Solar Feed-in Pricing Review Submission

What makes up a Fair Price for Solar PV?

by

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About the Author

I am a private consultant in sustainable energy (SE). I have worked in both renewable energy (RE) and energy efficiency (EE) for nearly 40 years, including:

- Solar and Wind Energy System design and installation,
- Energy Efficient Building design,
- Solar Water Heating design and installation,
- Energy auditing homes, businesses and schools,
- Related research and development at UQ, QUT and GU,
- RE technical training and public education,
- RE and EE policy.

I am the author of “Solar Electricity Consumer Guide” (2011) and author/co-author to a range of renewable energy, technical training resources books used through Australian universities and training colleges. These include “Introduction to Renewable Energy Technologies” and “Photovoltaic Power Systems”. I was branch president of the Australian Solar Council (formerly the Australian Solar Energy Society) and a founding member in Queensland of the Alternative Technology and Wind Energy Associations.

I am currently the energy policy researcher and writer for Sustainable Queensland forum group (www.sustainablequeensland.info). See attached flyer. I am trained in mechanical engineering and energy auditing at QUT and have a Masters of Environmental Education from Griffith University.

Submission

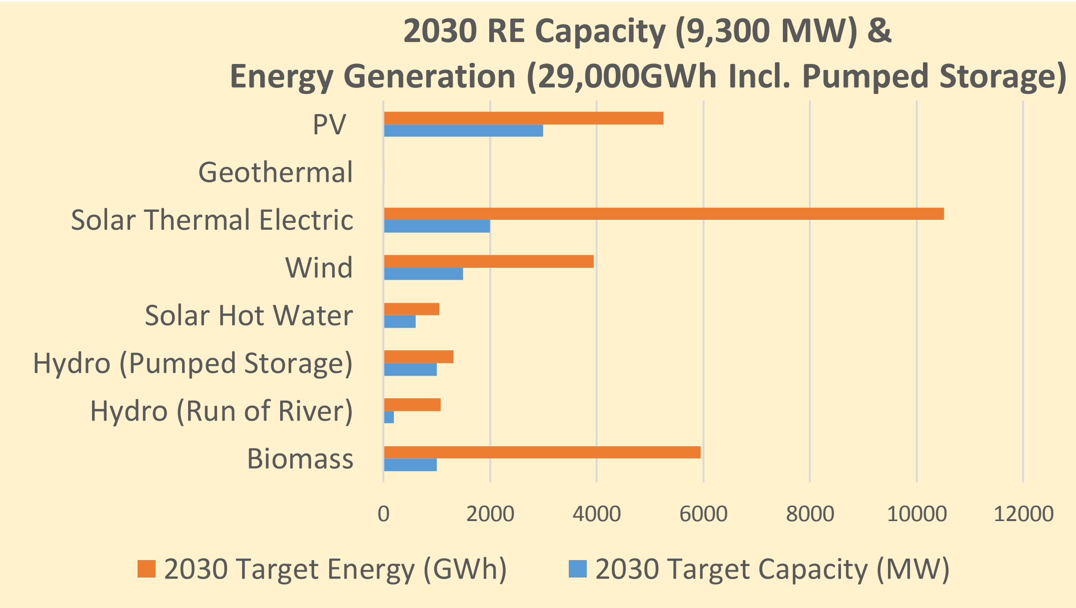
Sustainable Queensland welcomes the opportunity to contribute to the Solar Feed-in Issues Paper. The current Queensland Government recognises that we have a massive solar energy resource and has made some election commitments to expand the renewable energy industry, including a million solar PV systems by 2020. Solar PV is now one of the cheapest forms of energy production with costs continuing to fall (IEA, 2015; Bloomberg, 2013; Elliston et al, 2014; HSBC, 2015; IRENA, 2014).

