



Guideline to Introducing Quality Renewable Energy Technician Training Programs



PVPS

PHOTOVOLTAIC
POWER SYSTEMS
PROGRAMME

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Author: Geoff Stapleton, gses@bigpond.com

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Foreword

This document is a joint publication of the IEA PVPS (International Energy Agency's Photovoltaic Power Systems Programme) Task 9 and the International Solar Energy Society (ISES).

The IEA PVPS Programme

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD). The IEA carries out a comprehensive programme of energy co-operation among its 30 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The thirty PVPS members are: Australia, Austria, Belgium, Canada, the Copper Alliance, China, Denmark, European Union, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, the Netherlands, Norway, Portugal, SEIA, SEPA, SolarPower Europe, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey and the United States of America. South Africa, joined PVPS in 2016. The European Commission, the European Photovoltaic Industry Association, the US Solar Electric Power Association and the US Solar Energy Industries Association are also members. An Executive Committee composed of one representative from each participating country or organization heads the overall programme. The management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed Tasks can be found on the IEA-PVPS website www.iea-pvps.org.

Task 9, Deploying PV services for regional development, addresses the use of PV as a means to enhance regional development – both for rural electrification applications and more broadly in the urban environment. The Task achieves this by developing partnerships with appropriate regional and national organizations plus funding agencies, and carrying out work on specific applications of interest and relevant business models.

International Solar Energy Society

ISES is the largest international solar organization, with extensive membership worldwide. ISES has members in more than 110 countries, and sections in many countries with thousands of associate members, and over 100 company and institutional members throughout the world.

The Society is the longest standing solar organization in the world, with its roots dating back to 1954. In 1963 ISES became accredited with the United Nations and has been working with UN entities and programs since, taking part in important events like the UNFCCC Climate Change Conferences and the UN Commission on Sustainable Development meetings.

Through conferences, congresses, publications and webinars, ISES provides objective, scientific advice to governments and the public at a global level. ISES strong research and academic foundations bring credibility to its advice on technical and policy issues related towards achieving 100% renewable energy worldwide.

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Contact:

Global Sustainable Energy Solutions Pty Ltd
Mr Geoff Stapleton
Unit 4 17-19 Green Street
Botany, 2019 NSW Australia
Phone: + 61 2 9024 5312
Fax: + 61 2 9014 5316
E-mail: geoff.stapleton@gses.com.au

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Every effort has been made to ensure the accuracy of the information within this report. However, mistakes with regard to the contents cannot be precluded. Neither the authors, nor the IEA PVPS Programme shall be liable for any claim, loss, or damage directly or indirectly resulting from the use of or reliance upon the information in this study, or directly or indirectly resulting from errors, inaccuracies or omissions in the information in this study.

Abbreviations and Acronyms

ANSI	American National Standards Institute
APVI	Australian Photovoltaic Institute
AQF	Australian Qualifications Framework
AQTF	Australian Quality Training Framework
ASEAN	Association of South East Asian Nations
ASQA	Australian Skills Quality Authority
ATO	Approved Training Organisation
CEC	Clean Energy Council
CSIR	Council for Scientific and Industrial Research, South
ECOWAS	Economic Community of West African States.
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
ELV	Extra Low Voltage
GIZ	Gesellschaft fuer Internationale Zusammenarbeit (German Federal Enterprise for International Cooperation)
GSES	Global Sustainable Energy Solutions
IEA	International Energy Agency
IEC	International Electrotechnical Committee
IEC-RE	International Electrotechnical Committee Renewable Energy
IED	Innovation Energy Development
IEEE	Institute of Electrical and Electronic Engineers
IREC	Interstate Renewable Energy Council
IRENA	International Renewable Energy Agency
ISES	International Solar Energy Society
ISP	Institute for Sustainable Power
ISPQ	Institute for Sustainable Power Quality
LV	Low Voltage
MCS	Micro-generation Certification Scheme
NABCEP	North America Board of Certified Practitioners
OHS	Occupational Health and Safety
PACTVET	Pacific Technical and Vocational Education and Training
PPA	Pacific Power Association
PQF	Pacific Qualifications Framework
PV	Photovoltaics
PVPS	Photovoltaic Power Systems Program
QTF	Quality Training Framework
RCS	Regional Certification Scheme
R&D	Research and Development
RE	Renewable Energy
RTO	Registered Training Organisations
SAQA	South African Qualifications Authority
QCTO	Quality Council for Trades and Occupation
SARETEC	South African Renewable Energy Technology Centre
SEAS	Sustainable Energy Association of Singapore
SEIAPI	Sustainable Energy Industry Association of the Pacific Islands
TVET	Technical Vocational Education and Training
UL	Underwriters Laboratory
VET	Vocational Education and Training
WDA	Workforce Development Agency

Abstract

This document is intended as a guide for The Renewable Energy Industry, Multi-Lateral and Bi-Lateral Donors and Government Ministries/Departments that want to introduce competency based quality renewable training programs for technicians into a country or region.

The guide provides an overview of:

1. Quality Training Frameworks;
2. The processes involved in developing competency based Quality-Training programs; and
3. The capacity building requirements for the technical and vocational education sector

The overall objective of the guide is to enable stakeholders to identify the best way to introduce renewable energy courses into an existing quality training framework or, if one does not exist, to establish a process whereby the training being provided is following quality procedures.

The guide concludes with recommendation that the Global Renewable Energy Industry should consider the introduction of an international framework that would provide a mechanism for renewable energy training programs to be accredited by a third party.

Executive Summary

Introduction

In a mature industry companies are able to employ technicians who have obtained their skills training from an accredited and approved training centre¹. These training centres are offering courses that meet the needs of the relevant industry. Such a training framework is achieved through established committees comprising relevant stakeholders from industry, training institutes and at times government who identify and document the knowledge and skills required to perform a certain task, for example the installation of grid tied PV systems. The development of documents which set the required standards follows similar procedures around the world however they often have different names such as: Competency Standards, Units of Competence or Job Task Analysis. Within the present document Unit of Competence is utilised as the generic term for the variety of names.

Training institutes become accredited and/or approved to conduct these courses via an auditing process undertaken by a recognised body, often a government or semi-government entity. In addition to the approval to conduct specific training courses the training centres are audited and approved against a set of quality management/organisational standards with the objective that the training centres are providing quality service.

In many countries the above process is part of a National Qualifications Framework or **National Quality Training Framework**. Sometimes they can be regional and not national. These frameworks document the various qualifications that could be available through training centres (including Universities, technical colleges and similar), ranging from certificate level courses through to postgraduate degrees.

Though the renewable energy has increased dramatically over the last 10-15 years the training of the required technicians within approved and accredited training centres has not kept pace with the industry requirements. There are only a small number of countries where specific renewable energy training is already within the country's training framework.

Components of a Quality Training Framework

Most people do not necessarily understand quality training frameworks, they just accept them if they have already been implemented within their industry. However, since there is a great **need for quality renewable energy training** at the technician level globally many of the stakeholders do need to understand what a training framework is. If not, stakeholders will talk about the need for quality training without it being successfully introduced in their country or region. For this reason, this document provides an overview of **what is a quality training framework and how it operates**. It states that successfully introducing renewable energy training within an existing national or regional framework will require close liaison between the renewable energy industry stakeholders and the existing education stakeholders.

The overview of quality training frameworks in the document provides examples of the key elements that are included in the **quality management standard** which an approved training centre should be audited against. The quality management requirements are common for all

¹ This document uses the term training centres for describing an entity that provides technical training for technicians. In some countries these could be called training institutes, technical colleges, polytechnics etc.

training centres, independent of what industries the training centre is offering courses in. As an example, a quality management standard will include areas such as:

- Procedures relating to processing student applications.
- Minimum qualification requirements for teaching staff and their continuing professional development.
- Policies related to health and safety.
- Policies related to conducting assessments.
- Policies and procedures related to complaints.

The overview section of the document provides an explanation about **curriculums** and **Units of Competence**. It refers to existing documents showing the different formats on how these can be presented. Though some Units of Competence might be common across industries, there will always be particular Units of Competence unique to a particular industry.

Technician certification/accreditation schemes

To raise the professionalism and sometimes credibility of an industry some industries have **industry based certification or accreditation programs** where trained individuals participate through undertaking ongoing professional development activities to distinguish themselves from other people in their industry. The document summarises some of the schemes introduced for the solar industry.

Introduction of quality renewable energy training in a country or region

After providing an overview of quality training frameworks the document describes **what should be undertaken to introduce quality renewable energy technician training** into a country or region. The first step should be undertaking a needs and gap analysis which should identify information such as:

- The current and future market prospects for the various technologies and their applications.
- How many trained people per year are required for each technology application?
- Any training programs that are currently available and what training has been conducted in recent years.
- Whether the country or region has an existing quality training framework.

Based on the results of the needs and gaps analysis training courses should be introduced for the technology applications identified, however the document describes all things to be considered, not just the development of the Units of Competence. These include:

- Identifying where training should be conducted.
- Not flooding the market with too many training centres and too many trained technicians.
- The format of the training.
- The material that training centres will require.
- Training of the trainers.

If a framework already exists for a country or region then there will already be training centres that meet the quality management requirements. In introducing renewable energy training courses within that country or region then the industry stakeholders should be able to work with these existing, approved training centres. Industry stakeholders will have to lead the development of the Units of Competence required for their industry.

The **procedures for the development of Units of Competence** are common and independent of the industry. Though the existing training centres would have experience in the development of

Units of Competence this document does have a section dedicated to their development and in particular: how committees are formed; how they operate; how the Units of Competence are developed and approved. The reason is, if the renewable energy industry does want quality Units of Competence relevant to their industry needs they need to take control of the process and have a very good understanding of the process.

What if there is no country Quality Training Framework for the Vocational Training sector?

Though quality training frameworks do exist in a number of countries there are a number of countries where they do not. This raises the question on whether there is a need for an **international body that could accredit and approve renewable energy training centres?** Section 3 summarises work undertaken previously by a body established in 1996, the Institute for Sustainable Power, to provide this service and explains why at the time it was unsuccessful, namely because of the small size of the industry. The document suggests activities to identify whether such an organisation would still be useful.

Examples of Existing Quality training and technician's certification/accreditation schemes

The document provides **examples of the introduction of a number of quality renewable energy training programs** internationally including West Africa (ECREEE), France, India, Kenya, Malaysia, the Pacific region, South Africa, Singapore, and the United Kingdom. However, when providing examples of frameworks and Units of Competence (Job Task Analysis) focusses on Australia and the USA. These have not been included to imply that they are better than any other countries' programs, they have been selected because:

1. though they are different in one being compulsory (Australia) and the other being voluntary (USA), they are similar in operation and do show how most frameworks around the world are basically similar with only small differences; and
2. they are examples of some of the longest operating quality training programs being applied to the renewable energy industry and hence are quite mature.

