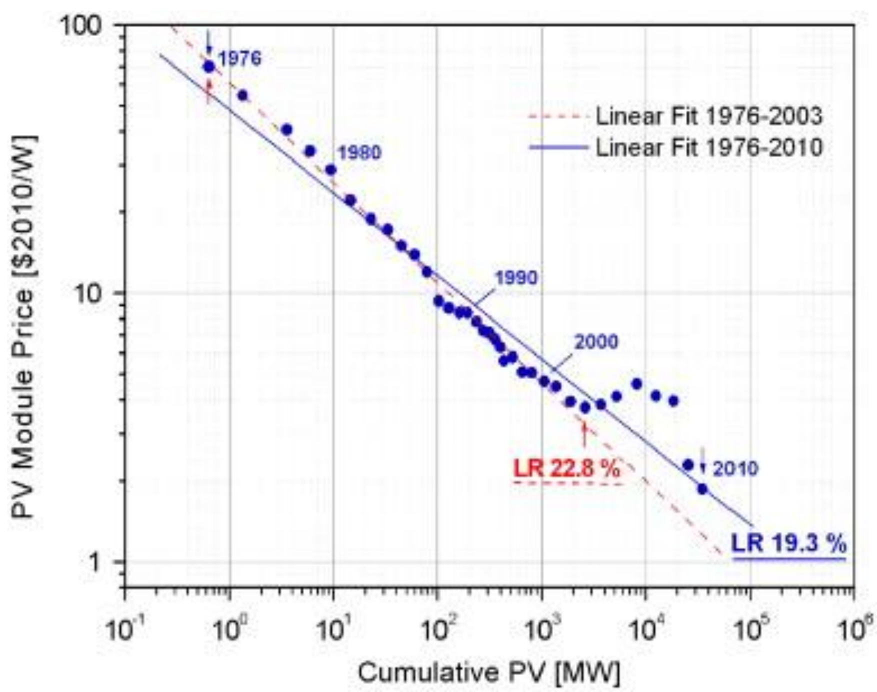

Figure 1: Learning rate for solar PV [source: Petter Jelle, Breivik, and Drolsum Røkenes [27]]

[22] Philibert, "Interactions of Policies for Renewable Energy and Climate."
[23] Ibid.
[24] Ibid.
[25] Nemet, "Beyond the Learning Curve."
[26] Petter Jelle, Breivik, and Drolsum Røkenes, "Building Integrated Photovoltaic Products."
[27] Ibid.

Health and the Environment

There are other external costs associated with fossil fuels, which are not covered by a price on emissions. A key example would include the impact on health and the environment (additional to climate impacts). A recent study from the UNSW surveys that cites 50 articles exploring the health and social harms of coal on community health from 13 countries[28]**.** The report cites excess deaths from lung cancer, chronic heart, respiratory and kidney disease related to living near coal mines. Other reports detail other externalities not included in cost estimates[29], and the negative health impacts have been estimated by the Australian Academy of Technological Sciences and Engineering (ATSE) at $2.6bn annually[30].

Energy Security

Historically, energy security has been of little or no concern to Australia (with abundant energy supplies). However, new linkage with international gas prices will have an impact on Australia's domestic energy security. A recent study[31] illustrates by increasing exposure to gas price uncertainty, Australia's electricity supply could become exposed to international fuel price volatility. Increasing penetration of renewable energy in our market has the potential to de-couple electricity prices from gas prices, increasing energy price security[32].

Renewable energy support policies may not be the "optimal" method to address such health, environment or energy security concerns. However, any comprehensive assessment of renewable energy schemes should take into account possible benefits that are not directly related to carbon emissions.

Additionality of Renewable Energy Support Schemes

The argument for the removal of renewable energy policy instruments is predicated on the assumption that overlap of the policy instruments increases the costs of achieving a given CO_2 emissions cap. This overlap does not have to be seen as policy conflict. The policies can be design such that the cap modifies to ensure efficient carbon abatement. In Germany for the expected emissions reduction for a renewable energy support option have been considered and accounted for by a commensurate reduction in the cap[33]. This quite clearly removes any undesirable overlap or interaction between the two policy mechanisms.