The Issues Paper correctly identifies many of the issues that need to be addressed and is a step in the right direction. This technology will be crucial in the goal of transitioning Queenslanders from being some of the most fossil fuel intensive energy users, and hence highest greenhouse gas emitters in the world (DERM, 2009), to a clean energy nation, using our abundant renewable energy sources. As part of this process, I have written a sustainable energy policy paper on behalf of Sustainable Queensland. Professor Ian Lowe is the patron of this group. This paper is included in my submission.

I have also written a follow-up paper that examines the scale of renewable energy systems deployment required to meet the State Government's 50 percent renewable energy electricity target by 2030 (Berrill, 2015). This paper (attached to this submission) also analyses the investment required and jobs created in order to reach this target. The paper identifies the need for at least 3000 Megawatts (MW) of solar PV by 2030. Figure 1 below shows a potential mix of renewable energy plant to achieve the target. About 1300MW of predominantly roof-top solar PV has already been installed. These paper can also be downloaded from www.trevolution.com.au.

To achieve the goal for a 50 percent renewable energy electricity target by 2030, strong and long term supportive policy is required. A solar PV feed-in price is a crucial part of this policy.

Figure 1 – Renewable Energy Capacity (MW) and Energy Generation (GWh) for 2030 Target



A Fair Price for Solar PV

A fair price for solar PV electricity should attempt to include a value against each of the categories in the following table from the Rocky Mountain Institute, as reported in the Clean Energy Council's report, "Calculating the Value of Small-scale generation to Networks" (CEC, 2015:23).

Table 1: DPV cost/benefit categories as described by the Rocky Mountain Institute [16]

Cost/benefit categories	Cost/benefit sub-categories
Energy	Energy
	Energy losses
Capacity	Generation capacity
	Transmission and distribution capacity
	DPV installed capacity
Grid Support Services	Reactive supply and voltage control
	Regulation and frequency response
	Energy and generator imbalance
	Synchronised and supplemental operating reserves
	Scheduling, forecasting, and system control & dispatch
Financial Risk	Fuel price hedge
	Market price response
Security Risk	Reliability & resilience
Environmental	Carbon emissions
	Criteria air pollutants (Sox NOx, PM10)
	Water
	Land
Social	Economic development (jobs and tax revenues)

The avoided cost method previously used by the Queensland Competition Authority (QCA) was too narrowly focused on wholesale price displacement, fees and network losses in deriving a regional value of 6.348c/kWh for exported PV energy. The QCA report stated incorrectly that there was no benefit to the 75 percent of electricity consumers who didn't yet have solar PV systems. This completely ignores the substantial environmental and social benefits of this technology in avoiding climate impacts, pollution and health impacts of fossil fuels. Hence the QCA method undervalued the benefits of solar PV energy, as set out in the table above, and has resulted in:

- A slowing in the uptake of solar PV across the State, including a substantial loss of jobs in this sector. Continued growth in PV uptake helps to off-set job losses in the mining sector due to the boom-bust nature of this industry, and the predicted decline of the coal industry in particular.
- The electricity retailers get to make a handsome profit by on-selling exported PV energy at a typical retail rate of 20 to 26 cents/kilowatt-hour, having paid around 6 to 11c/kWh only to the PV owner.

Simplicity & Pricing

The table below shows the value given to solar PV generation from the QCA and the Alternative Technology Association (see ATA submission to QPC inquiry). This is compared to a comprehensive study of distributed PV generation by the Maine Public Utilities Commission (MPUC). The US c/kWh are not adjusted for the exchange rate.

Table 2 – Comparison of PV generation valuations

Comparison of Valuations	
QCA Value of Solar PV (AUS c/kWh)	
Wholesale Energy Cost	5.57
NEM and ancillary service fees	0.083
Value of network losses	0.695
Total	6.348
ATA Valuation of Solar PV (AUS c/kWh)	
First 10 years – Wholesale+Avoided Market Fees+Merit Order Effect	29 - 34
Value thereafter	9 - 14
Main Public Utilities Commission Study 2015	
First Year Value (US c/kWh)	18.2
25 Year Levelised Value (US c/kWh)	33.7

Table 2 shows that more comprehensive analyses such as the MPUC study are likely to give a more accurate reflection of the real value of PV generation. This value is well above the QCA's valuation. Appendix 2 gives more details of the MPUC study.