Australia introduced a solar technician accreditation program in 1993 (now compulsory to work in specific sectors of the industry) and introduced renewable energy technician training into their technical colleges as early as 1989. From the late 1990's these programs were included in the national training framework and were compulsory for all renewable energy training courses offered in Australia to be endorsed within the relevant national training package and provided by registered training organisations. The USA based Interstate Renewable Energy Council (IREC) in 2005 successfully took the training framework standard developed by the Institute of Sustainable Power and implemented it in the USA as a voluntary training accreditation program while the North American Board of Certified Electrical Practitioners (NABCEP) also introduced a technician certification program in 2003

1. Introduction

The renewable energy industry has had exponential growth in the last ten years. However at conferences and workshops around the world, the training of technicians for the design, installation, maintenance and operation of renewable energy systems is still identified as a high priority for the industry. In many countries, there do exist National Quality Training Frameworks which already provide quality training programs within the Technical Vocational and Education Training (TVET) for other industries. However there are only a small number of countries where specific renewable energy training is already within the country's framework. For the industry to meet the priority for trained technicians requires the relevant stakeholders within the industry to engage with the education sector within the various countries where demand for technicians is high.

The ideal outcome would be that quality accredited renewable energy training courses are available within the existing technical educational centres. However for this to occur, the renewable energy stakeholders, in particular the industry, donors and the government personnel working in the energy field, need to understand the education sector, particularly where this sector is operating under a national or regional quality training framework. **The first objective of this guideline is to provide a brief overview of existing relevant quality training frameworks.**

Once the renewable energy stakeholders understand the relevant education sector, they can then work towards having renewable energy training courses integrated as part of that sector and ultimately accredited within the relevant framework.

However many countries and regions in which the renewable energy industry is expanding might not have any robust, technically based, quality training frameworks. Thus, the second objective of this guideline is to describe **what is required to offer quality courses even without the presence of a framework**. Admittedly without a framework, this outcome relies on a good relationship existing between the industry and the education providers so that the courses provided are of sufficient quality and content to meet the needs of the industry and those of clients who want independent sound technical advice.

Most of the equipment being used within the renewable energy industry is constructed in accordance with international standards like the IEC, IEEE or UL. The third objective of this guideline is to raise the issue of **whether there is a need for an international body to accredit renewable energy training programs**. This body would co-ordinate the development and approval of an international quality training framework and accredit training centres conducting RE training in accordance with the framework.

Task 3 of the PVPS Program was involved with quality for off-grid systems and in particular subtask 10 of Task 3 related to quality assurance schemes for a better reliability and lower global life cycle costs. Where Task 3 focussed on the equipment, the systems and their installation, this guideline focuses on quality programs for the technicians who design and install the systems.

Note: This guideline focuses on technician level training and in particular for grid and off-grid PV systems. However, for the off-grid systems it could include technologies such as the design and installation of small wind turbines, micro-hydro systems and hybrid systems which include fuel based generators.

2. Components of a Quality Training Framework

2.1. What is a quality system framework?

A quality system is a framework of standards against which individuals and organisations are measured for consistency of process, quality of results, success of continuous improvement procedures, and the documentation necessary to evaluate any portion of the process. A quality system within a workplace involves the following:

- A way of doing things that is understood by all involved from the most senior manager to the newest employee.
- A system of documenting development efforts, work procedures, work performed, testing, modifications, customer feedback, and so forth.
- Regular reviews and evaluation of critical aspects of the operation.
- Use of results of reviews and customer feedback to improve the quality of the company's work.

A quality training centre or institute is also a “workplace” and thus should have an internal quality system similar to that specified above. When a quality system is applied to the provision of training nationally or regionally it is typically known as a National or Regional Quality Training Framework.

A Quality Training Framework will often contain two sets of standards. One that relates to the operation of the training centres and the other that relates to the courses being conducted. The intention of this type of framework is that there is a minimum operational standard which all training centres² should meet and that the people attending similar courses (e.g. a solar energy installer's course) at different training centres are taught and assessed against a comparable set of standards that define what is being taught and assessed.

When it is a National Quality Training Framework, the body that manages the framework is often a government department or an entity established by the government. The role of this entity is:

- (a) To develop the standards which all training centres shall meet. (Section 2.3)
- (b) Establish the qualification levels across which the framework applies (Section 2.2).
- (c) Establish the mechanism for developing the course structure for the different qualifications across a multitude of different industries (Section 2.4)
- (d) Establish the procedures for training centres to apply to be an accredited training centre offering a set of qualifications or short courses within those qualifications (Section 2.4)
- (e) Establish the mechanism to audit the training centres against the relevant standards within the Quality Training Framework prior to the training centre being approved. Within this mechanism will be the procedures on removing the approval/recognition of the training centre if they are found not to be complying with the requirements of the standards either after the entity receives a complaint or when the training centre is re-audited at the time of renewal. (Section 2.5)

² Note: For the purpose of simplicity and consistency, training centres, training institutes or training providers' centres will be collectively called training centres in this document. This term will cover any entity that conducts training courses.

If the framework is a regional framework then it is generally managed via a regional body where the body and framework is endorsed through a mechanism that is accepted by the different Governments of countries within that region.

Following are examples of different quality training frameworks: Case Study 1 is the Australian Quality Training Framework that governs how all education and training is conducted within Australia; Case Study 2 is the Interstate Renewable Energy Council in the USA which has a framework for accrediting renewable energy and energy efficiency training programs. The intention is to show that there are different models that can be applied however they generally do have many common aspects. Figure 1 provides a flowchart on how the Australian Quality Framework interacts with all the stakeholders.

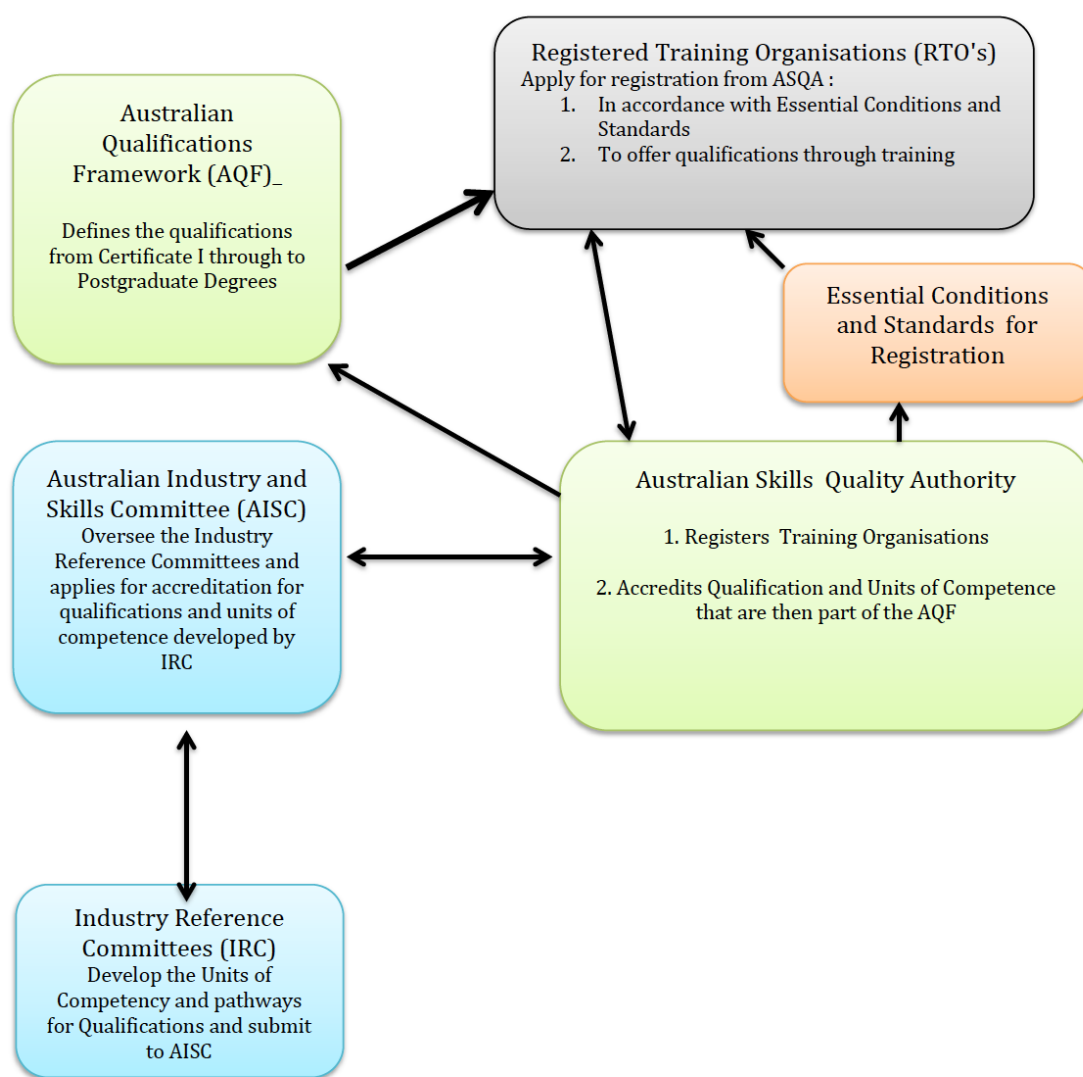


Figure 1: Australian Quality Training Framework Flowchart

Case Study 1: Australian Quality Training Framework

The Australian Quality Training Framework (AQTF) is the national set of standards to assure nationally consistent, high-quality training and assessment services for the clients of Australia's vocational education and training system.

Training centres that initially apply to be registered under the framework must meet the **Essential Conditions and Standards for Initial Registration** – once audited and accredited they are known as Registered Training Organisations (RTOs).

For RTOs to maintain their registration, they must meet the **Essential Conditions and Standards for Continuing Registration**.

RTO's are registered to provide training and assessment of courses approved under the Australian Qualifications Framework (AQF). Though it is a separate framework it is a key subset of the overall AQTF. Training centres to become RTO'S must meet all the quality management standards and then be approved to provide courses for specified qualifications within the AQF. It is within these qualifications where the Units of Competence exist.

The AQF defines all Australian qualifications. It provides a single framework for all qualifications from Secondary School to PhD level. AQF qualifications are recognised Australia wide and internationally.

There are three sectors within the AQF:

Secondary school

Vocational Education & Training (VET); and

Higher Education

The VET sector qualifications are as follows:

- Certificate I
- Certificate II
- Certificate III
- Certificate IV
- Diploma
- Advanced Diploma
- Graduate Certificate
- Graduate diploma

The management of the AQF is delivered by the Australian Government Department of Education and Training in consultation with the Australian Government Department of Industry and Science and state and territory governments.