[28] Colagiuri, Cochrane, and Girgis, *Health and the Social Harms of Coal Mining in Local Communities*.
[29] Richardson and Denniss, "Mining the Truth."
[30] Biegler, *The Hidden Costs of Electricity*.
[31] Riesz and Tourneboeuf, *Delivering Energy Price Security in an Age of Uncertainty*.
[32] Ibid.
[33] Matthes, *Greenhouse Gas Emissions Trading and Complementary Policies. Developing a Smart Mix for Ambitious Climate Policies*.

Technology Costs

The draft report rejected Solar PV as an effective form of distributed generation on the basis of technology cost and cost of abatement. Putting aside the other policy objectives of support mechanisms, and the inefficiently low carbon price, the costs on which the report is based on are out of date, and the approach used to determine cost of abatement are problematic for a technology with a rapidly declining cost.

Avoided Network Extension:

Solar PV was described as the *"least cost-effective [distributed generation] option"* for avoiding network extension, with a cost of "over $1.5 million per MW" (of peak power), and compared unfavorably with gas options (both decentralized such as co-generation and tri-generation, and centralized such as an open cycle gas turbine). There are two important developments to consider:

PV costs:

The report on which the cost of PV is based reports the cost of PV at between $5,030 to $5,845 dollars per kW. Whilst this may have been correct at the time of the report, it is already out of date, as a result of the ongoing and substantially cost reductions that have occurred in the last year (and recent years), reflecting the relationship between international deployment and technology costs depicted above. Table 1 illustrates the current average system costs (aggregated by location and system size), without including the impact of the Small-scale Technology Certificate (STC) subsidies[34].

Table 1: System costs per watt (without STC subsidy)

	1.5kW	2kW	3kW	4kW	5kW
Adelaide,	$2.22	$2.21	$2.02	$2.11	$1.99
Brisbane,	$2.51	$2.44	$2.26	$2.34	$2.19
Canberra,	$2.29	$2.28	$2.08	$2.15	$2.03
Hobert,	$2.40	$2.36	$2.14	$2.19	$2.11
Melbourne,	$2.50	$2.44	$2.26	$2.36	$2.21
Sydney,	$1.97	$2.07	$1.87	$1.83	$1.85
Perth,	$2.07	$1.86	$1.99	$1.88	$1.92
ALL	$2.26	$2.27	$2.07	$2.14	$2.04

Small systems fully utilizing current STC (e.g. 1.5kW systems with a solar multiple of two) can be found advertised at $1.6 per watt[35]

[34] "Solar Choice Price Index - November 2012 - Solar Choice."

[35] "Solar Power Systems - Melbourne and Victoria Special Solar Panel Deals."

Cost of Gas Technology:

Distributed gas generation is presented as a lower cost distributed generation source ($0.3 Million/MW c.f. $1.5 Million/MW for Solar PV). However, there does not appear to be any consideration of the cost of gas distribution, and the cost of gas itself.

Whilst distributed gas generation may alleviate networks issues on the electricity network, co-generation and or tri-generation shifts the network burden to the gas distribution network. Increasing the penetration of distributed gas and demand (including peak demand) on the gas grid could be expected to have similar (albeit not the same) impacts as increase demand on the electricity grid. Arguably, the gas network itself represents redundant infrastructure, with electricity now able to efficiently provide the same services gas provides (with, for example, heat pumps) and the potential for zero emissions provision.

The other development (which equally affects centralized gas generation) is the increasing gas price. Traditionally, Australia has enjoyed low gas prices (with current cost of cost of production at approximately $3 - $4/GJ) compared with other developed economies[36]. This is due to abundance of natural gas relative to domestic demand, and significantly the fact that historically there has been no method by which domestic gas prices could be directly linked to higher international or oil-linked prices[37].

The emerging Liquid Natural Gas (LNG) export industry is likely to change this, linking the Australia domestic market to international markets and prices. A similar scenario developed in the in Western Australia from the late 1980s, with the growth of LNG export capacity leading to the domestic market being increasingly exposed to international energy prices[38]. Australia's exports of natural gas have been project to more than triple by 2020 and upward pressure on domestic prices is likely, particularly in light of proximity to key Asian markets[39], a market in which the prices are linked to the oil price[40].