Conclusion

My conclusion from this simple comparison is that until a comprehensive similar analysis is available for Australia, a good starting point would be to offer PV owners **the equivalent of the current retail rate of around 20 to 26c/kWh.** This would:

- Making metering simple and easy to understand for PV owners.
- Help account for market distortions including external costs and subsidies to the fossil fuel generators in Queensland.

More discussion regarding these market distortions is given below.

Issues and Barriers

Market Failure

There has been and continues to be on-going market failure in the energy sector for many years through:

- The avoidance of paying external costs of fossil fuels over their life. For full details, see the Sustainable Queensland Energy Policy paper attached. These range from $19/Megawatt-hour, $40/MWh (black coal) (Australian report by Biegler, 2009) to as high as $200/MWh based on the comprehensive Harvard University study in the USA (Epstein et al, 2011). The Biegler study is a very conservative estimate and the real cost is likely to be between $40 and $200/MWh. This is because many environmental costs such as mine rehabilitation are predicted to be billions of dollars across the State (Main & Schwartz, 2015). There are over 15,000 abandoned mine sites (of all types) across Queensland (See map in Appendix 1). As well, ultimately, economics can't put a full price on preventing the deterioration of our natural wonders such as the Great Barrier Reef and the Wet Tropics due to global warming and other pollution.
- Government subsidies to the fossil fuel industry. This includes monies for electricity transmission infrastructure development that directly benefit the fossil fuel industry. Both my own research (Berrill, 2012) and that by The Australia Institute (Peel, 2014) show that Queensland Governments have been contributing about $1 to 2 billion annually to this State industry. Similar subsidies have happened in New South Wales (Climate & Health Alliance, 2015). The Federal Government also provides subsidies to the fossil fuel industry.

These factors contribute to market distortions. This is well recognised by the International Energy Agency and the International Monetary Fund and the Queensland externalities and subsidies are discussed (with references) in the Sustainable Queensland energy policy paper attached (Berrill, 2015).

Cross-subsidies are another form of market failure and contribute to wasteful energy use (measured in Gigawatt-hours) and peak demand (measured in MVA). Air conditioning is particularly problematic and has contributed greatly to peak demand across the network (EY, 2015:11). Previous estimates have put the cost to upgrade the network at between $10,000 and $13,000 per kilowatt of air conditioning. This cost is subsidised by the 25 percent of homes that don't need, choose not to have or can't afford air conditioning.

There is also substantial cross subsidising of the commercial and industrial sectors by the residential sector. This is because electricity tariff costs to both commercial and industrial users have historically been lower than residential users, even though each sector consumes about 30 percent of total electricity generation (GWh).

Security of Energy Supply

Energy supply security is key to a functioning society. Climate change is contributing to instability in the Middle East including Syria, and Asia. Also there is conflict over oil reserves in the South China See. This in turn threatens our oil supply. *Automotive gasoline, for example, is sourced entirely from Singapore (52 per cent), Taiwan (27 per cent) and Korea (21 per cent) while 67 per cent of Australia's petroleum imports must transit through the waters of the Indonesian archipelago* (Medcalf & Brown, 2014). As a result, Australia spends many millions of dollars each year on maintaining a military presence in both Asia and the Middle East. The rapid development of a renewable energy based electricity system combined with a shift to electric transport is now possible and happening. It would contribute to avoiding the need for military expenditure in defending our access to oil.

Metering

The issues paper has correctly identified the advantages and disadvantages of different metering options. There is a need for smart metering on all customers and gross smart metering is the preferred option. This is because:

- Smart meters monitor half-hourly power consumption and allow determination of the load profile (Power VS Time) of individual homes and businesses. This facilitates full cost reflective pricing and peak demand management.
- Gross metering (separate meter for PV output and consumer load) allows for:
    - Full performance assessment of PV system output – this could be done via the inverter energy meter as most inverters log power / energy output. This allows Government to measure rather than deem the output of PV systems. It gives feedback to PV owners regarding the actual performance of their systems.
    - Measurement of the energy use (kWh) and peak power demand (MVA) within residences or businesses allows full assessment of energy efficiency measures. This allows Government to measure the benefit of energy efficiency policy. It gives feedback to home and business owners regarding the benefits of energy efficiency.

