The impact of state feed-in tariffs and federal tradable quota support policies on grid-connected small wind turbine installed capacity in Australia

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ABSTRACT

Until recently, Australian federal renewable energy tradable quota policy support mechanisms were modest and failed to differentiate between technologies at different stages of industry development. Subsequent changes to federal tradable quota schemes and the development of a number of state-based feed-in tariffs (FiTs) have attempted to overcome recent deficiencies. This research discusses the relationships between federal and state-based support policies, small wind turbine (SWT) system installed capacity, and the intricacies of developing instruments that sustain the renewable energy industry over time. The research found the lack of due diligence in policy mechanism development generated poor outcomes for the small-scale renewable energy industry and a higher level of political risk. Australian state-based FiTs were generally poorly designed with respect to known risks, and are unlikely to promote sustainable industry development for small-scale grid-connected renewable energy systems, including SWT systems. The research suggests detailed independent and collaborative policy development is necessary (prior to policy implementation) that considers a range of technology types, the influence of other cross-jurisdictional support mechanisms, and regionally-specific system technical performance and project development costs. The recent 'mixed bag' of Australian support mechanisms have resulted in fluctuating private costs for small-scale systems, which as lead to disruptive industry expansion and contraction with ironically unsustainable regularity.

Keywords*: wind; small wind turbines; microgeneration; grid-connected; energy policy; feed-in tariff.*

1. Introduction

The maintenance of renewable energy support policies that are sensitive to institutional, technical, and natural resource diversity is a fundamental challenge [1], Persuading dominant political and economic actors to genuinely incorporate long-term external institutional and societal capacity building into renewable energy support policies may avoid the continuation of mechanisms that have to date been unable to provide a reliable foundation for renewable energy industries over time [2]. While market mechanisms as renewable energy policy instruments avoid the known pitfall of solely relying on administrative and political decisionmaking, the success of the policies within highly constructed electricity markets rely on the co-involvement of highly capable private and public decision-makers [3]. The difference between renewable energy policy effectiveness in theory and practice is notoriously difficult to project, and depends on a number of factors, actors, and political coalitions [4, 5]. Compounding this complexity is rapid short-term policy change that disrupts the necessary sustained governmental and market actor collaborations that create the institutional capacity to develop, evaluate, and implement successful long-term support policies and associated industry development strategies [2]. Renewable energy policies that attract little industry interest or generate levels of industry growth greater than expected over the short term but cannot be sustained financially, risk becoming withdrawn and undermining long term industry development [3]. Globally, the current suite of renewable energy policies tend to neglect the complex and diverse renewable energy resources and systems, and their unique applications, as well as industry needs [3, 6].

Renewable energy support policies must deliberately provide attractive investment conditions for new market entrants throughout the whole value chain, for a broad range of technologies, and support high-risk innovative entrepreneurship - without generating ‘windfall profits’ [1]. Tradable green certificate support schemes in the EU have been unable to achieve these challenging policy objectives within the criteria of effectiveness, efficiency, and equity in energy policy reform, and have generally only maintained current levels of renewable energy penetration into energy supplies [1]. There are also well-known hazards of FiTs, including

setting the fixed price too high, and also losing control over market growth [2]. Furthermore, renewable energy investment decision-making is rarely a simple 'rational' purchasing decision, and policymakers should be aware that 'long-run' strategic support policies may indeed be facilitating financially negative 'short-run' consequences for the society, the private investor, competing organisations, or all concurrently [6, 7]. In niche renewable energy markets such as the small wind energy sector, the bridging of the gap between 'self-interests' and the 'public interest' requires energy policy that reconciles values and interests over various time horizons, provides suitable incentives for sustained innovation and entrepreneurship, and that suits the characteristics of the local market [5]. There is relatively little new SWT installed capacity in Australia when compared to the UK and the USA, both which boast over 100 times the Australian SWT installed capacity [8-10]. In markets such as Australia, the USA and the UK, it is generally argued that FiTs are more effective than tradable quota schemes in promoting the deployment of distributed renewable electricity generation [11, 12], and this work seeks to explore if this general argument is consistent within the Australian market in terms of SWTs.

