Small Wind Turbine Installer Training and Accreditation in Australia Compared to UK and USA

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Abstract- **This paper examines the training and accreditation programs developed to support the promotion of a skilled workforce of small wind turbine (SWT) installers in Australia. The analysis contrasts the nascent Australian experience against the more mature SWT markets in the UK and USA. This research suggests that Australian SWT installer training and accreditation programs have the necessary institutional structures required to promote skill development essential to support growth, and importantly prevent the SWT industry from creating its own version of the 'Australian home insulation fire safety debacle'. Despite existing government capital subsidies and availability of accredited training programs for SWT installers, the major limiting factor in delivery of programs has been the minor market demand for SWTs in Australia. The small demand for SWTs and training courses offered by accredited institutions in Australia is in stark contrast to concurrent SWT developments in the UK and USA, where there is greater market demand. Given the right policy support to create demand for both SWT products and installers, the training programs in Australia can develop further with the use of experienced certified trainers, units with strong practical components, and material that covers both stand-alone and grid-connected small wind systems.**

Keywords- Small Wind Turbine; Installer Training; Certification; Accreditation

I. ABBREVIATIONS

TAFE	Technical and Further Education	RET	Renewable Energy Target
AQTF	The Australian Quality Training Framework	NSWTC	National Small Wind Turbine Centre
VET	Vocational Education and Training	ISP	Institute of Sustainable Power
UoC	Units of Competency	ISPQ	Institute of Sustainable Power Quality
CEC	Clean Energy Council	MCS	Microgeneration Certification Scheme
AusWEA	Australian Wind Energy Association	SWT	Small Wind Turbine
NABCEP	North American Board of Certified Energy Practitioners	NSAET	National Skills Academy for Environmental Technologies
NYSERDA	New York State Energy Research and Development Authority	ABCSE	Australian Business Council of Sustainable Energy
NSW	New South Wales	ASWEA	Australian Small Wind Energy Association

II. INTRODUCTION

The global market for small wind turbines (SWTs) has undergone tremendous growth in recent years, particularly in the USA and UK [1-4]. The market in the USA accounts for around 50% of the global market and in 2009 surpassed the milestone of 100 MW of SWT cumulative installed capacity, and in 2011 this increased to almost 200 MW [5, 6]. In 2010 there was a 65% increase in the annual SWT installations (up to around 10 MW) of SWTs in the UK, stabilising in 2011, but was expected to increase to around 20 MW, surpassing the USA annual installed capacity, establishing a new record for UK SWT deployment [6-8]. Over the period from 2005 to 2011, the UK deployed around 65 MW cumulative capacity of SWTs with an estimated market growth of 176% in 2012, worth GBP138 million [7, 8]. As the global SWT industry matures from an early adopter market, there is an increasing need to address consumer advocacy groups and policymakers with highly accessible information and dependable technology packages [2, 6]. Such 'mainstreaming' is dependent on the development of a strong renewable energy policy framework ensuring workforce holding and maintaining suitable training standards, and third-party verification of training certification, and institutional accreditation competencies [2, 9, 10]. Indeed, consumers, financiers, policymakers, etc. are increasingly requiring renewable energy services, products, and service delivery entities to be independently tested, certified, and accredited to a defensibly high standard, particularly within the context of existing infrastructure [2, 9, 11-13]. In particular, training of system installers is crucial to prevent instances such the Australian Commonwealth Government's Home Insulation Program, where unsafe electrical practices in installing the insulation led to hundreds of fires and a number of deaths [14, 15], and similar safety concerns associated with some photovoltaic installations

[16]. Accreditation and certification of installers within the SWT sector can protect this emerging industry by implementing best practices [2, 5, 6]. Effective training and accreditation may be viewed as a form of industry insurance that also develops consumer confidence by improving both performance and the public perception of small-scale renewable energy technologies [17].