The current net metering using a single meter with import and export registers is a low cost compromise that:

- Does not allow full measurement of demand with residences or businesses and so can't fully measure energy efficiency savings.
- Only measures the exported part of PV energy generation and so doesn't show that part that is supplied direct to home or business appliances.

Transitioning to an Energy Services Model based around a Smart Distributed Grid

A fundamental problem is that the current electricity supply model is outdated, being based around large centralised generators, remotely located near coal mines, supplying all energy use via long transmission/distribution systems to end users. It continues to encourage growth in electricity consumption as it generates its income via sales of units of electricity, and in some sectors by demand changes. Historically, it tried to forecast consumption (GWh) and demand (MVA) growth over long time periods, and build large centralised plant to meet both consumption and peak demand. Long term planning by these projections led to large step increases in generation capacity (e.g. 1500MW). This has invariably led to both over-supply (too much generation capacity) and over-building of the transmission and distribution network, via over-estimates of peak demand. This planning method mostly ignored the impact of energy efficiency and embedded generation such as solar PV. As we have seen over the past 5 years across the NEM, these growth predictions were completely wrong.

This old model is an unsustainable model that is rapidly being replaced by a new model, the smart (or intelligent) distributed grid model. As CSIRO has pointed out in its Intelligent Grid program, the new model is cheaper, helps maximise efficient use of energy and minimise emissions, and is more resilient to extremes in weather or terrorist attacks. In this model, embedded, modular, variable scale generators can be added rapidly to follow the long term trend in electricity demand.

The Rocky Mountain Institute has long promoted the alternative utility model, the Energy Services Model. This is where energy utilities change their focus from sales of units of energy to the supply the energy services we need (light, sound, heat, coolth etc.) at the least cost (including environmental cost). It has been stated many times that it is not gigawatt-hours that we need but the service the energy provides. This model also assists to decouple energy use and emissions from gross domestic product growth. This is essential if we are to address the global warming crisis. This is the approach that the most forward looking countries such as Germany are now adopting. Germany's energy transition program aims to halve all primary energy use by 2050 and supply 80 percent of electricity from renewable energy. It is well on the path, already generating 30 percent of electricity from renewables.

Relationship of Electricity Pricing to Sustainable Energy Policy

Pricing for renewable energy generated power is part of the requirements of the complex energy systems that run the Queensland economy. It should be developed in relation to government policy that provides for a sustainable energy supply system. **This current review seems to be putting the cart before the horse as in Queensland, we don't yet have such a policy in place. Energy policy is currently under review by the Department of Energy and Water Supply**.

Key elements to a sustainable energy system policy should include:

- Accepts global warming science and the need for action via targets and other initiatives
- Very low or no polluting emissions from energy supply technologies
- Highly efficient energy conversion
- Reliable and resilient supply
- Safe to workers and the community
- Affordable cost to end-user
- Promotes regional development
- Users pay a fair share of their energy costs and impacts
- Responsibility for the global commons

Sustainable energy policy work by the author are listed in the references below.