The Office of the Renewable Energy Regulator (ORER) in Australia has defined a small wind turbine (SWT) as one with a rated capacity of ≤10kW$_p$ and a total annual electricity output of less than 25 MWh [13]. If the SWT industry is to mature in Australia, it must penetrate the mainstream small-scale grid-connected market, which is presently dominated by the solar photovoltaic (PV) industry [14]. In contrast to large wind farms, small-scale distributed generation technologies like SWTs have been viewed as an alternative to centralised generation which avoids expensive augmentation of the electricity network [15-18]. Distributed generation is also widely discussed in terms of energy security, as it shifts energy supply from a reliance on a few central energy sources to a diversified range of sources located geographically, leading to increasing network resilience if located appropriately [16, 19-22]. Additionally, the introduction of residential and/or community-scale generation technologies increases the awareness of energy use and renewable energy system capability, which can cultivate parallel adoption of energy efficiency measures [23]. However, the high cost of SWTs relative to large centralised electricity supplies is a fundamental barrier preventing the wider

deployment of SWTs throughout grid-connected Australian communities. While small-scale renewable technologies like SWTs have the potential to contribute towards Australia's renewable electricity generation targets [15], the relative infancy of the SWT industry with respect to grid-connected applications is contrasted somewhat with the long-term experience with SWT installations in remote off-grid applications [24]. Therefore, the SWT industry require targeted government support with appropriate development policies if the unique development path of the SWT is to be successfully realised in Australia [25].

The primary objective of this research is to analyse the existence of both federal and state-based support policies since 2001 relevant to SWTs, and present the corresponding changes in regional SWT installed capacity over time. A secondary objective of this research is to analyse components of the support mechanisms in terms of either providing insufficient or wastefully excessive (and often transient) support for the development of a mature SWT industry in Australia. The research aims to facilitate the development of a stable, secure, and appropriate policy instrument(s) to foster emerging technologies in Australia in an economically efficient manner, using SWT installed capacity as an indicator.

2. Material and methods

An annotated list of the Australian federal and state policies relating to SWTs was compiled from government agencies, policy documents, reports, legislation, and peer reviewed literature. (The various minor local government initiatives were excluded in this research). The current status of the SWT sector in Australia was determined by collating annual SWT installations and installed capacity between 2001 and August 2010. This was undertaken by analysing the renewable energy certificate (REC) data held by the ORER's REC Registry.

The determination of accredited SWT RECs in the REC Registry under each policy iteration (such as the Mandatory Renewable Energy Target, MRET, the Renewable Energy Target, RET, and the more recent Solar Credits Scheme, SCS), enabled collation of the number and the corresponding capacity of annual SWT installations. This collation required some assumptions, including the use of the default setting for wind resource availability

provided by the ORER (2000 hours per year), and that all SWT installations were deemed over a 5 year period (the maximum possible for wind technologies). Finally, all installations registered after the start date of the SCS (20th Dec 2010) were assumed to have had the first 1.5 kW_p of their capacity calculated under the SCS (to take advantage of a significant capital cost rebate). This data analysis is embedded within contextual literature evaluating national and international experience of the two reviewed primary policy mechanisms (tradable quota schemes and FiTs) from the perspective of the SWT sector.

3. Results

3.1. Policies underpinning the SWT sector in Australia

Table 1: Federal renewable energy policies relevant to SWTs, 2001-2010

Federal Policies Relevant to SWTs		
Renewable Energy Target (RET)	*Objective*	To encourage the generation of additional renewable energy, reduce greenhouse gas emissions, whilst ensuring that the renewable energy sources are ecologically sustainable (Renewable Energy (Electricity) Amendment Act 2009).
	Policy Instrument	Tradable renewable energy certificates (RECs).
	Scheme	Mandates that 20% of Australia's electricity will be sourced from renewable resources by 2020 (45,000 GWh). The RET replaced the Mandatory Renewable Energy Target (MRET) and commenced mid 2009. The RET is open to all small and large scale renewable technologies. The RET legislation creates a legal liability for electricity wholesalers to source a specified annual percentage of electricity sales from accredited renewable energy generators. Compliance with the scheme is facilitated through the operation of a certificate trading market overseen by the ORER. One REC is created by accredited renewable energy generator for each MWh sold. Once RECs are registered on the REC Registry, they can be traded or sold to liable parties to demonstrate their compliance. REC prices are determined by a market. To support small-scale generation units (SGU) and reduce administrative costs under the RET scheme, SGUs can create RECs in batches known as deeming periods. For SWT installations RECs can be deemed for either 1 or 5 year deeming periods, after which an installation can be redeemed with the approval of the ORER [13].
Solar Credits Scheme (SCS)	*Objective*	To provide additional support to households, businesses and community groups that install small generation units (small wind turbines: no more than 10 kW_p and with a total annual electricity output of less than 25 MWh are eligible under this scheme) (Renewable Energy (Electricity) Amendment Act 2009).
	Policy Instrument	Solar Credits work by multiplying the number of RECs for which SGUs are eligible. This policy in effect functions as an upfront rebate towards any eligible SGU installation.
	Scheme	Solar credits apply to the first 1.5 kW_p of an installed SGU. The number of REC's that a SWT SGU is eligible for under the RET scheme is determined using the multiplier and is entitled to a pre-determined number of deemed RECs sold at a fixed value of AUD40.00 [26]. It should be noted that the Solar Credit Scheme only applies to the first deeming period accredited to an SGU, which corresponds to the first 5 years for small wind generators. Additional capacity of a SGU over and above 1.5 kW_p is calculated under the RET scheme [13].