Appropriate installer training is essential for the emerging SWT industry, as each potential installation site exhibits highly variable wind resource characteristics, which installers must identify to optimise SWT performance and investor return [18-21]. For example, the Energy Savings Trust, UK found that basic SWT installer siting competency has a major impact on the capacity factor of an installation, and capacity factors can range from 3% for poorly sited building mounted turbines to around 19% for well-sited free standing turbines. A report on a trial of 26 small wind turbines (< 10 kW) in Massachusetts showed that all 11 installers over-predicted the actual wind resource in filing grant applications for project funding for the SWT installation. The report showed that the accuracy of the online wind maps used by installers had an 8-15% average impact on the annual energy production of the turbine [22]. Traditionally, installer training in the SWT sector has largely been delivered in-house through programs aimed at up-skilling existing trade's people (usually electricians) or through ad-hoc training on the job [23]. Linking cross-jurisdictional accreditation schemes and policy incentives can also improve the technical performance of SWT deployment, increasing the overall return on investment from policy support [5, 6]. Industry certification and accreditation can be understood as a public statement that a threshold of quality has been achieved or surpassed [24]. It provides consumers with an assurance that services administered under such accreditation schemes will meet robust standards, while providing a clear route for complaints.

Skill shortages have long been identified as a constraint for the SWT market in Australia, the UK, and the USA [17, 25, 26]. The provision of quality training through institutions with recognised academic certifications and qualified teaching staff provides a clear career path for potential SWT installers along with a qualification that will be recognised across the sector [23]. If out-dated and inappropriate SWT industry training and accreditation programs are retained, many SWT systems are likely to become ineffective and thus expensive energy generation, with the industry being at risk of major inter-jurisdictional inconsistencies [23, 27]. Compounding inter-jurisdictional planning challenges in a nascent market is the need to find appropriately qualified training lecturers for a very small, yet dynamic job market [28]. Thus, understanding SWT market requirements and trends are fundamental to both the long-term expansion of SWT installed capacity and the system performance, and also ensuring future supplies of skilled SWT industry professionals [9].

III. MATERIALS AND METHODS

The research aim was to conduct a high-level basic review of the SWT industry's institutional structure in Australia, with the specific objectives of investigating current installer training and accreditation programs for SWT in Australia, accreditation schemes for SWT installers in Australia, and their links to training programs and government policy, and contrasting the Australian training and accreditation programs with installer training and institutional accreditation in the rapidly expanding SWT markets in the UK and the USA. The research asks the question: if the Australian SWT market undergoes an expansion akin to the recent growth of the UK and USA SWT markets, do Australian training and accreditation programs have the necessary structure in place to meet the needs of the domestic SWT industry to provide energy generation in a safe, reliable, cost-effective manner? The research method included a combination of literature review and semi-structured interviews of Australian SWT installer training providers and accredited institutions. The semi-structured interviews targeted key personnel at the eight registered training providers that, at the time of investigation, offered courses with the maximum number of units relevant to small wind turbines. Of these training providers, three organisations participated in the interviews, including the Skills Tech Australia from Queensland, the Western Sydney Institute of TAFE New South Wales and the Chisholm Institute from Victoria. In addition, a fourth interview was held with a staff member involved with the renewable energy course at the Sunshine Coast TAFE in Queensland. The interviews generated high-level insights into developments, needs, and concerns related to SWT installer training and accreditation program delivery, and qualified the strengths and weaknesses of the current Australian national training programs. All interviews were conducted by telephone, and the questioning scope covered training demand for SWT-related courses, student access to practical training components, student numbers, frequency of SWT courses offered, domestic market requirement for career SWT installers, and availability of suitable qualified SWT trainers. The authors would like to clarify that this paper focuses on training programs for SWT installers as opposed to training for SWT site assessors. In addition, a detailed evaluation of curriculum content and an analysis of training comprehensiveness or effectiveness in relation to installed SWT performance were outside the scope of this work.

IV. RESULTS: AUSTRALIAN INSTALLER TRAINING AND ACCREDITATION

The provision of a skilled and qualified workforce has been identified as an essential element required to underpin sustainable growth in the renewable energy sector in Australia [25, 29]. Renewable energy industry training programs commonly range from short courses and workshops, vocational and apprenticeship certifications, to university level courses [9, 30, 31], and catering for the educational needs of the growing industries requires a number of institutions active at many levels [28, 31]. Australian vocational training is delivered through a network of publicly-funded tertiary institutions such as Technical and Further Education (TAFE) institutes, or privately-funded training providers, collectively known as the Vocational