The International Energy Agency (IEA) has prepared a gas price forecast for the key regions under two scenarios. These scenarios account for the greater production of unconventional gas,

---

[36] AEMO, "Gas Statement of Opportunities."
[37] Ibid.
[38] Australian Energy Regulator and Australian Competition & Consumer Commission, *State of the energy market 2011*.
[39] EIA, "International Energy Outlook 2011."
[40] IEA, "World Energy Outlook 2011: Are We Entering a Golden Age of Gas?".

more ambitious gas-use policy in China, and the lower growth rates for nuclear power that is driving demand and prices[41]. Figure 2 illustrates the project gas prices in these scenarios.

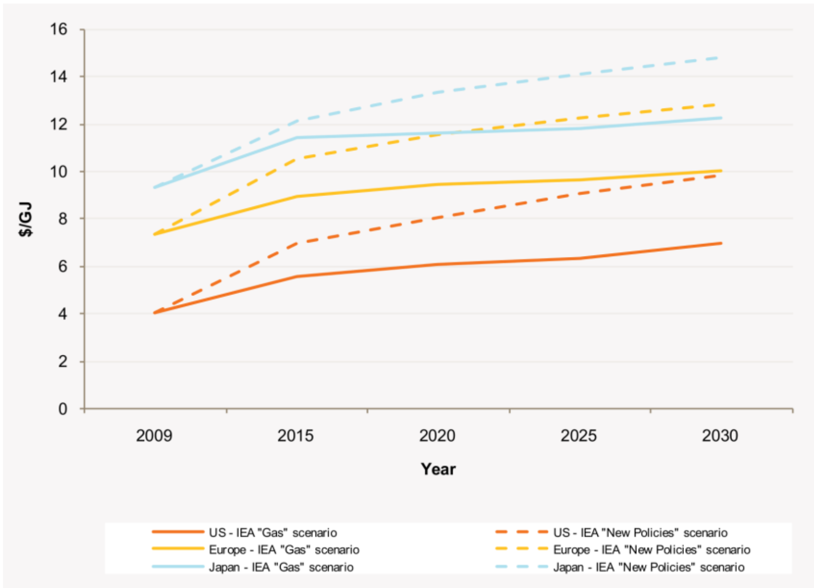

Figure 2: Gas Price Projections [source: AEMO[42]]

The Australian Energy Market Operator (AEMO) expects that the Eastern and South Eastern Australian gas producers are likely to achieve higher-value or oil linked gas pricing, in line with the IEA projections. For Australian produced gas, AEMO is projecing a range of domestic gas prices between ***$5*** and ***15/GJ,*** (depending on economic parameters such as oil prices, exchange rates and global economic growth rates)[43]. The Queensland Government's 2011 Gas Market Review suggests that it is "likely" that new contract prices will "rise substantially from 2013 to over $8/GJ in most markets" [44].

The movements in gas prices are likely to have a substantial impact on domestic gas fired electricity generation costs (both centralized and decentralized), and support a need for a consideration of energy security concerns, as previously raised.

In combination, the falling solar cost and rising gas cost would change the comparison between the two technologies. The draft reported the cost for solar PV to supply peak capacity at an annualized cost of $1.5 million / MW peak. This was based on a report that also included the

[41] AEMO, "Gas Statement of Opportunities."
[42] Ibid.
[43] Ibid.
[44] Ibid.

levelised cost of energy (LCOE) at $350/MWh[45]. A successful project developer in a recent "reverse auction" tender in the ACT won with an offer to supply energy at $189/MWh[46]. At this price, the cost to supply peak power falls to $0.8 million per MW-peak (including consideration for the supposed ability for PV to only be able to supply 30% of the peak demand).

The annualized cost for gas to supply peak MW capacity could also be higher than reported. The extent to which gas prices may affect this cost depends largely on the capacity factor and the heat rate of the particular form of gas generation considered). The report on which the estimate is based suggest the LCOE of a new combined cycle gas turbine is roughly $100/MWh[47] , which is at the lower end of the cost ranges recently prepared by the Bureau of Resources and Energy Economics (the higher end of which is based on higher fuel costs and is closer to $150/MWh[48]). Given this, it could be expected that the costs to supply a peak MW using gas technologies could be also expected to be higher.