National Solar Schools Program	*Objective*	To assist schools to tackle climate change by allowing schools to: generate renewable electricity; improve energy efficiency; provide renewable energy education; directly support the growth the of renewable energy industry (etc.) [27].
	Policy Instrument	Grant (SWTs are classified as an eligible item under the scheme)
	Scheme	Single campus schools: • the installation of a minimum 2 kW_p PV system will be provided for eligible items for up to AUD50,000. • if no PV is installed, or if it is less than 2 kW_p, a grant of up to AUD30,000 is available to be spent on eligible items. Multi-campus schools, with a student enrolment of at least 1000 pupils: • the installation of two PV systems of at least 2 kW_p each is eligible for a grant up to AUD100,000. • the instillation of one PV system of at least 2 kW_p is eligible for a grant up to AUD80,000. • if no PV is installed or it is less than 2 kW_p, a grant of up to AUD60,000 is available to be spent on eligible items. Note: a SWT is classified as an eligible item under the scheme [27].
Clean Energy Council (CEC) Accreditation	*Policy Instrument*	Accreditation came into effect December 2010 [13].
	Objective	To ensure the quality and effectiveness of renewable energy system installations. The aims of accreditation are: • to increase the uptake of renewable energy for the provision of energy services, by giving customers increased confidence in the design and installation work; • to improve safety, performance and reliability of renewable energy power systems installed in the field; • to encourage industry best practice for all design and installation work involving renewable energy systems; and • to provide a network of competent renewable energy system designers and installers [13].
	Scheme	To be eligible under the RET and Solar Credits Scheme new SWT installations will be required to be installed by a CEC accredited installer after the 20th December 2010 [13]. To become accredited the CEC requires installers to hold an unrestricted Electrical Licence and a record of successful completion of the following units of competency (UoC): • UEENEEK030B – Solve basic problems in wind energy conversion systems. • UEENEEK031B – Design wind energy conversion systems rated to 10 kW_p. • UEENEEK043A – Install small wind energy conversion systems for stand-alone systems. These UoCs are currently offered by a limited number of TAFE colleges around Australia [28].

Table 1 summarises the major federal policy pertinent to the SWT industry in Australia. The annotated list outlines the objective of each policy, the policy instrument used to implement the objective, and a short policy summary. The primary national renewable energy policy initiative from 2001 until mid 2009 was the MRET, a tradable quota scheme that preceded the current RET. The MRET was limited in its scope, its target was modest, and it failed to differentiate the support it provided to renewable technologies at different stages of industry development. Whilst large wind farms were a major beneficiary of the

MRET, least-cost policy support mechanisms purposefully favour near-commercial large-scale renewable energy technology implementation rather than assisting developing technologies such as small-scale PV and SWTs [29-31]. This was reflected in the narrow technology mix promoted under the MRET (primarily large-scale hydro and wind projects and also solar hot water technology), while small-scale generation technologies represented less than 1% of generation assisted under the scheme [14]. The lack of technology diversity is a primary criticism of tradable quota schemes [12, 31], and a resultant narrow support for a few near market ready technologies was highlighted in 'the Stern review' (2007). The notable review pointed out that it is not possible to know which technologies will be the most successful in the long term, and it is thus important to encourage a diversity of renewable energy technologies irrespective of current market readiness [32].