Education and Training (VET) sector. The VET sector delivers career-orientated training for individuals entering the workforce and for those requiring additional skills to adapt to market and industry change. For many years, the VET system has brought students, employers, governments and registered training organisations together to deliver training to match the skill requirements for a number of industries [32]. The Australian Quality Training Framework (AQTF) establishes the required qualifications and competencies for trainers, and requires relevant vocational competencies to at least the level being assessed. In 2009, Australia's Clean Energy Council [25] reported skill gaps in the renewable energy sector, and projected greater disparities between supply and demand if training programs were not expanded. There are currently no dedicated SWT qualifications offered under the 'Electrotechnology Training Package' prepared by Training Standards Australia. This package encompasses training relevant to the renewable energy industry under which SWT installer training qualifications would be administered [33]. However, the training package does offer four SWT training units, known as 'Units of Competency' (UoC): UEENEEK106A - Conduct periodic maintenance of remote power supply (RAPS) wind generators; UEENEEK130A - Solve basic problems in wind energy conversion systems; UEENEEK131A - Design wind energy conversion systems rated to 10 kW; and UEENEEK143A - Install Small Wind energy conversion systems for stand-alone applications [34, 35]. The titles of the UoCs show the bias of the training package towards stand-alone small wind systems. By the end of 2009, SWT UoCs were offered in all Australian states and territories, excluding Tasmania and the Northern Territory. Nevertheless, due to low student numbers, not all of the four UoCs were offered, although at least one of the above UoCs was being offered through 15 TAFEs or private training providers in Australia [36].

A. Installer Accreditation

Under the Australian federal government's Renewable Energy Target (RET) legislation, associated SWT system capital subsidy programs require, post 20th December 2010, systems to be designed and installed by an accredited Clean Energy Council (CEC) installer [37]. SWT accreditation largely follows the current solar photovoltaic accreditation scheme, also administered by the CEC, the peak industry association representing the clean energy sector in Australia. SWT units currently offered under the 'Electrotechnology Training Package' are used to provide the basis for the training required for installer accreditation under the 'Wind Endorsement Scheme'. Installers will be required to hold an unrestricted electrical licence to be eligible for accreditation for SWT systems over 50 V AC, and in some jurisdictions a building contractors license [38]. Under the CEC Wind Endorsement Scheme, SWT systems must have been designed to all relevant Australian Standards (or IEC equivalent) and installed by a CEC accredited individual for stand-alone and/or grid-connected photovoltaic power systems, and also be CEC endorsed for the design and installation of stand-alone and/or grid-connected small wind systems. To be CEC accredited, an individual must have completed a Certificate IV or diploma in 'Electrotechnology: Renewable Energy'. To gain CEC endorsement, an individual must either be able to demonstrate prior experience in SWT system design and installation, or if applying for endorsement as an unexperienced SWT designer/installer, the individual retains endorsement for 12 months within which they must supply the CEC with a case study of their work to retain their endorsement [38]. A fully accredited installer renews by committing to a certain number of points of professional development in the coming 12 months. An outline of the CEC's wind endorsement program was presented in a workshop in Nov 2010 in Melbourne [39]. In April 2010, the state of New South Wales (NSW) State Planning Department brought out a discussion paper on planning for renewable generation – small wind. This was then integrated into the State Environmental Planning Policy (Infrastructure) 2007. Planning regulations are very comprehensive for SWTs in Australia, and NSW laws streamline the approval regime for SWTs by introducing a class of complying development for certain installations. Interestingly, accreditation of the installer under the CEC Wind Endorsement Scheme is not required under the NSW laws, as long as the SWT is installed in accordance with the manufacturer's specifications [40]. Whilst Australian state and federal planning requirements, subsidy program requirements, and manufacturer specifications are not harmonised at present, there are more practical limiting factors for the SWT industry, including weak market demand.