The Australian Skills Quality Authority (ASQA) accredits qualifications and registers training organisations operating in the Australian Capital Territory, New South Wales, the Northern Territory, South Australia, Queensland, and Tasmania with domestic and/or international students, and training organisations operating in Victoria and Western Australia with international students and/or domestic students from other states and territories.

The Australian Industry and Skills Committee oversees industry reference committees responsible for training product development. Industry reference committees are supported by independent, professional skills service organisations. These reference committees develop the qualifications and units of competence that are endorsed by ASQA

Further information can be found at:

<http://www.aqf.edu.au>

<http://www.asqa.gov.au>

<https://education.gov.au/AISC>

Case Study 2: Interstate Renewable Energy Council Credentialing Program

The USA based Interstate Renewable Energy Council (IREC) Credentialing Program accredits clean energy training providers and certifies instructors and master trainers.

Although IREC does not use the term Quality Training Framework, the structure through which it operates is the same as a Quality Training Framework, but is focused on the provision of training for the clean energy industry within North America.

IREC 's initial involvement with accrediting clean energy training programs was as a licensee for the Institute for Sustainable Power (ISP) Quality standard (ISPQ). (Refer to Section 2.5 for more information on ISP). IREC became the owner of the original ISP Standard and has since grown, developed and improved standards that meet the needs within North America. Unlike the Australian framework, which is compulsory for training providers in Australia, the IREC program is voluntary. However it is very highly respected, with over 170 accredited or certified training providers within North America.

IREC has developed a number of standards:

- **ANSI/IREC Standard 14732-2014** *General Requirements for the Accreditation of Clean Energy Certificate Programs* is an American National Standard, which describes best practices for certificate programs in the clean energy fields. It outlines requirements for issuing a market-valued certificate by examining linkage to industry and correlation between curriculum and a current, valid Job Task Analysis.
- **IREC Standard 01023: 2013** identifies requirements for the quality systems, resources, personnel, and curriculum by which job-related training in clean energy technologies and practices may be accredited. Programs must base their curriculum on one or more IREC-accepted job task analyses in the clean energy technology fields. Adherence to this rigorous standard allows the training provider to demonstrate its commitment to high-quality training of students, employers and other industry stakeholders.
- **IREC Standard 01024: 2013** establishes requirements for the instructional and professional field experience, subject-matter expertise, and instructional quality by which instructors and master trainers in clean energy technologies and practices may be certified. Those professionals recognized must teach topics from one or more IREC-accepted job task analyses in the clean energy technology industry.

The requirements within these standards are very similar to those within national quality training frameworks like the AQTF. Applicants must apply to and be audited in accordance with the requirements of the standards and there is an ongoing requirement for renewal.

Further information can be found at: <http://www.irecusa.org>

The following figure summarises the different components of a Quality Training System Framework as an overview. The various components are described more in detail in the following subchapters.

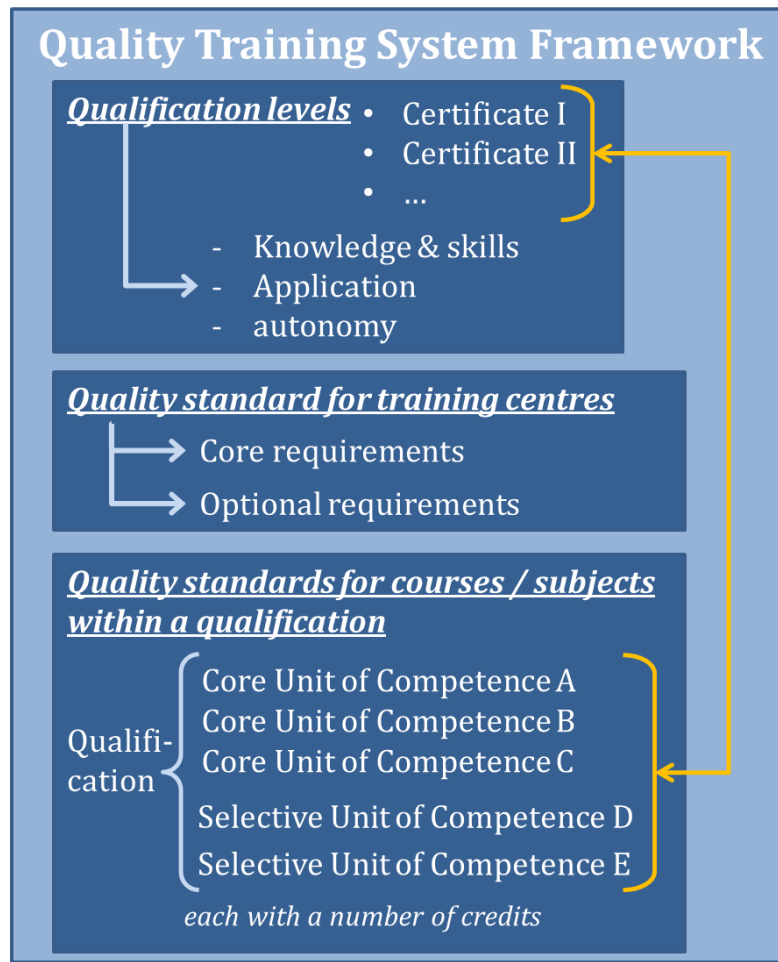


Figure 2: Important components of a Quality Training Framework

2.2. Qualification Levels

A national or regional qualifications training framework may comprise different levels of qualifications varying from certificate level courses conducted at vocational education and training centres up to doctoral degrees conducted at Universities. The level of competency expected of a person obtaining a qualification must be defined.

For vocational education and training the levels of qualifications may include:

- Certificate I
- Certificate II
- Certificate III
- Certificate IV
- Diploma
- Advanced Diploma
- Graduate Certificate
- Graduate Diploma

For higher education the level of qualifications may include:

- Graduate Diploma
- Undergraduate Degrees
- Postgraduate Master Degrees
- Doctoral (PhD) Degrees

This document is focussed primarily on vocational education and training to diploma level. Each framework will describe the different knowledge and skills, applications and autonomy requirements (or similar) for each of the qualification levels.

Using the Pacific Qualifications Framework as example, Table 1 shows the 5 technician qualification levels that could be acquired from technical colleges within the Pacific Region. Level 6 is typically considered as sub-professional and though technicians can study to this level, this document is focussed on the “hands on” technician. Table 2 distinguishes the different knowledge and skills, applications and autonomy requirements for the five different qualifications from Certificate I to the Diploma.

Table 1: Technician Qualifications levels within the Pacific Qualification Framework

Level	Qualification
1	Certificate I
2	Certificate II
3	Certificate III
4	Certificate IV
5	Diploma
6	Advanced Diploma; Associate Degrees; Diploma

Source: www.eqap.org.fj

Table 2: Knowledge and skills, application and autonomy of different Qualifications levels within the Pacific Quality Framework

Qualification	Knowledge and Skills	Application (Type and problem solving)	Autonomy: level of support and degree of judgment
Certificate 1	Demonstrated knowledge and skills that: <ul style="list-style-type: none"> are basic, foundational and explicit 	Applied in contexts that: <ul style="list-style-type: none"> are highly structured, defined and repetitive Involve straightforward and everyday issues that are addressed by simple and rehearsed procedures 	In conditions where there is: <ul style="list-style-type: none"> immediate support and clear direction almost no judgment or discretion required
Certificate II	Demonstrated knowledge and skills that: <ul style="list-style-type: none"> are factual or manual or operational 	Applied in contexts that: <ul style="list-style-type: none"> are structured and stable involve straightforward issues that are addressed by set, known solutions 	In conditions where there is: <ul style="list-style-type: none"> close support and direction or guidance minimal judgement or discretion required
Certificate III	Demonstrated knowledge and skills that: <ul style="list-style-type: none"> are factual, procedural, technical, with some theoretical aspects 	Applied in contexts that: <ul style="list-style-type: none"> are stable and predictable involve familiar issues that are addressed by selecting from known solutions 	In conditions where there is: <ul style="list-style-type: none"> routine supervision and direction or guidance some judgement and discretion required

Certificate IV	Demonstrated knowledge and skills that: <ul style="list-style-type: none"> are broadly factual, with technical and theoretical aspects 	Applied in contexts that: <ul style="list-style-type: none"> are stable but sometimes unpredictable involve familiar and unfamiliar issues that are addressed by interpreting or varying processes 	In conditions where there is: <ul style="list-style-type: none"> routine direction or guidance judgement and some planning required
Diploma	Demonstrated knowledge and skills that: <ul style="list-style-type: none"> are mainly technical and theoretical, within a broad field or with depth in one area 	Applied in contexts that: <ul style="list-style-type: none"> are both known and changing involve unfamiliar issues that are addressed using a range of processes that require some adaptation 	In conditions where there is: <ul style="list-style-type: none"> general guidance or direction both judgement and planning required

Source: *Pacific Qualifications Framework- Secretariat of Pacific Community 2015*

Table 2 is provided as an example of the differences between the various levels of qualifications within a qualification framework. However, there is no standardised, global process with respect to the use of the qualification levels. For this reason, a person who obtains a Certificate III qualification through one framework might not be recognised at that level by another country or regional framework.

As an example an electrician in Australia or New Zealand would be classified as a person with Certificate III qualification, but within these countries, the electrician would work unsupervised and would be required to solve technical problems. A person with the Australian Certificate III is a more highly qualified person than one with a Certificate III under the Pacific Quality Framework. This is not to state that one framework is better than another, however, it is important to appreciate that the definition of qualification levels are not currently defined under a global standard.

One way to compare different qualifications from different quality frameworks is to compare the required number of hours allocated to the training within the various qualifications. As an example, a Certificate III in Renewable Energy under the Australian Quality Training Framework requires the equivalent of 900 hours of training. Under other frameworks, a Certificate III can be as little as 200-300 hours.

2.3. Quality Standards for Training Centres

Under a quality training framework, training centres need to apply to become approved training centres endorsed via the framework. The language used can vary from country to country, but the training centres once approved can be known as accredited training providers, registered training organisations, approved training organisations or similar.

The framework will require a training centre to submit evidence in their application that they meet all the requirements that are specified within a standard. The initial application would be followed by an onsite audit verifying the evidence submitted by the training centre in their application. Renewals will generally be desk top with onsite audits either carried out randomly or

at a specified time period. However, if the entity that approves the training centres receives complaints then audits could be undertaken as part of the complaints process.

The standard within a framework, which must be met by training centres, would include core requirements and optional requirements depending on what courses are being offered. The core requirements would have to be met by all training centres that are to be approved under the framework while the optional requirements would be based on the type of courses being offered. The optional requirements could be set out based on how the courses are being offered or the aim of the course. The term optional does not mean that they are not compulsory requirements. It means that they are not compulsory for every single training centre. If the course centre is offering courses delivered a certain way (e.g. online training), then all optional standards related to that form of delivery (that is optional standard relating to delivery of online training) are compulsory for that training centre.