Table 2 is the estimated annual deployment of SWTs in Australia between 2001 and August 2010 derived from the REC Registry database. The stagnation of grid-connected SWT deployment during the operational life of the MRET substantiates that least-cost policies do not assist small-scale emerging technologies to benefit from economies of scale and industry learning. In mid 2009 the MRET was replaced by the RET which mandates that 20% of Australia's electricity be sourced from renewables by 2020, and in practice mainly supported large-scale renewables. The RET operates in parallel with the SCS which provides technology specific support for small-scale renewables. To date this policy combination seemingly has stimulated SWT installations in Australia, and by August 2010, the installed SWT capacity had reached 669 kW_p – around a ten-fold increase in annual installed capacity in only 8 months. This is likely to be an unsustainable level of growth, and seems to indicate the generation of 'windfall profits'. However, there are a number of parallel policy mechanisms in existence at both the national and state level which complicate this simple assertion. Other national policy initiatives such as the National Solar Schools Program (recent changes include the scheduled closure two years earlier than expected in 2013), and the long running, yet now defunct Renewable Remote Power Generation Program that provided a capital subsidy to increase the use of renewable generation in off-

grid parts of Australia, largely failed to stimulate SWT deployment over the period when compared to solar capacity [18].

Table 2: National annual SWT installations 2001-2010[a]

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Installations	22	12	17	19	12	6	12	43	57	75
REC's	160	60	94	172	100	117	62	539	1068	8021
Annual Installation (kW_p)	16.8	6.3	9.9	18.1	10.5	12.3	6.5	56.7	49.3	482.8
Cumulative Installed (kW_p)	16.8	23.1	33.0	51.1	61.6	73.9	80.4	137.1	186.4	669.2

[a]Assumptions: Based on a five-year deeming period for SWT REC creation, a 2000 hour annual wind resource (considered to be conservative), and any REC registered in the REC Registry after 6th June 2009 was categorised under the RET/Solar Credits Scheme. Re-deemed installations have been removed from the data. The 2009 data is best viewed as an estimate as it is not possible to determine exactly which installations were created under the SCS from the primary Registry data. Source: [9].

3.2 The recent influence of the state-based FiTs in Australia

Whilst the federal RET and SCS implementation may circumstantially seem to have stimulated the recent expansion in SWT capacity, new state/territory-based FiTs were also introduced in New South Wales (NSW), the Australian Capital Territory (ACT), Victoria (VIC) and Western Australia (WA) (Table 3). The NSW scheme was introduced at the beginning of 2010 and guaranteed a premium gross tariff of AUD0.60 per kWh through to the end of 2016. As Table 4 indicates, there was a staggering 471 kW_p of new SWT capacity installed in NSW under the FiT, of which all installations would have been eligible for both the federal RET and SCS capital subsidies.

Table 3: State/Territory-based renewable energy policies relevant to SWTs, as of Dec. 2010

State/Territory Policies Relevant to SWTs		
Australian Capital Territory (ACT) **Electricity Feed in Tariff**	*Objective*	Stage 1 of this scheme is aimed at householders and small businesses to: • promote the generation of electricity from renewable energy sources; • to reduce the ACT contribution to anthropogenic climate change; • to diversify the ACT energy supply; and • to reduce the ACT's vulnerability to energy price volatility [33].
	Policy Instrument	Gross Feed-In Tariff
	Commenced	1st Mar 2009, and operates for 20 years after an agreement is arranged.
	Scheme	The scheme is available to all non-government (government schools are also eligible) electricity customers with an accredited renewable energy generator (PV or wind) of no greater capacity than 30 kW_p. The scheme places an obligation on electricity suppliers to purchase all electricity generated by an eligible generator at a guaranteed premium price for 20 years. The premium price is set by the ACT regulator annually at a rate greater than the prevailing retail price. Systems connected between 1st Mar 2009 and 30th Jun 2010 will receive the premium price of AUD0.5005 per kWh for systems up to 10 kW_p. Installations greater than 10 kW_p and no more than 30 kW_p will receive AUD0.4004 per kWh. From the 1st of July 2010 the premium price will be AUS0.457 per kWh for all systems under the scheme. This scheme is currently un-caped, however, new proposed legislation will likely cap total generation capacity to 15 MW_p [33].
New South Wales (NSW) **Solar Bonus Scheme**	*Objective*	The scheme is open to all electricity customers with an annual consumption of less than 160 MWh. The objectives are to: • encourage and support renewable energy; generate employment in the renewable sector, and; respond to climate change [34].
	Policy Instrument	Gross Feed-In Tariff (paid for by an increase in general electricity prices)
	Commenced	1 January 2010, to operate for 7 years.
	Scheme	The eligible technologies under the scheme are PV and SWTs no greater than 10 kW_p. The scheme places an obligation on electricity suppliers to purchase all electricity generated by an eligible generator at a fixed rate of 60 cents per kWh for the 7 year duration of the scheme. A review of the scheme was triggered when installed capacity reached 50 MW_p in August 2010. In response to the review the tariff for new investors has been reduced to AUD0.20 per kWh from 28th October 2010. In addition, the scheme has also been capped at 300 MW_p. Changes to the scheme are not retrospective [34].
Victoria (VIC) **The Standard FiT**	*Objective*	To provide a framework for reasonable prices and terms and conditions for electricity generated from small-scale renewable generators and purchased by energy suppliers in Victoria (*Energy Legislation Amendment Act 2007*).
	Policy Instrument	Net Feed-In Tariff (paid for by an increase in electricity prices)
	Commenced	1st January 2008
	Scheme	The eligible technologies under the scheme are wind, hydro, biomass, and PV systems up to 100 kW_p. The scheme is a net tariff with excess generation eligible for the standard 'one for one' feed-in tariff that electricity retailers are obliged to provide under the scheme. In real terms this means that any excess generation exported to the grid is purchased by electricity retailers at the prevailing retail rate [35]. This scheme is uncapped and appears to be open ended.