B. Semi-structured Interviews with VET Representatives

Semi-structured interviews regarding the adequacy of the current SWT training provided by the VET sector under the 'Electrotechnology Training Package' are presented as a preliminary insight into SWT training in Australia. Confidential discussions revealed that the training demand for SWT-related courses was not widespread, yet the material provided under the 'Electrotechnology Training Package' was perceived as adequate to support the training for SWT installers. One of the major deficiencies identified by the TAFE representatives was the lack of student access to practical training experience for SWT installations. The reasons behind this included the high costs associated with the installation of SWTs as a training exercise, particularly with low student numbers, alongside difficulties in finding suitable sites for such installations close to the training institutions. Low student numbers were identified as a major constraint to attract internal funding to invest in SWT training activities, and also the number and frequency of SWT UoCs that could be offered at an institution. The interview results suggest that the low level of SWT installed capacity in Australia relative to the UK and USA (Fig. 1), and an unclear future domestic market requirement for career SWT installers, alongside the lack of general public awareness of current SWT technologies available, were believed to be major contributors to low student enrolments. Furthermore, the lack of SWT trainers was recognised as an issue that is likely to grow if SWT installation demands and associated training requirements increase – a problem experienced by the photovoltaic industry during the rapid domestic growth of the past few years. The VET interviewees indicated that SWT installer training would be greatly facilitated by improving access to existing local SWT

installations where available, along with specific 'field days' designed to keep trainers up to date with current technology and industry practices. In response, the National Small Wind Turbine Centre (NSWTC) based at Murdoch University held a practical training course for ten Perth-based Central Institute TAFE students in May 2011. The aim was to address at least some of the concerns raised by training providers regarding the lack of access to SWT installations. Practical training was provided in the areas of SWT assembly, installation, operation, and maintenance. SWT pilot installation courses were also held by The Alternative Technology Association in conjunction with the Institute for Sustainable Futures of the University of Technology Sydney and TAFE NSW in June to September 2011 in NSW. The courses improved knowledge in the area of site assessment and may become part of the CEC's accreditation requirements for small wind in the future.

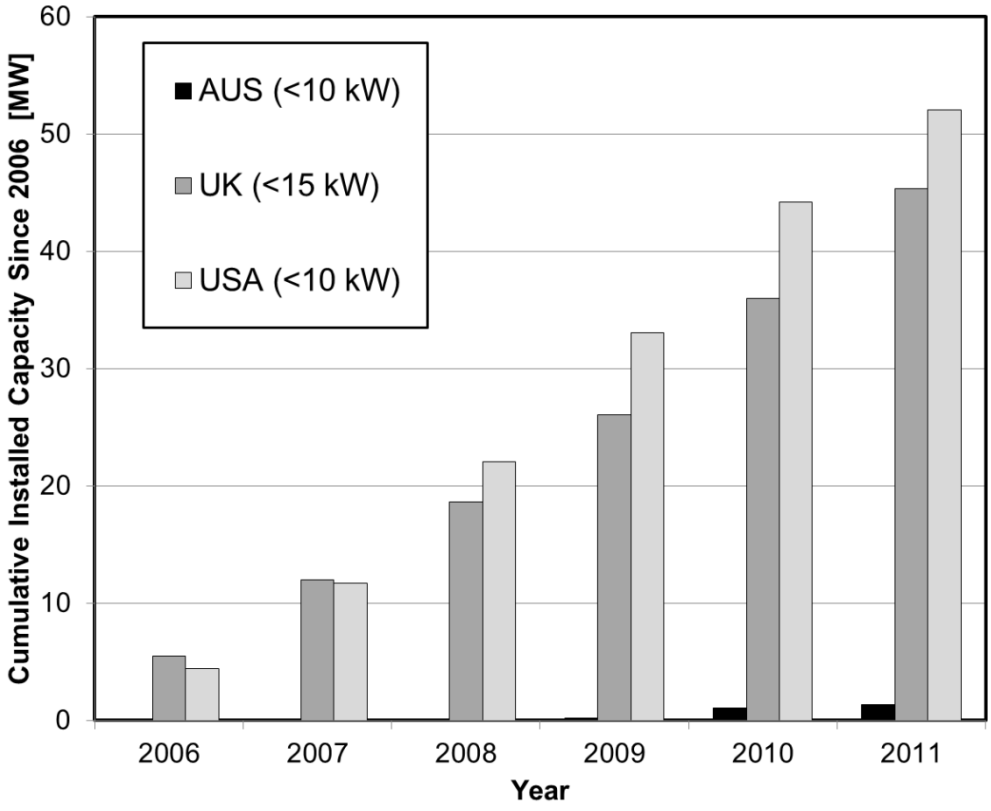

Fig. 1 Cumulative installed capacity of micro- and residential-scale SWTs: Australia, the UK and the USA. Sources: [5, 37, 41]