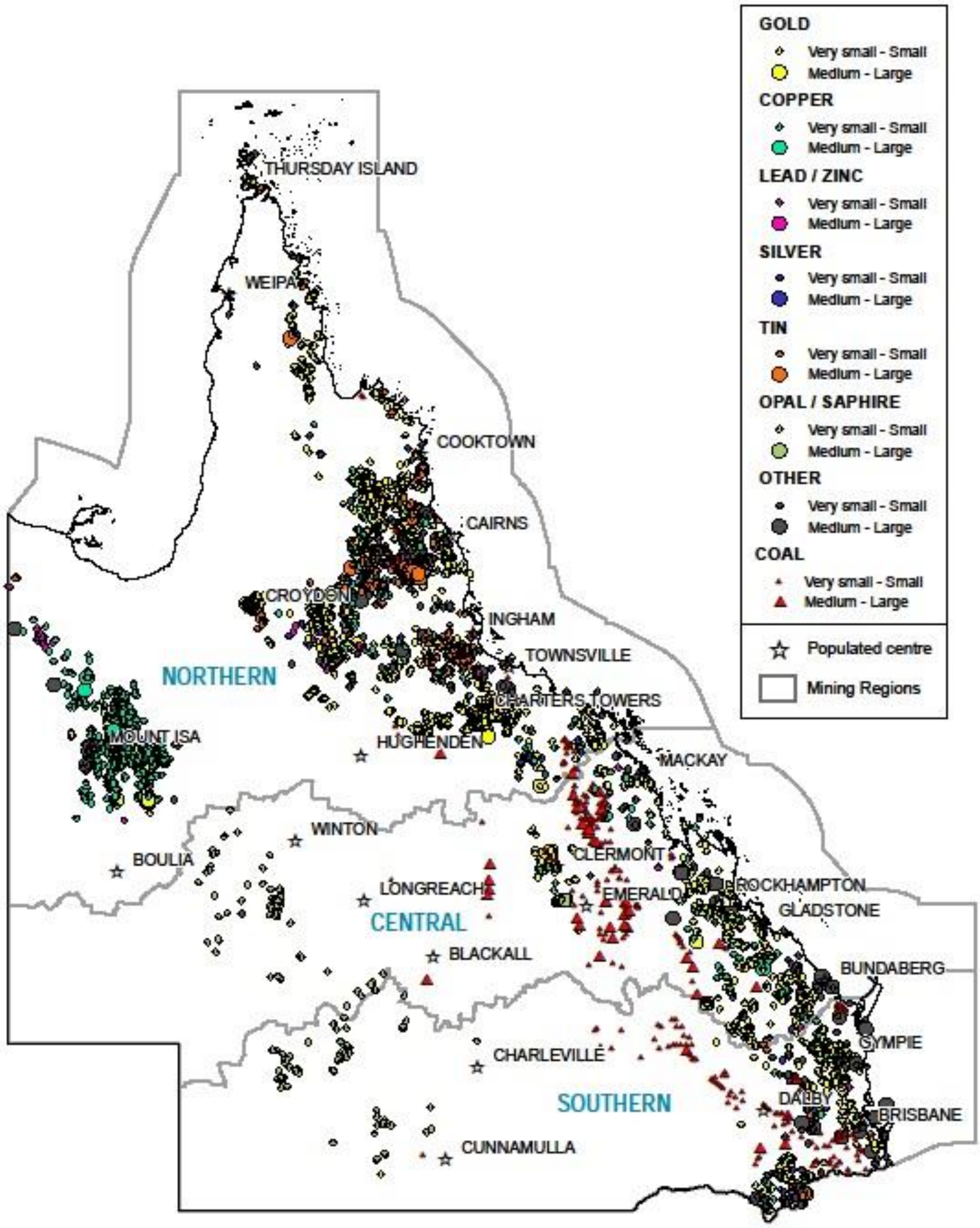
Appendix 1 - External Costs of Coal-Fired Electricity over Life Cycle

Mean values from Study by Epstein, P. et al (2011). Full cost accounting for the life cycle of coal. Published in Annals of the New York Academy of Science: Ecological Economics Reviews