Cost of Abatement:

The draft report suggests that the support schemes represent a *"relatively high cost option for reducing greenhouse gas emissions".* The implicit cost of abatement for small scale PV subsidy schemes is recounted from a previous Productivity Commission Report (*"Carbon emission policies in key economies"*[49]*)*, at $432-$1042/t CO2-e (pg 455). Again, ignoring the carbon policy issues, and the important and required cost reductions expected through "learning by doing", these numbers must be scrutinized.

Firstly, these numbers were contested by various stakeholders when they were first published, and the Productivity Commission itself amended these figures in a supplement released late last year (*"Carbon emission policies in key economies: Responses to Feed Back on Certain Estimates"* [50]*).*The supplement revised the implicit cost of abatement to $177-$497/t CO2-e, and included a summary of some of the key criticisms and issues with the approach used in the original report.

However, the Commissions approach (including the updated figures) considered the *total* subsidy provided to owners of Solar PV, and not the marginal cost. This results in the implied

[45] Dunstan, C. et al., "Think Small: The Australian Decentralised Energy Roadmap: Issue 1."
[46] ACT Government (Chief Minister), "ACT Labor Government Delivers Big Solar for Canberra."
[47] Dunstan, C. et al., "Think Small: The Australian Decentralised Energy Roadmap: Issue 1."
[48] BREE, *Australian Energy Technology Assessment*.
[49] Productivity Commission, *Carbon emission policies in key economies*.
[50] Productivity Commission, *Carbon emission policies in key economies: Responses to Feedback on Certain Estimates for Australia*.

cost of abatement represent the *"upper bound estimate of the resource cost of policies"* (as noted in the supplement), and not a useful reflection of current implied abatement cost.

The issues with this approach can be illustrated by considering a point at which solar PV can be installed without subsidy (for example due to rising electricity prices and/or falling technology costs). Should this occur, the marginal cost of abatement would be zero, however, approach used by the Productivity Commission would still return a perhaps significant "implied cost of abatement". The cost of abatement would still include for example the Feed-in Tariff.

Current Cost of Abatement:

Table 2 below shows the current average Small-scale Technology Certificate (STC) rebate received by owners of PV systems, aggregated by state and system size[51].

Table 2: STC cost ($/certificate), for PV systems by state and size[52]

	1.5kW	2kW	3kW	4kW	5kW
Adelaide, SA	$26.43	$26.43	$26.29	$26.43	$28.43
Brisbane, QLD	$26.17	$26.29	$26.29	$26.29	$26.29
Canberra, (ACT)	$26.80	$26.80	$26.80	$26.80	$26.80
Hobart, (Tas)	$26.67	$26.67	$26.67	$26.67	$26.67
Melbourne (Vic)	$25.50	$25.50	$25.50	$25.50	$25.50
Sydney (NSW)	$26.40	$26.40	$26.40	$27.60	$27.60
Perth (WA)	$27.20	$27.20	$27.20	$27.20	$27.20
ALL	$26.45	$26.47	$26.45	$26.64	$26.93

Many of the states have wound back or entirely removed feed-in tariffs (as noted in the draft report), and as such the STC remains the primary subsidy for new PV installation, and can be used to determine a current marginal cost of abatement.

We calculated the implied cost of abatement for two hypothetical systems (1.5kW and 5kW) in Zone 3 (Zone 3 covers Sydney, Brisbane and Adelaide). The current emission intensity of 0.85t-CO2-e/MWh[53] (which has fallen since the introduction of carbon pricing) and a solar multiple of two was used for the calculation (with the first 1.5kW being eligible for the solar credits, meaning the smaller system receives a proportionally higher subsidy). The cost of abatement was calculated based for both 15 years (the 'deeming period' for the STC calculation) and for 25 years (the expected lifetime of a new installation).

---

[51] "Solar Choice Price Index - November 2012 - Solar Choice."
[52] Ibid.
[53] AEMO, *Carbon Price Market Review*.