V. RESULTS: UK INSTALLER TRAINING AND CERTIFICATION

RenewableUK, an industry body supporting the renewable energy industry, publishes an annual 'Small wind systems market report'. The generous feed-in-tariffs together with a streamlined approval process in the UK remain the dominant stimuli behind recent record increases in SWT installed capacity and associated consumer interest, particularly the larger grid-connected SWTs in the 10-100 kW range [7, 8]. The UK SWT market expansion occurred despite planning laws (local authorities in particular) that limit some SWT installations, the UK government's failure to design guiding planning policy specifically for the SWT sector, and the economic recession. The UK introduced its current accreditation scheme, the Microgeneration Certification Scheme (MCS), in November 2008, requiring all SWT products and services (including installation) to meet standards developed by industry [42]. Standards have been designed for each microgeneration technology including SWTs, and the MCS independently certifies the SWT technology and the organisations who install them. The MCS has underpinned UK policy instruments that have driven SWT deployment, limiting subsidy mechanisms to only those with MCS certified technologies and installers [17]. MCS certification lasts for a year, at which point installers have to renew and an annual surveillance visit of a SWT previously set up by the installer is undertaken by MCS assessors.

A. UK Installer Accreditation

Despite the growing SWT demand and SWT technology accreditation/certification, the sector in the UK was not supported by a cohesive training program until 2011. Installer training was predominantly delivered through short courses run by manufacturers, industry in-house training programs, or through a limited number of government colleges, and in 2010 there were only four courses, ranging between three days and three weeks, listed under courses suitable for SWT installers [41]. Today there are some courses exclusive to SWT installation but many are classroom-based. There are a small number of accreditation bodies that are qualified to certify the training programs under the MCS Installer Standards. At present, some of the more practical training courses on installing SWTs are run by companies who offer industry training in the electrical,

construction and renewable energy industries. The courses vary from one to eight days in length and although the program may not be directly MCS-accredited, it does count towards installer experience for the MCS register, and in some cases the trainer is an MCS-approved installer. One company, Construction Training Services [43], offers a specific course on small-scale grid-connected residential wind turbines. The 2010 review into the UK's Microgeneration Strategy acknowledged that training provisions for installers needed strengthening to ensure the best technical performance of the installation, and thus the success of the Microgeneration Strategy [44]. The 2010 Microgeneration Strategy review also recommended that manufacturers continue to play a central role in providing training and ensure that training providers keep their content current [44]. Leading Edge Turbines Ltd. [45] for instance, offers very practical training for the distributors of their turbines, and would be qualified to advise training providers on content. It was recommended that a National Skills Academy for Environmental Technologies (NSAET) be established to support the development and deployment of installer training programs in the UK. National Skills Academies are government bodies that operate training programs in partnership with colleges and private training providers to match training requirements with industry needs [46]. In early 2011, the UK government established the NSAET to provide a nationally consistent and accredited network of renewable microgeneration system (<50 kWe and <45 kWth) training qualifications, [47]. The National Skills Academy currently consists of 22 leading 'hub' colleges as well as two manufacturer hubs who work in partnership with other training providers to offer the environmental qualifications, and a micro-wind technology training course is under development by NSAET.

VI. RESULTS: USA INSTALLER TRAINING AND CERTIFICATION

In contrast to the UK, there are many institutions providing training for SWT installers across the USA, including universities, community and technical colleges, training programs accredited by the Institute of Sustainable Power (ISP), and industry led programs run by various manufacturers [48]. There is a robust history of quality renewable energy training in the USA that was initiated in 1996 when the ISP was established as a non-profit organisation to help 'coordinate, develop, and maintain standards for the education and qualification of renewable energy, energy efficiency, and distributed generation practitioners' [19]. The North American Board of Certified Energy Practitioners (NABCEP) was launched in 2001 and lists the types of institutions that provide training for SWT installers [49]. Minimum installer certification requires 70 hours of training, of which at least 35 hours should be dedicated to practical experience [48]. Training providers include universities, community colleges, manufacturers and industry associations. Montana State University is among a number of training providers that maximise the hands-on experience delivered to the students by engaging an experienced nationally certified SWT installer, keeping student numbers low, with workshops over a number of days to give sufficient contact time for the students [50].