Life Cycle	Externalities	External Cost (c/kWh) US
Mining	Subsidies – electricity/water/fuel rebates Reduced Prop. Values Displacement of other industries / Jobs / long term earnings – Agriculture/Tourism Econ. Boom/bust cycle of commodities Mortalities/Morbidity workers / community Trauma surrounding communities Accidents and Fatalities – workers/ transport /subsidence Hospitalisation costs Heavy metals and contaminated land / rivers /estuaries / GBR Loss of habitat and species Air pollution Acid mine drainage Methane emissions Rehabilitation and monitoring	4.4
Transportation - 70% of rail traffic is for Coal (USA)	Subsidies Rail and road repairs Accidents and Fatalities Hospitalisation costs GHG emissions Air pollution Vegetation damage	0.09
Combustion	Mortality/Morbidity Hospitalisation costs GHG emissions Other Air pollutants (NOx, mercury, arsenic, selenium , Ozone and particulates) Infrastructure deterioration – acid rain Rail and road repairs Water and Marine pollution Soil contamination, coal ash and other wastes Freshwater use	12.7
Abandoned Mines and Waste Disposal	Heavy metal health impacts – contamination, trauma following spills, tailing dam failure	0.44
Transmission	Energy losses Ecosystem disturbance Vulnerability of grid to climate change events	0.01

Figure 1 - Abandoned Mine Sites in Queensland – An example of a very significant external cost that is not fully included in current mining costs.

Source: https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0003/262659/abandoned-mines-map.pdf



Appendix 2 – Maine Public Utilities Commission PV Valuation Study

Source:

Figure ES- 1. CMP Distributed Value – First Year ($ per kWh)

First Year		Distributed Value ($/kWh)
Energy Supply	Avoided Energy Cost	$0.061
	Avoided Gen. Capacity Cost	$0.015
	Avoided Res. Gen. Capacity Cost	$0.002
	Avoided NG Pipeline Cost	
	Solar Integration Cost	-$0.002
Transmission Delivery	Avoided Trans. Capacity Cost	$0.014
Distribution Delivery	Avoided Dist. Capacity Cost	
	Voltage Regulation	
Environmental	Net Social Cost of Carbon	$0.021
	Net Social Cost of SO_2	$0.051
	Net Social Cost of NO_x	$0.011
Other	Market Price Response	$0.009
	Avoided Fuel Price Uncertainty	$0.000
		$0.182

Avoided Market Costs $0.090

Societal Benefits $0.092

Figure ES- 2. CMP Distributed Value – 25 Year Levelized ($ per kWh)

25 Year Levelized		Gross Value A ($/kWh)	×	Load Match Factor B (%)	×	Loss Savings Factor (1+C) (%)	=	Distr. PV Value D ($/kWh)
Energy Supply	Avoided Energy Cost	$0.076				6.2%		$0.081
	Avoided Gen. Capacity Cost	$0.068		54.4%		9.3%		$0.040
	Avoided Res. Gen. Capacity Cost	$0.009		54.4%		9.3%		$0.005
	Avoided NG Pipeline Cost							
	Solar Integration Cost	($0.005)				6.2%		($0.005)
Transmission Delivery Service	Avoided Trans. Capacity Cost	$0.063		23.9%		9.3%		$0.016
Distribution Delivery Service	Avoided Dist. Capacity Cost							
	Voltage Regulation							
Environmental	Net Social Cost of Carbon	$0.020				6.2%		$0.021
	Net Social Cost of SO_2	$0.058				6.2%		$0.062
	Net Social Cost of NO_x	$0.012				6.2%		$0.013
Other	Market Price Response	$0.062				6.2%		$0.066
	Avoided Fuel Price Uncertainty	$0.035				6.2%		$0.037
								$0.337

Avoided Market Costs $0.138

Societal Benefits $0.199

Gross Values represent the value of perfectly dispatchable, centralized resources. These are adjusted using

- Load Match Factors to account for the non-dispatchability of solar; and
- Loss Savings Factors to account for the benefit of avoiding energy losses in the transmission and distribution systems.

The load match factor for generation capacity (54%) is based on the output of solar during the top 100 load hours per year. The load match factor for Avoided Transmission Capacity Cost (23.9%) is derived from average monthly reductions in peak transmission demand.

The Distributed PV value is calculated for each benefit and cost category, and these are summed. The result is the 25-year levelized value, meaning the equivalent constant value that could be applied over

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