As an example there could be optional requirements for courses being delivered face to face in a classroom and separate optional requirements for courses being delivered online. Similarly, if the course relates to teaching practical skills (e.g. installing a solar array) then the training centre must have the equipment required for teaching and assessing those particular skills. The specific requirements for teaching particular courses should be specified within the Unit of Competence related to the course or subject (refer Section 2.4).

Core requirements within a quality standard for a training centre could include the following:

- Procedures relating to processing student applications
- Procedures related to maintaining records
- Policies related to student confidentiality and release of information
- Policies related to avoiding conflicts of interest
- Minimum qualification requirements for teaching staff and their continual professional development
- Policies related to health and safety
- Policies related to conducting assessments
- Policies and procedures related to complaints
- Policy and procedures for undertaking surveys and course evaluations.
- Commitment to continual improvement of the course delivery and related material.
- Delivering courses as per the requirements of the relevant standards approved within the quality training framework (refer Section 2.4)
- Policies for internal audits

Optional requirements within the standard could relate to the following:

- Requirements for training facilities
- Tools equipment and hardware requirements
- Appropriate trainers to students ratio

The various Appendices provide examples of existing standards that a training centre offering renewable energy courses would be required to meet if the training centre wanted to be accredited in accordance with those standards.

2.4. Quality Standards for Courses/Subjects within a Qualification

Within a qualification there will be a number of individual subjects, modules, units or individual courses. The names do change depending on the actual terminologies within a quality framework. In some quality frameworks each one of these subjects or modules will have an allocated number of credit points. The qualification will be obtained when a person has undertaken and passed enough subjects/modules to reach a specified number of credit points. Other frameworks will use the word curriculum and the overall qualification will comprise a specified number of subjects within the curriculum. Although names might change, the general structure is the same such that the overall qualification will comprise both core and elective subjects/modules.

With the introduction of competency based qualifications, new terminologies have been introduced within some of the frameworks to replace the terms 'subjects' and 'modules'. The qualifications comprise 'Units of Competence', or 'Units of Competency' or 'Competence Units', which are sometimes called 'Competency Standards'³. In some frameworks they use the title 'Job Task Analysis'. Though the names might be different, in principle, they mean the same thing, however, the level of complexity and evidence requirements within the descriptions for the different forms of Units of Competence can vary.

The term 'curriculum' has also been replaced in some frameworks with the term 'mapping'. That is, a specified qualification is mapped against core and elective Units of Competence. Again, they will often have credit values or points and the mapping leads to a specified number of credits in core and elective Units of Competence for a person to obtain the qualification.

Under competency-based training the objective is that someone is deemed competent when he/she can perform a specified duty or task. The title of the Unit of Competence reflects the task that a person will be able to do after they are deemed competent in that Unit of Competence.

The Unit of Competence will therefore specify all the knowledge and skills a person must have to perform the specified task.

Hence a Unit of Competence may have the title: "Install a Grid Connected PV system". The document will therefore list all the knowledge and skills a person will be required to be able to install a grid connected PV system.

A training provider who then plans to conduct training based on that Unit of Competence and wants to be accredited within a Quality Training Framework will be required to provide evidence to the body administering the Quality Training Framework that they are teaching all the identified knowledge and skills.

In some Quality Training Frameworks, those providing the training will also undertake the assessment, while in others it requires that independent assessors undertake the assessment. There are arguments for and against both models, however both are being applied successfully around the world.

It is for this reason that the levels of requirement between different versions of Units of Competence or Job Task Analysis will vary. All will have a description of the essential knowledge and skills that are required to perform a specified task. Most will also state what pre-requisites are required before a person can undertake the training course. These pre-requisites might be based on previous education levels, such as mathematics from school or could include other Units

³ Note: For the purpose of consistency this guide will mainly use the term Unit of Competence.

of Competence. However, not all will specify the level of assessment and evidence required for a person to prove they are competent in that unit. Some will also specify the minimum types of equipment required by the training provider to teach and/or assess that unit.

Although each Unit of Competency specifies a particular task, as stated previously a qualification will comprise a number of Units of Competence to be successfully completed before the qualification can be provided.

Just as there are different qualifications levels, e.g. Certificate I through to Diploma the Units of Competence will have specified levels. The degree of difficulty within the Unit of Competence will then reflect its level.

Units of Competence used for obtaining a Certificate I will all be level 1. Certificate II will comprise Units of Competence at levels 1 and 2. Certificate III will comprise Units of Competence at levels 1, 2 and 3. Certificate IV will comprise Units of Competence at levels 1, 2, 3 and 4.

Only a few countries in the world have introduced complete renewable energy qualifications (Certificate I through to Diploma or Advanced diploma) within their quality training framework however, some have introduced specific Units of Competence or Job Task Analysis to train people in specified tasks. For example: 'Design a Grid Connected (grid-tied) PV system' or 'Install a Grid Connected (grid-tied) PV system' or 'Maintain a Grid Connected (grid-tied) PV system'.

In some areas the term Skill Sets has been introduced where a number of Units of Competence have been combined to provide a specified skill, e.g. Design, Install and Maintain a Grid Connected (grid-tied) PV system.

Under a quality training framework there will be a set of procedures specifying how the Units of Competence will be developed. A committee comprising subject knowledge experts and experienced trainers should undertake the development of the Units of Competence. The subject knowledge experts should include experienced people who are performing the work that the Unit of Competence will cover. Section 4 goes into more detail on how to develop Units of Competence.

To understand the difference in format for different version Units of Competence or Job Tasks Analysis, example of an Australian Unit of Competence for the design of grid connected PV system is shown in Appendix B, while Appendix C shows a Job Task Analysis for the design of Grid Connected PV systems based on the ISP format (refer Section 5). The ISP standard which was originally developed with the purpose to become an international standard was introduced into the Pacific region in 2012. The ISP job task analysis was more focussed on supplying short courses to meet industry needs based on a single task analysis. A list of all the Australian renewable energy Units of Competence is provided in Appendix D. The Australian individual Units of Competence do cover particular tasks but were designed that a number of Units of Competence would complement one another to be a skillset for the industry – e.g. Design and Installation of a Grid connected PV. A full qualification (e.g. Certificate III) would be based on a larger number of Units of Competence being completed.

Case study 3 below provides more information on the renewable energy qualifications available within the Australian Qualifications Framework. Case study 4 provides information on the Job Task Analysis that had previously been developed by the Institute for Sustainable Power (ISP.) To obtain an appreciation of activities that have been undertaken in developing renewable energy training and certification programs, Appendix E summarises activities that have been undertaken

in West Africa (ECREEE), France, India, Kenya, Malaysia Pacific region, Singapore, and United Kingdom.

Case Study 3: Renewable energy qualifications available under the Australian Quality Training Framework

Registered Training Organisations within Australia can offer the following qualifications:

Course Code	Course Title
UEE21307	Certificate II in Remote Area Essential Service
UEE21407	Certificate II in Remote Area Power Supply Maintenance
UEE21507	Certificate II in Renewable Energy
UEE32007	Certificate III in Renewable Energy - ELV
UEE41607	Certificate IV in Renewable Energy
UEE41907	Certificate IV in Electrical – Renewable Energy
UEE50707	Diploma of Renewable Energy
UEE60907	Advanced Diploma of Renewable Energy Engineering
UEE61007	Advanced Diploma of Renewable Energy – Technology

The pathways for these qualifications consist of common Units of Competence used by many qualifications. The renewables/sustainable energy Units of Competence are listed in Appendix D.

If the full descriptor is required for one of the qualifications it can be assessed using the following web address and the XXXXX at the end is replaced by the 5 numbers of the unit:
<https://training.gov.au/Training/Details/UEEXXXXX>

For example, the descriptor for the Certificate IV in Renewable Energy would be available from:
<https://training.gov.au/Training/Details/UEE41607>

Note: The three letters UEE are not an acronym they are used to describe any courses or Units of Competencies developed through the national Electrotechnology Training Package.

Case Study 4: Job Task Analyses Developed by Institute for Sustainable Power ISP

The Institute for Sustainable Power was formed in 1996 to provide third party accreditation of renewable energy training courses worldwide (refer Section 2.5). Through a number of projects, the following Job task Analyses (Units of Competence) were developed:

1. Designer of Grid Connected PV Systems
2. Designer of Solar Based Off-Grid Power Systems
3. Installer and Maintainer of Solar Based Off-Grid Power Systems
4. Installer of Solar Based Off-Grid Power Systems
5. Installer of Grid Connected – Photovoltaic System
6. Designer of Large Grid Connected PV Systems
7. Installer of Large Grid Connected PV Systems
8. Designer of PV (1 or 2 Modules) Solar Home Systems
9. Installer of PV (1 or 2 Modules) Solar Home Systems
10. Designer of Village Central Hybrid Systems
11. Installer of Village Central Hybrid Systems
12. Designer and Installer of Micro (Pico) Hydro Systems
13. Designer and Installer of Biogas Systems
14. Designer of Central Biomass System – Grid Connected
15. Designer and Installer of Village Biomass
16. Designer and Installer of Mini-Grids

Copies of these are available by sending an e-mail to gses@bigpond.com

2.5. Compliance with Standards

The entity that administers the Quality Training Framework will have a mechanism for undertaking audits of training centres when they apply to be approved as a training centre operating within the framework.

This mechanism will require the training centre to complete an application form and provide all the relevant documentation to prove that the training centre will provide quality training programs in accordance with all the requirements of the standards that are an integral part of the Quality Training Framework.

Upon receiving the application, the administering entity will organise a desk top audit followed by an onsite audit of the training centre. The outcome of the audit will be documented and the auditor will either recommend that the training centre is approved or will provide a list of where the training centre has failed to meet the standards. Once all the standards have been met then the training centre will be approved.

This approval could be for one year or up to a period of 5 years. The training centres will need to renew at the expiration date. The renewal process will include a desk top audit of the application and it may or may not require onsite audit. The renewal process is similar to the initial application and the training centre is either approved again or will be required to undertake the necessary improvements in order to comply.

Quality Training Framework's will also include the mechanism for complaints against the training centre to be lodged. When a complaint is received an auditor would be assigned and will investigate the relevance of the complaint with the training centre. Complaints can force the training centre to improve and ensure they comply with the standard. Sometimes complaints can lead to training centres having their approval removed. The process of complaints procedures should be well documented within the operation procedures of the Quality Training Framework.

3. Technician certification/accreditation programs

In a number of countries, third party certification or accreditation of technicians has been implemented. These are either being administered by entities established just to undertake that process or have been developed and administered by the relevant local industry associations.