	System 1	System 2
Total System Size (kW)	1.5	5
Zone Rating (zone 3) [-]	1.382	1.382
Deeming Period (yrs)	15	15
Number STC's [-]	62.19	134.745
Subsidy Value ($)	$1,653.51	$3,582.60
Capacity Factor (%)	15%	15%
Annual Electricity Production (kWh)	1971	6570
Emissions Intensity (tonnes CO2-e / MWh)	0.85	0.85
Abated Emission Annual (tonnes/annum)	1.67535	5.5845
Implied Cost of Abatement ($/tonne CO2-e)		
15 years (deeming period)	$65.80	$42.77
25 years (expected lifetime)	**$39.48**	**$25.66**

The marginal cost of abatement, as calculated here, is an order of magnitude smaller than the total abatement cost numbers presented in the Productivity Commissions reports.

It is acknowledged that the emissions intensity may not remain at the current levels of 0.85t/MWh, however the capacity factor (15%) used in the calculations are conservative (and the technology costs continue to decrease). This impact of a reduction in emission intensity (to a projected 0.7t/MWh by 2020[54] in some scenarios) on the calculated cost of abatement would be offset by an increase in capacity factor to 18% (which some current rooftop systems achieve, and utility scale flat scale systems may have capacity factors as high a as 21%[55]). It should also be noted the current average size of installation is 3.2 kW[56], and the solar multiple will soon (early 2013) reduce to one[57].

[54] AEMO, "2011 National Transmission Network Development Plan Consultation Report Input Tables."
[55] Electric Power Research Institute (EPRI), "AEGTC 2010."
[56] "Data Reports - Clean Energy Regulator – Renewable Energy Target."
[57] Minister for Climate Change and Energy Efficiency (Commonwealth of Australia), "Minister for Climate Change and Energy Efficiency."

Wholesale value and varying tariffs

The draft report endorsed the finding of the Victorian Competition and Efficiency Commissions (VCEC) report in feed-in tariffs, which suggested that *"remuneration should be delivered by net feed-in tariffs based on the wholesale value of electricity (adjusted for effects on system losses)".*

This approach fails to take into account the impact of hedging and contracting, which tends to obscure the publicly available information on the 'real' wholesale value of electricity. High levels of contracting result in lower wholesale spot prices (the publically accessible price signal) as the existence of contracts changes market behavior. Consequently, contract prices are higher than the average (publicly available) spot prices[58].

That is to say, contract prices (and the 'real' wholesale value) are typically higher than the spot price, and as such, the value placed on power from Solar PV is actually *lower* than that which comes from existing technology (mainly coal fired generation). Whilst the wholesale value should be adjusted for the systems losses, consideration should also be given to the impact of contacting when determine the true "wholesale value".

As identified in the PC report, time varying tariffs should be implemented to encourage efficient installation of PV units, and we would support this recommendation. However, given that (as previously discussed):

- Carbon Cost has been insufficiently internalized;
- Other market failures (included knowledge "spill over" through learning by doing) are not covered through market based pricing;
- Efficient additionality to emissions caps is practically possibility
- Spot prices do not reflect the true wholesale value of energy

the appropriate rate is not encapsulated by the market price alone (even with additional payments from network businesses).

[58] Anderson, Hu, and Winchester, "Forward Contracts in Electricity Markets."

References

ACT Government (Chief Minister). "ACT Labor Government Delivers Big Solar for Canberra." *ACT Government*, May 9, 2012. http://www.cmd.act.gov.au/open_government/inform/act_government_media_releases/corbell/2012/act_labor_government_delivers_big_solar_for_canberra2.

AEMO. "2011 National Transmission Network Development Plan Consultation Report Input Tables." *2011 NTNDP Consultation*, January 31, 2011. http://www.aemo.com.au/Consultations/National-Electricity-Market/Closed/~/media/Files/Other/planning/0418-0012%20xls.ashx.

———. *Carbon Price Market Review*. Melbourne, Australia: Australian Energy Market Operator, November 8, 2012. http://www.aemo.com.au/Reports-and-Documents/Reports/~/media/Files/Other/reports/CarbonPrice_MarketReview.ashx.

———. "Gas Statement of Opportunities." Australian Energy Market Operator, 2011. http://www.aemo.com.au/Gas/Planning/2011-Gas-Statement-of-Opportunities/~/media/Files/Other/planning/GSOO2011/documents/chapter5%20pdf.ashx.