Western Australia (WA) **Residential Net FiT**	*Objective*	To support the installation of residential renewable energy generators and encourage energy efficiency in the residential sector [36].
	Policy Instrument	Net Feed-In Tariff (a subsidy paid by the WA Government)
	Commenced	1 August 2010, and continues for 10 years after a contract is agreed.
	Scheme	The scheme is open to all grid connect solar PV, wind and micro hydro systems installed in the residential sector, who participate in the Renewable Energy Buyback Scheme. Installations up to 5 kW_p for Synergy, the Government-owned disaggregated retailer on the South West Interconnected System (SWIS) and up to 10 kW_p per installation (maximum installed capacity of 30 kW_p per residence) for customers of Horizon Power, the Government-owned vertically integrated electricity utility operating on networks off the SWIS. The scheme pays a set price for any excess electricity exported to the network above household consumption. The net FiT is AUD0.40 per kWh. The duration is 10 years for each eligible system, and the scheme will be reviewed every three years or each time new installed capacity reaches a multiple of10 MW_p.
Renewable Energy Buyback Scheme (REBS)	*Objective*	NA
	Policy Instrument	Buyback Scheme (pays for the value of the electricity to an electricity supplier)
	Commenced	NA
	Scheme	The REBS places an obligation on Synergy and Horizon power to purchase any electricity exported to the grid by eligible renewable generators under 'fair and reasonable' terms and conditions [36]. The REBS is available for renewable energy grid-connected systems on the SWIS of capacity between 500 Wp and 5 kW_p. Until 2010, the REBS was calculated on the net import total over the billing period, at a tariff equal to the purchase rate minus GST AUD0.1884 per kWh. In 2010 this became AUD0.07 per kWh on the SWIS, while the other major state-owned retailer, Horizon Power remained at the equal rate minus GST. To be eligible for REBS in WA, the customer must be on the A1 or SmartPower tariff. [36, 37].

Although the NSW FiT may be subjectively viewed as highly successful to date, it was unlikely to promote the sustainable deployment of SWTs in NSW. Due to the apparently unexpected high level of uptake of the NSW FiT the first review was triggered in early August 2010. The NSW Government subsequently reduced the tariff to AUD0.20 per kWh from the 28th October 2010, and installed capacity was capped at a total of 300 MW_p, an astonishingly high cap for the amended FiT rate [34]. It is unlikely that a non-premium FiT tariff similar to the retail rate will attract much additional SWT capacity in NSW, as is the case in VIC and WA. As the NSW FiT will be discontinued at the end of 2016, the policy will do little to develop a sustainable SWT industry.