A. USA Installer Certification

While training in the renewable energy sector has been a priority in the USA for over a decade, national certification for the SWT sector has only recently been introduced, and is currently voluntary. NABCEP introduced a voluntary SWT installer certification scheme in September 2010 that aims to promote the SWT industry by enabling certified installers to distinguish themselves from their competitors, while encouraging safe work practices and developing consumer confidence [48]. Certification is gained under the scheme by providing evidence of training or equivalent industry experience, along with passing an exam set by the NABCEP. The SWT installer's exam is based on a task analysis that identifies the skills required by an installer to safely and successfully install a SWT. Maintaining certification requires holders to attend at least 18 contact hours of continuing education over a three-year period and demonstrate that they are continuing to installing SWTs, with at least three installations in three years. In most USA states, installer certification is not explicitly tied to any of the federal, state, utility, or local government support initiatives (including rebates, tax credits, grants, low-interest loans). According to the American Wind Energy Association that represents the SWT industry, these initiatives collectively supported around USD38 million (18.5 MW) of SWT installed capacity in 2011 [6]. The New York State Energy Research and Development Authority (NYSERDA) small wind program, the leading small wind incentive program in the USA, however, highlights NABCEP certified installers amongst its list of qualified installation companies [51]. There are similar acknowledgements of certified NABCEP installers in the Vermont Small-Scale Renewable Energy Incentive Program [52]. In Wisconsin, applications for the Focus on Energy Unlisted Small Wind Turbine Incentive Program are ranked according to a number of criteria, including the qualifications of the installation team [53]. Globally, there are fundamental issues in relation to voluntary or mandatory installer certification and the scope to which it is recognised [9]. For example, while certified installers are more likely to be more competitive, voluntary accreditation does not provide minimum standards to prevent incompetent negligent installations [18, 27]. If installer certification is not linked to USA government incentives it may reduce the effectiveness of the NABCEP scheme. Oteri and Sinclair [54] reported that only nine installers have gained NABCEP certification since the certification scheme was introduced in 2010. Nonetheless, the USA domestic and export SWT market expansion remains relatively robust (Fig. 1).

VII. DISCUSSION

Tables 1 and 2 provide a summary of the results and show that training and accreditation schemes implemented to support the SWT sector in Australia, the UK, and the USA vary widely in their establishment, form, and their mode of delivery. The small size of Australia's SWT sector means that the accredited delivery of training certification is limited, as is the range of training providers in Australia compared to the UK and the USA. However, it is clear that the institutional structures are well

developed, including the VET training network in combination with CEC accreditation requirements to access existing Australian federal government SWT capital subsidies, and any remaining state feed-in-tariffs. Despite the availability of a well-developed SWT training and accreditation sector in Australia, the semi-structured discussions with training providers identified that a shortage of both students and trainers was constraining the number of UoC courses on offer, in combination with limited opportunities for practical experience of SWT installations. It is beyond the scope of this paper to comment in detail on the content and relevancy of the small wind UoCs, but in general the material appears comprehensive for stand-alone small wind systems, in particular for SWT and site selection, although it may need revision as the grid-connected sector of the SWT market expands. In the authors' experience, SWT projects in Western Australia have generally stalled due to lack of familiarity with SWT inverters and their interaction with the turbines, and lack of familiarity with the utilities technical rules, particularly in directly connecting small induction generator turbines to the electricity grid. The focus of the UoCs on stand-alone small wind systems contrasts markedly with specific courses in UK grid-connected residential small wind systems.

TABLE 1 COMPARATIVE INDICATORS OF NECESSARY STRUCTURES FOR TRAINING PROGRAMS.