Anderson, E. J., X. Hu, and D. Winchester. "Forward Contracts in Electricity Markets: The Australian Experience." *Energy Policy* 35, no. 5 (2007): 3089–3103.

Arrow, K. J. "The Economic Implications of Learning by Doing." *The Review of Economic Studies* (1962): 155–173.

Australian Energy Regulator, and Australian Competition & Consumer Commission. *State of the energy market 2011*. Melbourne: Australian Energy Regulator, 2011.

Australian Treasury. *Strong growth, low pollution : modelling a carbon price*. Canberra: Treasury, 2011.

Biegler, T. *The Hidden Costs of Electricity: Externalities of Power Generation in Australia*. ATSE, 2009.

BREE. *Australian Energy Technology Assessment*. Canberra: Bureau of Resources and Energy Economics, 2012. http://www.bree.gov.au/documents/publications/aeta/Australian_Energy_Technology_Assessment.pdf.

Colagiuri, Ruth, Johanne Cochrane, and Seham Girgis. *Health and the Social Harms of Coal Mining in Local Communities*. Sydney: Health and Sustainability Unit, The Boden Institute for Obesity, Nutrition and Exercise, The University of Sydney, 2012. http://media.beyondzeroemissions.org/coal_health_Report_FINAL.pdf.

Denniss, Richard, and Andrew Macintosh. "Complementary or Contradictory? An Analysis of the Design of Climate Policies in Australia." The Australia Institute, February 2011. http://www.tai.org.au/file.php?file=/media_releases/PB22%20Complementary%20or%20contradictory.pdf.

Downing, T., D. Anthoff, R. Butterfield, M. Ceronsky, M. Grubb, J. Guo, C. Hepburn, C. Hope, A. Hunt, and A. Li. *Social Cost of Carbon: A Closer Look at Uncertainty. Final Report. Stockholm Environment Institute*. Oxford, UK, 2005.

Dunstan, C., Boronyak, L., Langham, E., Ison, N., Usher, J., Cooper, C., and White, S. "Think Small: The Australian Decentralised Energy Roadmap: Issue 1." Institute for Sustainable Futures, December 2011. http://igrid.net.au/resources/downloads/project4/Australian_Decentralised%20Energy_Roadmap_December_2011.pdf.

EIA. "International Energy Outlook 2011." U.S. Energy Information Administration, September 2011. www.eia.gov/forecasts/ieo/pdf/0484(2011).pdf.

Electric Power Research Institute (EPRI). "Australian Electricity Generation Technology Costs – Reference Case 2010." Department of Resources, Energy and Tourism, February 2010. www.ret.gov.au/energy/Documents/AEGTC%202010.pdf.

Fischer, C., and R. G. Newell. "Environmental and Technology Policies for Climate Mitigation." *Journal of Environmental Economics and Management* 55, no. 2 (2008): 142–162.

IEA. "World Energy Outlook 2011: Are We Entering a Golden Age of Gas?," 2011. http://www.iea.org/weo/docs/weo2011/WEO2011_GoldenAgeofGasReport.pdf.

———. *World Energy Outlook 2012*. International Energy Agency, 2012. http://www.worldenergyoutlook.org/media/weowebsite/2012/goldenrules/WEO2012_GoldenRulesReport.pdf.

Isoard, S., and A. Soria. "Technical Change Dynamics: Evidence from the Emerging Renewable Energy Technologies." *Energy Economics* 23, no. 6 (2001): 619–636.

Jaffe, A. B. *Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits and Market Value*. National Bureau of Economic Research Cambridge, Mass., USA, 1986. http://www.nber.org.ezp.lib.unimelb.edu.au/papers/w1815.

Keppler, Jan Horst, and Michel Cruciani. "Rents in the European Power Sector Due to Carbon Trading." *Energy Policy* 38, no. 8 (August 2010): 4280–4290. doi:10.1016/j.enpol.2010.03.057.

Kverndokk, S., and K. E. Rosendahl. "Climate Policies and Learning by Doing: Impacts and Timing of Technology Subsidies." *Resource and Energy Economics* 29, no. 1 (2007): 58–82.