Table 5 compares FiTs for different states and territories of Australia. Interestingly, the ACT's gross FiT exhibits a similar rate (AUD0.50 per kWh) to the original NSW scheme rate, yet had not resulted in a single SWT installation by August 2010 since its inception in early

2009 [9]. This is despite the ACT's gross FiT exhibiting many of the elements deemed necessary to support the deployment of SWTs. The fundamental difference between the NSW and the ACT FiT seems to be the uncertain tariff rate from year to year due to the annual review by the ACT regulator. While this reduces the uncertainty for Treasury forward projections, the policy seems to have created unacceptable uncertainty for SWT project developers in the ACT. This uncertainty is contrasted against the similar NSW FiT which provided a maximum of only seven years of a fixed rate (despite the non-retrospective changes), leading to a rapid rate of SWT installation. Whilst the (maximum) seven years of certainty is contrasted against the longer serviceable life of a SWT (around 15 to 20 years), this short period appears sufficient for small-scale project developer perception of risk. However, this assertion will require detailed research to understand how the perceptions of risk/reward and associated uncertainties influence SWT installed capacity when very similar jurisdictions with similar policies exhibit a divergence in rates of development.

Table 4: Annual SWT installation estimates (kW_p) by state/territory: 2007-2010[a]

State	NSW	QLD	VIC	TAS	SA	WA	ACT	NT	Totals
2007	0.9	4.4	0.0	0.0	0.3	0.8	0.0	0.0	6.5
2008	20.6	3.3	5.3	6.0	14.4	7.2	0.0	0.0	56.7
2009	15.2	1.9	3.5	14.7	2.6	11.4	0.0	0.0	49.3
2010	471.4	1.2	5.4	0.2	0.0	4.6	0.0	0.0	482.8

[a]Assumptions: Based on a five-year deeming period for SWT REC creation, a 2000 hour annual wind resource (considered to be conservative), and any REC registered in the REC Registry after 6th June 2009 was categorised under the RET/Solar Credits Scheme. Re-deemed installations have been removed from the data. The 2009 data is best viewed as an estimate as it is not possible to determine exactly which installations were created under the SCS from the primary Registry data. Source: [9].

Table 5: Comparison of FiTs relevant to SWT in Australia prior to Jan. 1 2011

	Australian State/Territory-based FiTs			
	ACT	**NSW**	**VIC**	**WA**
Policy/Start Date	2009	2010	2009	2010
Generation Eligible	Gross	Gross	Net	Net
Size/ Eligibility	<30 kW_p	≤10 kW_p	<100 kW_p	Synergy ≥500 W and ≤5 kW_p, Horizon Power ≤10 kW_p per installation (total of 30 kW_p)
Tariff	Reviewed annually	AUD 0.60 per kWh Revised down to AUD 0.20 per kWh on the 28th Oct 2010	Retail Rate	Premium tariff (funded by government)
Tech. Specific Tariffs	Only in the first year of the program	No	Yes (Solar receives a premium)	No
Variable/locked	locked in at the premium tariff prevailing at the time of joining the scheme	Fixed	locked in at the premium tariff prevailing at the time of joining the scheme	Fixed
Degression	No formal degression	No	NA	No
Duration of Contract	20 years	Program ends 2016	ongoing	10 years
Special Features		Since the 28th October 2010 the scheme has been capped at 300 MW_p		In addition to the Renewable Energy Buyback Scheme (REBS)

4. Discussion

Australia's new tradable quota schemes, the RET in combination with the SCS may effectively ensure a range of emerging renewable energy generation and/or enabling technologies are encouraged, even without state-based FiTs. However, insufficient time has elapsed to assess this new federal approach, although it does mirror successful SWT policy incentives developed in the UK and the USA. Even so, it is argued that FiTs are more effective than tradable quota schemes in promoting the deployment of distributed renewable

electricity generation [11, 12]. Despite such early results, this argument seems to be consistent in Australia. In particular, FiTs seem to have reduced developer risk by requiring electricity utilities to connect all eligible renewable generators, and provide economic and regulatory certainty by guaranteeing a long term electricity purchase contract through a transparent and administratively straightforward process [30, 38]. These administrative changes derived from FiT development clearly benefit the small-scale renewable energy industry in terms of levelling basic access in a similar manner to large institutional and political players in the energy industry, and also enable a greater level of discourse and co-involvement of highly capable private and public decision-makers [3].