Being certified/accredited is typically voluntary, although in a number of countries, including Australia and Kenya, it is mandatory. The Australian government has made it a requirement for any funding and subsidy program that the design and installation of PV systems can only be undertaken by accredited designers/installers. Kenya has introduced legislation for Solar Licensing.

As is the case for different quality training frameworks the operation of these certification programs can be different. The North America Board of Certified Practitioners (NABCEP) scheme in USA requires the applicant to undertake an exam conducted by NABCEP, however many applicants do undertake a training course before sitting the exam. NABCEP itself does not offer trainings but rather only tests and accredits applicants. Meanwhile the Clean Energy Council (CEC) accreditation program in Australia recognises the Australian Quality Training Framework and all

applicants must successfully complete the relevant Units of Competence from a Registered Training Organisation.

One thing common in most schemes is that the certification/accreditation is not for life. The different schemes all have renewal processes, which often require the certified/accredited technician to continue professional development or their accreditation will not be renewed. All have a set of rules, and often Codes of Practice or Codes of Ethics that certified/accredited technicians must abide by.

Case Study 5: Clean Energy Council's Accreditation Program

The Australian Accreditation program was launched in 1993. The then industry association, Solar Energy Industry Association of Australia was concerned about stand-alone power systems (off grid solar systems) being oversold/over promised and the industry reputation was being effected.

At the annual conference in 1992 it was decided to introduce a training program and those who passed the training were then accredited as designers and/or installers of Stand Alone Power systems. The program and training was launched in 1993.

At the time, the training program was provided by the Industry Association. However, over the years the industry worked with government and training institutes until renewable energy training was formally part of the electrical national training package within the Australian Quality Training Framework.

The pathways for accreditation then mapped the units of competence that a person must complete before applying for accreditation.

From the late 1990's every state government that introduced a subsidy program required the system to be designed and installed by an accredited person. This was also taken up by the Australian Federal Government when it introduced a subsidy program and it is now a requirement under the renewable energy target (RET) where solar systems are eligible for renewable energy certificates which are traded as part of the RET scheme.

The program has grown and technicians/engineers can be accredited in the following technology applications:

- Design Stand Alone Power Systems
- Install Stand Alone Power Systems
- Design and Install Stand Alone Power Systems
- Design Grid Connected PV Systems
- Install Grid Connected PV systems.
- Design and Install Grid Connected PV systems

and obtain endorsements in:

- Hybrid systems
- Small wind
- Micro Hydro
- Grid Connect with battery storage.

Accredited technicians/engineers must reapply each year based on the requirements of obtaining a specified number of Continual Professional Development Points which are tied to short training programs, conferences, webinars and other professional development activities.

The accreditation program is administered by the Clean Energy Council and further information is available from the website:
<http://www.solaraccreditation.com.au>

Case Study 6: North American Board of Certified Practitioners

The North American Board of Certified Energy Practitioners (NABCEP) offers entry level knowledge assessment, professional certification, and company accreditation programs to renewable energy professionals throughout North America

NABCEP was founded in 2002 as a non-profit 501 (c)(6) corporation with a mission “to support, and work with, the renewable energy and energy efficiency industries, professionals, and stakeholders to develop and implement quality credentialing and certification programs for practitioners.” The first NABCEP Solar PV Installer certification exam (now called PV Installation Professional) was administered in 2003. The Solar Heating Installer certification was first administered in 2006 and the PV Technical Sales Professional was launched in 2011. NABCEP has been running Entry Level examinations since 2006 and the Company Accreditation Program started in 2012.

NABCEP is committed to providing a certification program of quality and integrity for the professionals and the consumers/public it is designed to serve. NABCEP’s programs are administered to the highest standards for certifications and testing. The NABCEP PV Installation Professional and Solar Heating Installer Certifications are accredited to the ISO/IEC 17024 standard by the American National Standards Institute (ANSI). NABCEP understands the importance of impartiality in carrying out its certification activities. NABCEP treats all applicants, candidates, and credential holders fairly and impartially by following the policies and procedures outlined in the Certification Handbook. The organization maintains policies and procedures designed to manage conflicts of interest and to ensure objectivity throughout the certification process.

NABCEP also requires certified individuals to undertake continual professional development as part of their renewal.

Further information is available from the website:
<http://www.nabcep.org>

Case Study 7 : PPA/SEIAPI Certification/Accreditation program

The Pacific Power Association (PPA) and Sustainable Energy Industry Association of the Pacific Islands (SEIAPI) launched a technician certification and company accreditation program in 2012 for the Pacific Island Countries and Territories.

The program requires technicians to undertake training courses before applying for their certification. To be accredited, companies must have a certified technician as part of their staff, or sub-contract a certified technician.

Further information is available from the website:
<http://www.seiapi.org>

4. Introduction of Quality Training into a Country or Region

4.1. Needs and Gaps Assessment

If renewable energy industry stakeholders believe that there is a need for quality training in a region or country, the first step should be undertaking a needs and gap analysis which should identify:

- The current and future market prospects for the various technologies and their applications?
- How many trained people per year are required for each technology application⁴
- Any training programs that are currently available and what training has been conducted in recent years.
- Whether the country or region has an existing quality training framework, and if so:
 - How does it operate?
 - Are there any existing training centres accredited under the framework where renewable energy subjects could be introduced? e.g. already conducting electrical or mechanical training courses.
 - Is there a mechanism for introducing new training courses under the framework and how does it work?

Like any product the supply of quality training should be adequate to meet the demand. There should be sufficient available quality training programs to provide the number of trained technicians per year required by the industry. Conversely, if there are too many training programs available compared to the need for trained technicians in that technology application then either some of the training centres will have nothing to do or the industry suddenly has too many trained technicians and there are insufficient jobs available.

To determine the number of trained technicians needed an analysis of the approximate number of technicians required per MW of installation for each RE technology being deployed within that country should be undertaken and the time taken to install per MW. This is then compared with the anticipated MW of installation per year over the next 3 to 5 years to determine how many technicians will be required each year. The technicians per MW should be obtained from discussions with existing project developers, planners and installers either within that country or from similar countries if it is a new market for that country. For small individual off grid systems then the metrics might be based on number of technicians required per system and how many systems they can install per year. This would then be compared to the anticipated number of systems to be installed over the next 3 to 5 years.

The training programs should be located where the needs are, for example, it is little use offering training in off-grid systems if the training centre is located in a capital city far from where the technicians need to be located.

If there is a quality training framework available for the country or region, the stakeholders (industry, development partners or others) wanting to introduce quality training should

⁴ Note: The term technology application refers to how a technology is applied, for example the market for grid connected PV systems is a completely different market to small off grid solar home systems.

thoroughly investigate how renewable energy training courses could be introduced within that framework. As described in Section 2, the framework could consist of a standard setting out how training centres operate and related standards or requirements detailing how units of competence and qualifications are to be developed and applied.

With respect to the operational standard for training centres, the stakeholders wanting to introduce quality training either have to work with training centres that are already approved and/or if training centres offering renewable energy training already exist, to encourage them or work with them, to apply for accreditation through the framework. However non-accredited training centres may only be able to apply for accreditation once there are approved renewable energy courses within the framework.

If there is no existing training framework, training centres should as a minimum be encouraged to implement quality management systems, but ideally to the level that the framework would meet and similar to those in other accredited training centres. Section 5 provides detailed examples of what these requirements are in some frameworks.

To introduce quality renewable energy training within a framework, the stakeholders must identify the process required to introduce any new course into the framework. The framework would comprise procedures for doing this and these must be followed. The development of the Units of Competency must also follow a standard process and this is detailed in Section 4.2. With respect to the procedures for introducing courses within a framework, this often requires an entity that administers the approval of new courses. This could be one entity for all industries or it might be broken down to different entities for different types of industry.

One issue to be resolved within a framework is the level of courses able to be approved. What this means is that the framework might focus on the approval of qualifications only, such as certificate courses through to diploma level courses. For a relatively young industry such as renewables, this could be a barrier. The Certificate courses might be courses in the range of say 6 months to 3+ years of training, whereas the industry needs short specific skills based courses delivered now that might be of duration of only 1 week up a number of weeks. Hence consideration should be given to Units of Competence being developed that focus on particular technology applications e.g. installation of grid connected PV systems, with these units being incorporated into an existing certificate course (e.g. electricians training) or being included with other new and existing units to build into a new certificate course directly related to renewable energy. With the second approach existing industry people could gain or improve their skills via a short course consisting of Units of Competence in a particular technology application that meets the immediate industry needs. Over a period of time, students could undertake a number of courses based on Units of Competence that aggregate to a qualification e.g. Certificate III in Renewable Energy.

Once the industry has sufficient numbers of trained technicians to meet the current market demands, all new industry entrants should be required to undertake the complete set of qualification courses.

4.2. Development of Units of Competence

A training course, which has been developed by one training centre or in particular one trainer, does not necessarily result in the course teaching all the knowledge and skills that should be taught. The objective of a Unit of Competence is to ensure that it is structured to include all the knowledge and skills that a person needs to competently perform a task. For this reason, Units of Competence developed under a quality training framework will typically need to be developed by

a committee comprising people from industry; the training centres and other interested stakeholders.

Quality training frameworks endorse or approve Units of Competence and thus Qualifications that follow a minimum process where:

- The contents of the Unit of Competence are developed via a committee; and
- There is regular review of the Unit of Competence.

Where stakeholders want to introduce quality training within a country or region experience has shown that it is essential to obtain “buy-in” by the local renewable energy industry. Since many of the industry participants have had no experience in the development of quality training and though they want their technicians trained they sometimes see the process for developing quality training as a barrier to their often new industry. When introducing quality training one of the key activities will be the formation of an entity that oversees the development of the required Units of Competence and the local industry must have some involvement with this entity. This section is aimed at helping the renewable energy industry stakeholders (and possibly other stakeholders) understand how competency standards are developed. In addition, it recalls the fact that this is a process where they can be involved.

The entity which develops Units of Competence might be a committee comprising the major stakeholders such as representatives from: key government departments or ministries; the major industry players or if they exist, industry associations; the donor community, training centres, universities and interested individual or bodies. For quality training development to proceed, it requires that the entity/committee formed has the credibility and respect amongst the stakeholders so that they can endorse/approve the Units of Competence once they have been developed. Alternatively, the entity can submit the Units of Competence to a recognised body within a quality training framework for endorsement/approval.

Under a quality training framework, these entities will be recognised and will have a described role as part of the framework. In some frameworks these entities have been selected to represent certain industries. Their role is to act as the administrative unit in the development and maintenance of Units of Competence and to submit them for approval.

This administrative entity or committee would oversee the development of sub-committees whose role is to actually develop the Units of Competence. These are sometimes called Technical Advisory Committees or similar and comprise the independent subject matter experts, experts from industry and the training centres who undertake the development and ongoing reviews of the Units of Competence. Depending on the number of different technologies and applications, many different technical advisory committees could exist.