	Australia	**UK**	**USA**
Training providers	Technology institutes, universities, industry sectors.	Government colleges, manufacturers, industry sectors.	Universities, community colleges, manufacturers, industry sectors.
Trainer SWT experience and qualifications	Demonstrate competency to at least the level of those being assessed.	Some courses use MCS-approved installers.	Some courses use NABCEP-approved installers.
Hands-on course components	Generally limited due to lack of access to facilities.	Some providers have practical workshops over several days.	Some providers have practical workshops over several days.
National certification of installers	Endorsement by the CEC.	MCS has a small number of certification bodies.	NABCEP certification.
3rd party national training program accreditation	Accreditation by the CEC.	Some programs meet MCS accreditation requirements.	Some programs ISP accredited and linked to NABCEP certification.
Relevant installer standards	Focus on Australian Standard AS4509 - Stand-alone Power Systems.	MCS Installer Standards, e.g., MIS 3003 Small and Micro Wind Systems.	Institute of Sustainable Power Quality (ISPQ) Standards.
Government departments that provide policy to support training	Federal Department of Education, Employment and Workplace Relations.	National Department of Energy and Climate Change.	Federal Department of Energy, State Departments.

TABLE 2 COMPARATIVE INDICATORS OF NECESSARY STRUCTURES FOR INSTALLER CERTIFICATION.

	Australia	**UK**	**USA**
Certification cycle	1 year.	1 year.	3 years.
Continuing requirements	Continuous professional development courses.	None required.	At least 18 contact hours of continuing education.
Industry body independent from accreditation body	No.	Yes.	Yes.
Requirements for no. of turbines installed	1 case study needed to attain full accreditation.	Annual surveillance visit to site of an installed turbine.	At least 3 systems in 3 years.
Policy support mechanisms that require certified installer	Capital subsidies associated with Federal RET legislation, State feed-in-tariffs.	National feed-in-tariff scheme.	A small number of State-based capital subsidy incentive programs.

The act of adding the small wind UoCs to the existing VET training programs for stand-alone and/or grid-connected photovoltaic power systems could be said to be one of convenience, and means that SWT installers have either to hold an unrestricted electrical license or complete several units to test their competency in electrical systems. It could be argued that some of these units may be redundant for SWT installers who need to focus on site and turbine selection, civil works, and project management, and only a small component is the actual electrical installation of the SWT. On the other hand, the training package places emphasis on 'protection of persons and property from damages of system malfunction' [55], and electrical system malfunction remains high in the list of potential risks in installing SWTs. If any attempt to restructure the training package or to move the wind modules into a separate package were to occur, this would need to be undertaken without compromising the electrical competence of installers and the electrical safety of installations. The strong focus on practical installation experience within NABCEP certification in the USA draws a parallel with the concerns of the Australian TAFE representative preferences for additional practical components in training courses. The NSWTC in Western Australia provided a one-day practical workshop for Central Institute TAFE students in 2011, but have since lacked the funds to offer them on a

regular basis. Future growth of the number of SWT installations in Australia will allow the kind of 'on-the-job' training being used in the USA, and will reduce the costs to educational institutions in arranging installation training exercises. It remains to be seen how the NSAET in the UK will support the development and deployment of installer training programs to cater for the expanding UK SWT industry needs. Some regions of Australia have recently experienced very high levels of SWT installation growth and this has had an effect on the development of SWT installer training programs in Australia. Such developments were located in areas with generous feed-in-tariffs rather than located in regions with particularly good wind speeds. For example, 97% of SWT capacity installed in Australia in 2010 was located in NSW, which had the most generous feed-in-tariff in Australia at the time (AUD0.60 per kWh gross) [56]. It is no coincidence that the NSW state planning guidelines, the small wind assessor's course, and a 'consumers' guide to SWTs' were all developed first in NSW [57]. The 2010 growth in SWT installations in NSW has generated much interest in the NSW planning guidelines nationally, and was a strong stimulus for the CEC to develop the Wind Endorsement Scheme. However, since 2010 most Australian feed-in-tariffs that were available at the beginning of 2010 (including the NSW feed-in-tariff) were revoked or severely revised to non-premium tariffs, despite being introduced in most cases only around twelve months prior. Therefore, it is likely that SWT installed capacity in all Australian states will stagnate in the near term, and that demand for installer training courses from accredited providers will similarly contract. This is despite a roughly similar return on investment and federal government capital subsidy for SWTs as equivalent rated photovoltaic systems in Australia [58]. Linking feed-in-tariff eligibility with the use of certified installers appears to be successful in increasing the demand for installer certification in the UK. In the USA, there are too few states that link incentive eligibility to installer certification so that "installer certification does not seem necessary" [54, p5].