The Stern Review (2007) noted FiTs achieve larger deployment at lower costs when compared to market-oriented tradable quota schemes [32], as project developers perceive higher levels of risk under tradable quota schemes. The higher perception of risk centres around the future market value of the certificates in tradable quota schemes [39], and consequently developers will likely require higher returns. Therefore, the crucial characteristic of FiTs seem to be the greater policy certainty which reduces project developer's risk, creating an economically efficient support mechanism relative to tradable quota schemes [30, 38, 40, 41]. However, FiTs have been employed to primarily attract small-scale domestic renewable energy systems investment, for which the drivers and the associated financial risk tolerance of proponents are not the same as for large-scale projects. As the RET and SCS have fixed the price of SGU credits to AUD40.00 per REC, this may provide sufficient certainty to domestic project developers without the influence of FiTs. Furthermore, FiTs without a fixed rate period, or a perception that the policy will not be supported for long, may be deemed too risky by the majority of domestic project developers. This may be a contributing factor in the ACT, although further analysis is necessary. Nonetheless, the known FiT hazards of high fixed prices leading to large budgetary implications from 'windfall profits' (often made by new market entrants at the expense of long-term players), is likely to have negative consequences for the states that developed such generous, yet short-sighted policies. In theory, the benefits of these policies have passed both to householders and businesses that comprise the small-scale renewable

energy industry. However, these benefits are likely to be short lived (along with many businesses[1]) when FiT policies that are too generous are removed, and in many cases the Australian householder now may pay higher prices for their electricity than available from electricity retailers [42, 43]. To provide useful analyses of the medium-to-long-term influence of these policies on niche renewable energy markets (such as the small wind sector) requires collaborative government and market actor cooperation to document the benefits, costs and lessons learned in the process.

Despite the inherent difficulty in determining policy efficacy over time, there is significant merit for policymakers to implement stable and lasting renewable energy policies with the high level of political risk associated with renewable energy decisionmaking [30, 41]. Nonetheless, it is clear that when FiTs are developed without a due diligence assessment with regard to the actual costs of renewable electricity generation and developer return on investment, it is unlikely that the FiT will sustainably facilitate small-scale renewable energy industries over time. The basic concern with FiTs is the determination of a suitable tariff rate which fails to promote significant deployment, and prevents inadvertent 'windfall profits' to developers leading to inefficient investment [40, 41]. The stand-out FiT example in this research is the 'overly attractive' NSW FiT which clearly did not consider the influence of the federal tradable quota policies and resulted in a dramatic increase in SWT capacity in NSW. Whilst criticism of the NSW FiT is appropriate, the FiTs of the other Australian states (VIC, WA and ACT) should not escape attention as all have failed to stimulate the SWT industry to any noticeable extent.

This research suggests Australian policymakers explore 'conservatively attractive' renewable energy support mechanisms that assist a diversity of emerging technologies to balance risk and reward over longer time horizons. Such mechanisms should ideally reflect both market values and economic values (internalised externalities and social

[1] This assertion is based on private discussion between the authors and professional members of national renewable energy industry networks.

costs/benefits), and also the cost of the technology for the developer to generate competitive renewable electricity in the geographical location of the network it is proposed to be installed [44]. This approach can be contrasted against the recent rapid increase in SWT capacity primarily only in NSW, due to the combination of the amended federal tradable quota schemes and the 'less than moderate' NSW FiT (since revised).

5. Conclusions

At an international level, the limited penetration and growth of comparable SWT installed capacity in Australia is dwarfed by the UK and the USA, each of which have exhibited over 100 times the SWT installed capacity over the last decade [8-10]. Australian policies can be seen to have delayed the provision of a stable base onto which a sustainable SWT industry can be built, and have not supported emerging technologies generally. This has largely been due to inadequacy of consistent policy incentives supporting the emerging SWT sector in Australia, specifically the technology-neutral tradable quota schemes targeting least-cost generation rather than diversity. Like most emerging technologies, the higher cost of grid-connected SWT systems relative to network electricity remains the primary barrier to their deployment, and this research demonstrates that the FiTs and tradable quota schemes to date have failed to address this critical barrier in a consistent manner.

This research suggests that project developer attitudes to risk may influence installed capacity of emerging technologies to a greater extent that is generally recognised in policy circles. The example of between the high uptake of the NSW FiT and low uptake of the similar ACT FiT is an interesting case in point which needs further investigation. Complicating this simple assumption are information asymmetries, the recent revision and implementation of Australian tradable quota schemes and FiTs, and their aggregate influence. This assertion will require further assessment when sufficient data becomes available. This research infers that government ideology, the lack of detailed analysis with respect to renewable energy policy development, and the exclusion from policymaking of manufacturers, service industry

professionals and independent experts, continues to undermine the foundations of a sustainable renewable energy industry [2, 31, 42, 45, 46].

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