Since the process for developing the Units of Competence follows a similar process to that used for the development of product and installation standards, the Units of Competence can be recognised as Competency Standards.

The formal development of Units of Competence is a key function in establishing quality training for any industry. Even without having a national Quality Training Framework, if the relevant stakeholders introduce the appropriate oversight committee and technical advisory committees, this is an excellent start to introducing quality training programs. The major issue is that without the framework, there is no way to confirm that training centres are training in accordance to the requirements of the Units of Competence. This could be achieved by the entity having oversight of the development of the Units of Competence also introducing a process whereby training

centres can apply for approval to teach in accordance with the Unit of Competence as well as auditing procedures for the approvals process.

4.3. Developing pathways to Qualifications

While the Unit of Competence has been developed a decision needs to be made whether they will just be used for short courses such as: Design and Install Grid Connect (Tied) PV systems; Design and Install Off Grid Systems or whether full certificate level qualifications need to be developed. For such full certificate level qualifications pathways need to be developed mapping which Units of Competence are required for the different qualifications.

Building Capacity of Training Centres

Once the Units of Competence, and hence pathways to qualifications, have been identified and developed, the building of capacity within the training centres is required. This includes:

- experienced renewable energy trainers conducting training the trainer courses;
- development of trainer guides;
- development of training resources including PowerPoint presentations, related course manuals, practical exercises and assessment material; and
- procurement of equipment and tools to facilitate the hands on training.

4.4. Introducing a Technician certification/accreditation program

Some countries, which have introduced quality training in renewable energy, have also introduced programs to certify, accredit or license the technicians once they are qualified. Section 2.5 provides some examples, however one thing common to many of these programs is the requirement for ongoing training for technicians to maintain their certification/accreditation. In addition to increasing the quality of the technicians and keeping them up to date with new developments, these programs also support the need for training centres to be able to provide ongoing professional development courses for the industry.

5. What if there is no country Quality Training framework for the Vocational Training Sector?

If renewable energy stakeholders within a region or country want to have quality training available, then it is recommended that:

1. From the gaps and needs analysis as recommended in Section 4.1 a list should be developed prioritising the different **types of technology applications** for which training is required.
2. Relevant **technical committees** should be formed for the development of the Units of Competence.
3. Develop and form the **overriding committee** or entity that endorses the units when the technical committee completes them. There should be a policy for review of the Units.
4. Develop the **minimum quality management standard** that training centres should follow.
5. Investigate a **funding structure** so that the costs of administration are covered.

Implementing the above should result in training being available at least to a minimum standard, however, experience, from similar projects in countries without a quality-training framework, has shown that it relies very much on a "voluntary" structure instead of a sustainable structure. In the voluntary structure it relies on the committees being managed by volunteers whose interest could change and therefore reduce their effort and it also means that the training centres are voluntarily following all the requirements, not forced to follow the Units of Competence. Hence it is questionable whether it will remain operating in the long term

The ideal structure is one that is **part of the education system of the country**, but this might not be possible or it might take many years to develop and implement.

Given the fact that there are countries that do not have a Quality Training Framework established, the question for the International Renewable Energy Industry is: ***Is there need for an international body that can provide third party accreditation of renewable energy technical training courses?***

This is not a new idea and it has been tried before. The Institute for Sustainable Power (ISP) was formed in 1996 with the objective of providing third part accreditation for renewable energy, energy efficiency and distributed generation training programs (refer Case Study 8).

Over the years there has been a lot of work undertaken in promoting the Institute for Sustainable Power Quality ISPQ third party accreditation of RE and EE training programs but unfortunately it has been only in the USA where it gained traction. Examples of some of the activities of ISP include:

1. In the ASEAN region from 2004 a 3 years program established all the necessary committees and task analyses for quality training programs but with the exception of a training centre in Malaysia no other country was in the position to have training institutes accredited against the ISP standard.
2. A similar project was undertaken in China from 2009 to 2012 resulting in a few accredited training programs but again it did not progress after the project was completed.
3. In Europe, Brazil and Ghana a few institutes have been accredited.

Part of the issue was that, though every stakeholder thought third party accreditation of training programs was required, many of the training institutes did require assistance to improve their own internal practices to meet the standard and ISP was being run by volunteers with limited time available to provide this support. At the time, there was also only a small number of available training centres that were spread around the world, so it was not financially viable for ISP operating just as an entity accrediting training centres and providing the support services they required. IREC who bought the ISP standard was able to make it viable in the USA after a number of years because accrediting training centres was not its only activity meaning IREC was based on a number of different sources of funding / income, and the training market in USA grew rapidly.

However the industry has grown exponentially since the time the above projects were undertaken. Today, there is a greater interest in quality renewable energy training programs and therefore the question is legitimate: has the time come for an international body to operate a global program that caters for the countries where there is no existing quality training framework?

This investigation would require a global study identifying:

- How many countries do not have quality training frameworks for technician level training?
- How many of these countries require RE technician level training?

This information would help identify if there is a real need for a new international entity or not. If there is no need the study should provide recommendations on what should be done to facilitate quality training being conducted in those countries without a framework.

If the study does identify that there is a need for an international body which could accredit RE training centres, the challenges include, but are definitely not limited to:

- Selecting the body and then the development of the actual framework that would be internationally accepted.
- How are the international committees formed for developing the Units of Competence?
- How are the auditors selected for undertaking the audits of the training centres?
- The logistics in undertaking the audits.
- Managing complaints including those from training centres who fail audits and also against training centres not delivering in accordance with the framework.

Though challenges all of these can be overcome. **The biggest challenge is how is it funded and sustainable?** National frameworks are usually established by governments but the training centres do pay for their own accreditation which each is set to cover the costs of administering the framework. In countries like Australia, where training must be provided by Registered Training Organisations, the fees make it sustainable. An international body might be able to operate as the “entity” that will oversee the development and administration of the framework but having a fee structure that is both affordable and covers real costs globally will be a major challenge. Possible options could be organisations such as IRENA (www.irena.org), International Solar Energy Society (www.ises.org), IEC-Renewable Energy (IEC-RE), the Clean Energy Ministerial (<http://www.cleanenergyministerial.org/>) or the Global Solar Council (<http://www.globalsolarcouncil.org>). Funds could be pooled and a country by country (or region by region) structure established, possibly including initial subsidy elements for training centres.

Case Study 8: Institute for Sustainable Power

The **Institute for Sustainable Power (ISP)** is a non-profit organization, incorporated in 1996, to coordinate, develop, and maintain international standards for the education and qualification of renewable energy (RE), energy efficiency (EE), and distributed generation (DG) providers.

The goal of the ISP's Quality (ISPQ) credentialing process is to improve and expand the renewable energy, energy efficiency, and distributed generation industries by:

- raising the level of training quality, competency, and availability;
- encouraging safety and the training of safe practices in the industry;
- supporting training programs by providing guidance and consensus standards on the content and delivery of courses.

The ISPQ accreditation and certification programs began development in 1996 by the Institute of Sustainable Power (ISP) under the direction and leadership of Mark Fitzgerald. International renewable energy, education, training, and accreditation experts worked to create ISPQ Standard 01021, which provides the guidelines and sets the bar for the accreditation of training programs and the certification of trainers in the renewable, distributed generation and energy efficiency fields. The objectives of the Standard are:

- To provide training programs worldwide with harmonized training content and delivery guidance for the knowledge and skills competencies for the renewable energy, distributed generation and energy efficiency workforces;
- To increase the confidence level that industry, employers, consumers, financiers, and governments can have in the participating training programs and trainers by providing a globally accepted process of evaluation and surveillance (audit and periodic re-evaluation) of training programs and trainers, and periodic re-evaluation of the standards; and
- To encourage safety and the training of safe practices within the industry.

The ISPQ Regional Licenses accredited training institutes and certified trainers on behalf of ISP. Organizations accredited by the ISPQ Regional Licensees, and individuals certified, attest that they have the skills and resources to deliver high-quality training covering the skills and competency requirements of specific RE/EE/DG trades.

From 2005 to 2010 there were 3 licensees:

- Interstate Renewable Energy Council IREC - United States
- Institute for Sustainable Power Quality ISPQ - Europe
- Global Sustainable Energy Solutions (GSES) , Pty Ltd - Australia (concentrating on Asia and Pacific)

with a fourth starting in 2010:

- Institute for Sustainable Power, Inc. - China.

Each Licensee was responsible for the full accreditation and certification cycle including processing applications, assigning registered auditors, awarding the credential, and maintaining all records of applicants, candidates and certificates. Unfortunately, except for IREC the licensees were not able to remain operational. In the USA the demand for training grew to match the industry growth and hence IREC had a market for training centres to apply for accreditation. At the time there was insufficient demand for training and for accredited training centres in Europe, Asia and Pacific and the other licensees were not viable.

In 2011 the then regional and most active licensee IREC in the United States, took over ownership of the standards and still licensed the standard to regional licensees.

Currently there is an ISP board, which still believes in the original vision of the founder but it has been struggling. The president of the board is Geoff Stapleton of GSES and there is an executive director (volunteer) based in Washington, Mr Jack Werner.

Contact: Jack F. Werner, Jr. Executive Director, ISP e-mail: jackfwerner@aol.com

6. Conclusion

Many well established, mature industries have embedded their training requirements within the national technical education structure. It is time that this becomes the norm for the Renewable Energy Industry world-wide.

This document provides a brief overview of a Quality Training Framework and in particular the key standards required for the framework to operate. Ideally the renewable energy stakeholders who want quality training for the industry should work with the relevant Government and education stakeholders to introduce renewable energy training courses into any existing national Quality Training Frameworks.

If a Quality Training Framework does not exist, this document briefly outlines what is required to at least improve the quality of the training within a country or region.

However, more importantly if a real need is identified, the global Renewable Energy Industry and Stakeholders must decide if it is time to introduce a sustainable global framework for the third party accreditation of renewable energy training programs in those countries without a framework. This will provide a platform whereby renewable energy technicians in those countries without a framework have more or less equivalent qualification.

7. Appendix A: Requirements of a Quality Training Centre

Section 2.3 provides an overview of the operational requirements that a training centre might be required to meet when applying to be accredited within a national quality training framework. Many of these are standard requirements, which any business would meet when operating within a typical quality management system. Analysis of the many different quality training frameworks shows that they have very similar requirements often just presented slightly differently. They are also amended and updated regularly similarly to what happens with standards.

This appendix provides an overview of two actual standards, namely the “Australian Skills Quality Authority Standard for Registered Training Organisations” and “the Interstate Renewable Energy Council Standard 01023: 2013: General Requirements for the Accreditation of Clean Energy Technology Training”. These have been selected because they have each been applied to RE technician level for over 10 years.