Consumer advocacy remains a major need in the global SWT industry [59], and the promotion of SWT systems in schools is a prime marketing opportunity that may assist in promoting the need for addressing antiquated planning policies and regulations [27]. The Australian SWT industry may follow the model adopted by the small-scale photovoltaic industry in the parallel development of advocacy to policymakers and the public alongside attainable installer competency standards. Building upon the directions in the NSW state planning guidelines, a comprehensive review of Australian renewable industry strategies and standards should ideally address in parallel requirements for planning policy, consumer advocacy, as well as R&D for adequate support of safety, design, and installation of effective systems [60-63]. Such necessarily collaborative activities aim to address limiting factors (particularly the low SWT demand and limited installation training opportunities) to ensure long-term sector-wide SWT system assurance and greater market expansion in Australia. Yet, at present there is not as clear a division between the industry body and the installer accreditation body in Australia as there is in the UK and the USA. This was not always the case, as prior to 2007 there were two separate organisations, the Australian Wind Energy Association (AusWEA), and the Australian Business Council of Sustainable Energy (ABCSE) who handled installer accreditation. In 2007, the two bodies merged to form the CEC in order to have a more unified and stronger lobbying voice. The CEC is now the peak body representing the clean energy industry with installer accreditation handled by a separate Standards, Training and Accreditation committee within the CEC [64]. In the authors' opinions, while it is more transparent to have complete separation of the industry association, and industry-related accreditation bodies, the institutional structuring of the CEC is not uncommon in the area of accreditation. For instance, global companies such as TÜV Rheinland [65] and Germanischer Lloyd [66] handle both testing and accreditation of renewable energy products, admittedly in different sections of the company. In addition, small industry associations, such as the Australasian Small Wind Energy Association (ASWEA) that briefly formed in 2010 and dissolved a year later, find it difficult to have a voice and, in the case of ASWEA, their best option was to urge the CEC to pick up the cause, which it did by forming a Small Wind Steering Committee and releasing a small wind policy position in 2011 [67]. At the broader scale, the registered training organisations in Australian need to remain aware of changes to small wind policy and the market. At present, incentives for small wind in Australia fall under the Small-scale Renewable Energy Scheme of the RET legislation and an installation from an accredited installer is eligible under the scheme only if the system has a capacity of no more than 10 kW. In contrast, the federal, state and utility assistance programs in the USA have placed no such eligibility restriction for small wind turbine and training programs that cater for one to 100 kW SWTs. Expanding the Australian training programs to include SWTs up to 100 kW would be appropriate if there are drivers that are stimulating the growth of commercial-size turbines, e.g., in the range 10-100 kW.

VIII. CONCLUSIONS

It is evident that the emergent training and accreditation programs for SWT installers have the necessary structures to sustain the development of a skilled workforce to underpin potential growth in the SWT sector in Australia. The training programs, however, can develop further with the use of experienced certified trainers, units with strong practical components and material that covers both stand-alone and grid-connected small wind systems. For the SWT industry to make use of standards, training, and planning developments, it must penetrate the mainstream small-scale renewable energy market in a similar manner as the photovoltaic industry has in the recent past [68]. For Australia to reach the levels of SWT installed capacity penetration in the USA and UK, it must be noted that suitable industry training and accreditation schemes are only one piece in the puzzle, and that there are a number of factors that the Australian SWT industry should focus on. Such factors are likely to include consumer advocacy and product marketing although further research is required to examine the relative importance of these factors across the three jurisdictions. While skill shortages have been predicted as a constraint for the Australian renewable energy sector, this research suggests that the strong interest in the renewable energy sector training,

certification/accreditation, and planning policy requires commensurate policy that aims to facilitate the currently very small Australian SWT market demand. This will allow SWT manufacturers and VET institutions to confidently invest in the sector in support of long-term industry needs, alongside policies that directly and indirectly support the short-to-medium-term SWT installed capacity growth akin to the USA and UK.

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