Lehmann, P. *Climate Policies with Pollution Externalities and Learning Spillovers*. UFZ-Diskussionspapiere, 2009. http://www.econstor.eu/handle/10419/44722.

Lehmann, P., and E. Gawel. *Why Should Support Schemes for Renewable Electricity Complement the EU Emissions Trading Scheme?* UFZ-Diskussionspapiere, 2011. https://opus.zbw-kiel.de/dspace/handle/10419/48674.

Matthes, F. C. *Greenhouse Gas Emissions Trading and Complementary Policies. Developing a Smart Mix for Ambitious Climate Policies*. Berlin: Öko Institute, 2010. http://www.oeko.de/oekodoc/1068/2010-114-en.pdf.

Minister for Climate Change and Energy Efficiency (Commonwealth of Australia). "Minister for Climate Change and Energy Efficiency: Media Releases 2012." *Climate Change and Energy Efficiency*, November 16, 2012. http://climatechange.gov.au/minister/greg-combet/2012/media-releases/November/MR-307-12.aspx.

Nemet, G. F. "Beyond the Learning Curve: Factors Influencing Cost Reductions in Photovoltaics." *Energy Policy* 34, no. 17 (2006): 3218–3232.

New South Wales. Parliament. Legislative Council. General Purpose Standing Committee No. 1, and Fred Nile. *The gentrader transactions*. [Sydney, N.S.W.]: General Purpose Standing Committee No. 1, Parliament of New South Wales, 2011.

Petter Jelle, Bjørn, Christer Breivik, and Hilde Drolsum Røkenes. "Building Integrated Photovoltaic Products: A State-of-the-art Review and Future Research Opportunities." *Solar Energy Materials and Solar Cells* 100 (May 2012): 69–96. doi:10.1016/j.solmat.2011.12.016.

Philibert, Cédric. "Interactions of Policies for Renewable Energy and Climate." International Energy Agency, 2011. www.iea.org/papers/2011/interactions_policies.pdf.

Productivity Commission. *Carbon emission policies in key economies*. Melbourne: Productivity Commission, 2011. http://www.pc.gov.au/__data/assets/pdf_file/0003/109830/carbon-prices.pdf.

———. *Carbon emission policies in key economies: Responses to Feedback on Certain Estimates for Australia*. Melbourne: Productivity Commission, 2011. http://www.pc.gov.au/__data/assets/pdf_file/0016/114244/carbon-prices-supplement.pdf.

———. *Electricity Network Regulatory Frameworks, Draft Report, Vol 2*. Vol. 2. Canberra: Productivity Commission, 2012. http://pc.gov.au/__data/assets/pdf_file/0013/120046/electricity-draft-volume2.pdf.

Richardson, D., and R. Denniss. "Mining the Truth." *The Australia Institute* no. 11 (September 2011): 70.

Riesz, Jenny, and Elisabeth Tourneboeuf. *Delivering Energy Price Security in an Age of Uncertainty*. Sydney: AECOM, July 2012. http://www.aecom.com/deployedfiles/Internet/Geographies/Australia-New%20Zealand/DeliveringEnergyPriceSecurity_DrJennyRiesz.pdf.

TNS Gallup, and Vestas. *Global Consumer Wind Study*. Vestas, 2012. http://www.vestas.com/Admin/Public/Download.aspx?file=Files%2fFiler%2fEN%2fEnergy+Transparency%2fGlobalConsumerWindStudy2012_Oct.pdf.

"Data Reports - Clean Energy Regulator – Renewable Energy Target." Accessed November 22, 2012. http://ret.cleanenergyregulator.gov.au/REC-Registry/Data-reports.

"NSW's Great Big Coal Subsidy Scandal | Climate Spectator." Accessed November 22, 2012. http://www.climatespectator.com.au/commentary/nsws-great-big-coal-subsidy-scandal.

"Solar Choice Price Index - November 2012 - Solar Choice." Accessed November 22, 2012. http://www.solarchoice.net.au/blog/solar-choice-price-index-november-2012/.

"Solar Power Systems - Melbourne and Victoria Special Solar Panel Deals." Accessed November 22, 2012. http://www.energymatters.com.au/specials/victoria-solar-power-special.php.