The objective is to provide an appreciation of how standards can be similar but presented in different formats. Training centres in Australia (RTO's) would be accredited as Registered Training Organisations once they have been successfully audited proving they meet the requirements of the Australian Skills Quality Authority Standard for Registered Training Organisations. While training centres in North America would be accredited once they have been successfully audited proving they meet the requirements of the Interstate Renewable Energy Council Standard 01023: 2013.

7.1. Australian Standards for Registered Training Organisations

Note: The Information contained in this section is from the "Users Guide to the Standard for Registered Training Organisations" available from website:

http://www.asqa.gov.au/verve/resources/Users_Guide_to_the_Standards_for_Registered_Training_Organisations_RTOs_2015.pdf

The Australian Standard for RTOs comprises eight standards. The guide referenced above is a 110 page document that explains in detail how the standards apply to the RTOs and what RTOs must do to prove compliance. The following is a summary of the requirements for each of the eight standards.

Standard 1: The RTO's training and assessment strategies and practices are responsive to the industry and learners needs and meet the requirements of training packages and VET accredited courses.

Under this standard RTOs shall

- implement a comprehensive training and assessment strategy;
- engage with industry;
- support learners;
- conduct effective assessment;
- employ skilled trainers and assessors;

- provide supervision of trainers where needed;
- employ experts to teach trainers and assessors; and
- manage transitions from superseded training products

Standard 2: The operations of the RTO are quality assured.

Under this standard RTOs shall:

- implement quality assurance strategies; and
- monitor independent third parties who provide services on behalf of the RTO.

Standard 3: The RTO issues, maintains and accepts AQF certification documentation in accordance with these Standards and provides access to learner records.

Under this standard RTOs shall:

- provide secure certification; and
- provide credit for prior studies.

Standard 4: Accurate and accessible information about an RTO, its services and performance is available to inform prospective and current learners and clients.

Under this standard RTOs shall:

- provide accurate information to learners about services and qualifications.

Standard 5: Each learner is properly informed and protected.

Under this standard RTOs shall:

- inform and protect learners.

Standard 6: Complaints and appeals are recorded, acknowledged and dealt with fairly, efficiently and effectively.

Under this standard RTOs shall:

- manage complaints and appeals fairly.

Standard 7: The RTO has effective governance and administration arrangements in place

Under this standard RTOs shall:

- ensure authorised executive officers are in place;
- assess financial viability risk;
- protect prepaid fees by learners;
- hold public liability insurance; and
- provide accurate information about performance and governance.

Standard 8: The RTO cooperates with the VET Regulator and is legally compliant at all times.

Under this standard RTO's shall:

- provide requested information to Australian Skills Quality Authority (ASQA);
- notify ASQA regarding third party agreements;
- make an annual declaration on compliance with the Standards; and
- comply with all relevant legislative and regulatory requirements.

7.2. Interstate Renewable Energy Council Standard 01023: 2013: General Requirements for the Accreditation of Clean Energy Technology Training

Note : The Information contained in this section is from the "Interstate Renewable Energy Council Standard 01023: 2013: General Requirements for the Accreditation of Clean Energy Technology Training" and is available from website:

<http://www.irecusa.org/standards-development/training-programs/>

The following is the contents page of the standard, which provides a summary of the requirements that a training centre must meet to become accredited. The standard provides the requirements in detail. The contents include:

1. Scope
2. Referenced Documents
3. Terminology
4. General Requirements
 - 4.1. Legal Entity
 - 4.2. Financial Fitness
 - 4.3. Training Delivery Experience
5. Ethical Practices
 - 5.1. Non-Discrimination
 - 5.2. Avoiding Conflicts of Interest
 - 5.3. Confidentiality
 - 5.4. Release of Information
6. Administration and Management
 - 6.1. Organizational Goals
 - 6.2. Commitment to Quality
 - 6.3. Commitment to Continuous Improvement
 - 6.4. Management System
 - 6.5. Record-Keeping
 - 6.6. Stakeholder Input
 - 6.7. Complaint, Dispute and Appeals
 - 6.8. Information for Students
7. Safety
 - 7.1. Commitment to Safety and Safe Practices
8. Training Content
 - 8.1. Curricula and Syllabi
 - 8.2. Curriculum Management
 - 8.3. Student Learning Assessment Methodology
9. Training Delivery
 - 9.1. Facilities
 - 9.2. Continuity of Training Delivery
 - 9.3. Instructor-Student Interaction
 - 9.4. Library Resources
 - 9.5. E-learning
10. Training-Related Personnel
 - 10.1. Written Job Descriptions
 - 10.2. Organizational Structure
 - 10.3. Competency Requirements and Performance Evaluation

8. Appendix B: Example of Australian Unit of Competence

Note: Australian Government owns the copyright to the material contained in this appendix.

UEENEEK148A Install, configure and commission LV grid connected photovoltaic power systems

Modification History

Not applicable.

Unit Descriptor

Unit Descriptor

1) Scope:

1.1) Descriptor

This unit covers the installation, adjustment and set-up of photovoltaic power systems and connecting to a supply grid inverter. It encompasses working safely and to installation standards, matching components with that specified for a given location, placing and securing system components accurately, making required circuit connections and completing the necessary installation documentation.

Application of the Unit

Application of the Unit 2)

This competency standard is suitable for employment-based programs under an approved contract of training at the AQF level of the qualification in which the unit is first packaged or higher.

The unit may be selected as an elective from the relevant schedule (see qualification packaging rules) provided that all prerequisite units are undertaken or addressed through recognition processes.

This unit may be included in a skill set provided that it is listed in the schedule of electives (see Qualification Framework) and all prerequisite units are undertaken or addressed through recognition processes.

Delivery and assessment of this unit should be undertaken within regard to the requirements of License to Practice (1.2 above), Prerequisite Competencies and Literacy and Numeracy skills (2 above) and the recommendations for concurrent assessment and relationship with other units (9.5 below).

Practice in the workplace and during training is also subject to regulations directly related to occupational health and safety and where applicable contracts of training such as apprenticeships.

Note:

1. Compliance with permits may be required in various jurisdictions and typically relates to the operation of plant, machinery and equipment such as elevating work platforms, powder operated fixing tools, power operated tools, vehicles, road signage and traffic control and lifting equipment. Permits may also be required for some work environments such as confined spaces, working aloft, near live electrical apparatus and site rehabilitation.

2. Compliance may be required in various jurisdictions relating to currency in First Aid, confined space, lifting, risk safety measures etc.

Licensing/Regulatory Information

License to practice

3)

The skills and knowledge described in this unit require a license to practice in the workplace subject to regulations for undertaking of electrical work. Practice in workplace and during training is also subject to regulations directly related to occupational health and safety and where applicable, contracts of training such as apprenticeships.

Note.

Competency requirements to be granted a license to carry out installations, fault finding, repair or maintenance on low voltage electrical installations is incorporated in unit UEENEEG105A and all prerequisite units it specifies

Pre-Requisites

Prerequisite Unit(s)

4)

Competencies

4.1)

Granting competency in this unit shall be made only after competency in the following unit(s) has/have been confirmed.

UEENEEK125A Solve basic problems in photovoltaic energy apparatus and systems

UEENEEG103A Install low voltage wiring and accessories

Literacy and numeracy skills 4.2)

Participants are best equipped to achieve competency in this unit if they have reading, writing and numeracy skills indicated by the following scales. Description of each scale is given in Volume 2, Part 3 'Literacy and Numeracy'

Reading 3 Writing 3 Numeracy 3

Employability Skills Information

Employability Skills 5)

The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit of competency is packaged will assist in identifying Employability Skill requirements.

Elements and Performance Criteria Pre-Content

6) Elements describe the essential outcomes of a competency standard unit Performance Criteria describe the required performance needed to demonstrate achievement of the element. Assessment of performance is to be consistent with the Evidence Guide.

Elements and Performance Criteria

ELEMENT

PERFORMANCE CRITERIA

1 Prepare to install photovoltaic power systems.	1.1	OHS procedures for a given work area are obtained and understood
	1.2	Health and safety risks are identified and established risk control measures and procedures in preparation for the work are followed
	1.3	Safety hazards that have not previously been identified are noted and established risk control measures are implemented
	1.4	Installation of the system is prepared in consultation with others effected by the work and sequenced appropriately
	1.5	The nature and location of the work is determined from documentation or appropriate person to establish the scope of work to be undertaken
	1.6	Location of system components is planned within the constraints of the building structure, significants and regulations

ELEMENT**PERFORMANCE CRITERIA**

	1.7	Advice is sought from appropriate persons to ensure the work is coordinated effectively with others
	1.8	Material needed for the installation work is obtained in accordance with established procedures and checked against job requirements
	1.9	Tools, equipment and testing devices needed to for the installation work are obtained in accordance with established procedures and checked for correct operation and safety
	1.10	Preparatory work is checked to ensure no damage has occurred and complies with requirements
2	Install photovoltaic power systems.	
	2.1	OHS risk control measures and procedures for carrying out the work are followed (Note 1: risk control measures need to incorporate risks associated with dc voltages of extra low voltage and low voltage levels)
	2.2	The need to test or measure live is determined in strict accordance with OHS requirements and when necessary conducted within established safety procedures
	2.3	Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures
	2.4	System components are installed to comply with technical standards and job specifications and requirements with sufficient access to affect terminations, adjustment and maintenance (Note 2: hazards relating to photovoltaic energy apparatus and isolation need to specifically address issues of dc arcing and suitable dc protection systems for dc voltages of extra low voltage and low voltage levels.)
	2.5	Wiring is terminated at components and associated equipment in accordance with manufacturer specifications and functional and regulatory requirements
	2.6	Established methods for dealing with unexpected situations are discussed with appropriate person or persons and documented
	2.7	Unexpected situations are dealt with safely and with the approval of an authorised person

ELEMENT	PERFORMANCE CRITERIA
	2.8 Ongoing checks of the quality of installed apparatus are undertaken in accordance with established procedures
	2.9 System installation is carried out efficiently without waste of materials or damage to apparatus, circuits, the surrounding environment or services and using sustainable energy principles
3 Completion and report installation activities.	3.1 OHS work completion risk control measures and procedures are followed
	3.2 Work site is cleaned and made safe in accordance with established procedures
	3.3 Final checks are made so that the installed apparatus conforms to requirements
	3.4 'As-installed' apparatus and associated equipment is documented and appropriate person(s) notified in accordance with established procedures

REQUIRED SKILLS AND KNOWLEDGE

8) This describes the essential skills and knowledge and their level, required for this unit.

Evidence must show that knowledge has been acquired of safe working practices and installing and setting up LV grid connected photovoltaic power systems.

All knowledge and skills detailed in this unit should be contextualised to current industry practices and technologies.

KS01- EK148A Photovoltaic LV installations

Evidence shall show an understanding of LV photovoltaic array grid connection to the extent indicated by the following aspects:

REQUIRED SKILLS AND KNOWLEDGE

- T1 PV array installation requirements encompassing:
- OH&S requirements and methods for working on roofs.
 - common methods of roof construction (rafters and tile battens) and methods to ensure integrity of waterproofing.
 - common types of roof mounted and free-standing PV array frame construction and methods of tilt angle adjustment.
 - fixing methods for different roof types.
 - array mounting methods for north orientation roof sections and non-north facing roof sections.
 - aesthetic considerations in choosing an appropriate array location and type of mounting.
 - the mounting and fixing methods for at least one type of commercially available building integrated PV product.
- T2 Electrical PV array installation requirements encompassing:
- methods used in wiring and connecting PV arrays as per the Australian Standards AS 4509 and AS5033
 - considerations involved in wiring of series connected PV modules in order to minimise power losses due to shading.
 - PV array wiring diagram including the placement of blocking and bypass diodes.
 - considerations involved in choosing the location of associated system equipment including regulators, d.c. control board, inverters and inverters for grid connected systems.
 - cable route from PV array/s to inverters so as to minimise the route length.
- T3 System installation and maintenance encompassing:
- installation work on a PV power system in accordance with relevant standards and OH&S guidelines.
 - correct isolation and shutdown procedures prior to carrying out maintenance tasks.
 - routine maintenance tasks on PV arrays.
 - required vegetation control to remove or reduce shading or soiling on a PV array
- T4 Inverters encompassing:
- types of inverters used in grid connected systems.
 - AS symbol for a low voltage inverter
 - the basic function of an inverter.
 - simple block diagram of a typical inverter used in grid connected system
- T5 Inverter operation encompassing:
- the basic principle of operation of a single phase inverter

REQUIRED SKILLS AND KNOWLEDGE

- (using switch analogue)
 - the operation of an inverter bridge and half-bridge configuration.
 - operation of a FET inverter
 - connection of a grid inverter and measurement of the inverter parameters for various loads
- T6 Inverter characteristics encompassing:
- the characteristics which distinguish inverters suitable for grid connected photovoltaic array application from standard inverters.
 - using waveform diagrams, the function of PWM techniques in square wave, modified square wave and synthesised sine wave inverters
 - output voltage waveforms for square wave, modified square wave and synthesized sine wave inverters showing typical voltages and periodic times
 - the six (6) essential inverter specifications
- T7 PV grid connected system operation encompassing:
- block diagram of a PV grid connected system.
 - operation of grid interactive PV systems including synchronisation, safety feature, power flow control, passive and active anti-islanding, and metered energy for systems.
 - schematic diagrams of common grid connected inverter circuit configurations including metering arrangements, isolation and connection with respect to RCDs in accordance with AS 4777.1.
- T8 Installation of grid connected inverters encompassing:
- major installation requirements for all system components which will ensure correct operation, long life, safety and ease of maintenance consistent with AS 4509, AS 4086.2, AS/NZS 3000 and relevant OH&S guidelines
 - selection of a suitable location for the PV array, inverter and other components, at a given installation site in accordance with AS2676.2 and AS3011.2, and the considerations given in AS4509 and AS4086.2.
 - typical installation configurations for grid connection of energy systems via inverters
 - the function and operation of a "grid protection device" as specified in AS4777
 - array wiring plan for series connected modules to minimise power loss due to shading at a particular site.
 - installation requirements for a grid connected system.
 - labelling and signage requirements for switchboards supplied with power from grid connected inverters, as set

REQUIRED SKILLS AND KNOWLEDGE

- out in AS 4777.1.
 - the additional requirements for UPS systems as specified in AS4777.1.
 - installation of a PV grid connected system
- T9 System commissioning and maintenance encompassing:
- the isolation procedures required for grid connected inverters.
 - relevant commissioning procedures including start-up and shut-down procedures for grid connected inverter systems in accordance with AS 4509.
 - testing a grid connected inverter system for correct operation.
 - location and rectification of an electrical fault within a PV array/inverter and wiring.
 - maintenance schedule for a grid connected PV power system.
 - performing commissioning work on a PV power system in accordance with AS 4509, AS 4086.2, AS/NZS 3000 and AS 3010.1

Evidence Guide

9) This provides essential advice for assessment of the unit and must be read in conjunction with the performance criteria and the range statement of the unit and the Training Package Assessment Guidelines.

The Evidence Guide forms an integral part of this unit. It must be used in conjunction with all parts of this unit and performed in accordance with the Assessment Guidelines of this Training Package.

Overview of Assessment 9.1)

Longitudinal competency development approaches to assessment, such as Profiling, require data to be reliably gathered in a form that can be consistently interpreted over time. This approach is best utilised in Apprenticeship programs and reduces assessment intervention. It is the industry-preferred model for apprenticeships. However, where summative (or final) assessment is used it is to include the application of the competency in the normal work environment or, at a minimum, the application of the competency in a realistically simulated work environment. In some circumstances, assessment in part or full can occur outside the workplace. However, it must be in accordance with industry and regulatory policy.

Methods chosen for a particular assessment will be influenced by various factors. These include the extent of the assessment, the most effective locations for the assessment activities to take place, access to physical resources, additional safety measures that may be

required and the critical nature of the competencies being assessed.

The critical safety issues inherent in working with electricity, electrical equipment, gas or any other hazardous substance/material present a challenge for those determining competence. Sources of evidence need to be 'rich' in nature to minimise error in judgment.

Activities associated with normal everyday work have a bearing on the decision as to how much and how detailed the data gathered will contribute to its 'richness'. Some skills are more critical to safety and operational requirements while the same skills may be more or less frequently practised. These points are raised for the assessors to consider when choosing an assessment method and developing assessment instruments. Sample assessment instruments are included for Assessors in the Assessment Guidelines of this Training Package.

**Critical aspects
of evidence
required to
demonstrate
competency in
this unit**

9.2)

Before the critical aspects of evidence are considered all prerequisites must be met.

Evidence for competence in this unit must be considered holistically. Each element and associated performance criteria must be demonstrated on at least two occasions in accordance with the 'Assessment Guidelines – UEE11'. Evidence must also comprise:

A representative body of work performance demonstrated within the timeframes typically expected of the discipline, work function and industrial environment. In particular this must incorporate evidence that shows a candidate is able to:

- Implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria and range statement
- Apply sustainable energy principles and practices as specified in the performance criteria and range statement
- Demonstrate an understanding of the essential knowledge and associated skills as described in this unit. It may be required by some jurisdictions that RTOs provide a percentile graded result for the purpose of regulatory or licensing requirements.
- Demonstrate an appropriate level of skills enabling employment
- Conduct work observing the relevant Anti Discrimination legislation, regulations, policies and workplace procedures

Demonstrated consistent performance across a representative range of contexts from the prescribed items below:

- Install and set up grid connected photovoltaic power systems as described in 8) and including:

- | | |
|---|---|
| A | Reading and interpreting drawings related to and apparatus locations and circuit connections |
| B | Placing and securing system components accurately |
| C | Maintaining fire integrity |
| D | Connecting system components to comply with requirements |
| E | Dealing with unplanned events by drawing on essential knowledge and skills to provide appropriate solutions incorporated in a holistic assessment with the above listed items |

Context of and specific resources for assessment

9.3)

This unit should be assessed as it relates to normal work practice using procedures, information and resources typical of a workplace. This should include:

- OHS policy and work procedures and instructions.
- Suitable work environment, facilities, equipment and materials to undertake actual work as prescribed by this unit.

These should be part of the formal learning/assessment environment.

Note:

Where simulation is considered a suitable strategy for assessment, conditions must be authentic and as far as possible reproduce and replicate the workplace and be consistent with the approved industry simulation policy.

The resources used for assessment should reflect current industry practices in relation to installing and setting up LV grid connected photovoltaic power systems.

Method of assessment

9.4)

This unit shall be assessed by methods given in Volume 1, Part 3 'Assessment Guidelines'.

Note:

Competent performance with inherent safe working practices is expected in the Industry to which this unit applies. This requires assessment in a structured environment which is intended primarily for learning/assessment and incorporates all necessary equipment and facilities for learners to develop and demonstrate the essential knowledge and skills described in this unit.

**Concurrent
assessment and
relationship with
other units**

9.5)

For optimisation of training and assessment effort, competency development in this unit may be arranged concurrently with unit:

UEENEEK125A Solve basic problems in photovoltaic energy apparatus and systems

The critical aspects of occupational health and safety covered in unit UEENEEE101A and other discipline specific occupational health and safety units shall be incorporated in relation to this unit.

•

RANGE STATEMENT

10) This relates to the unit as a whole providing the range of contexts and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

This unit must be demonstrated in relation to installing photovoltaic power systems in at least two different types of premises construction or environment.

Generic terms used throughout this Vocational Standard shall be regarded as part of the Range Statement in which competency is demonstrated. The definition of these and other terms that apply are given in Volume 2, Part 2.1.

Unit Sector(s)

Not applicable.

Competency Field

Competency Field 11)

Renewable and Sustainable Energy

...

9. Appendix C: Job task Analysis Based on ISP format

Objectives and Task Analysis for the Installer of Grid Connect – Photovoltaic System

Introduction

This document presents an in-depth task analysis (job analysis or key skills analysis) for practitioners who install, and maintain photovoltaic (PV) power generation systems and equipment for grid connect system.

The purpose of this task analysis is to define a general set of competencies and/or skills typically required of practitioners who install and maintain PV systems. Specifically, the task analysis helps establish the basis for training curricula, and helps define requirements for the assessment and credentialing of practitioners. These tasks, or modified version thereof, may be used as guidelines for organisations that wish to train, test, certify, or otherwise qualify existing or new workers to install PV systems. The principal goals of these efforts are to help develop an accredited training infrastructure that produces a knowledgeable, skilled, and experienced workforce, thus helping to ensure the safety, quality, and consumer acceptance of PV installations.

Scope

This task analysis is intended to be all-inclusive of the skills expected for any qualified PV installer, and does not differentiate skills or experience that may be common among existing tradespersons. Furthermore, this list only defines what the tasks are, not how they are accomplished – these issues are mainly dealt with through training and assessment mechanisms. In general, these tasks include fundamental electrical skills expected of journeymen electricians, as well as special skills related to PV technology and its application.

Fundamentally, these tasks assume that the installer begins with adequate documentation for the system design and equipment, including manuals

for major components, electrical and mechanical drawings, and instructions. While these tasks have been developed based on conventional designs, equipment, and practice used in the industry today, they do not seek to limit or restrict innovative equipment, designs, or installation practice in any manner. As with any developing technology, it is fully expected that the skills required of the practitioner will develop and change over time, as new materials, techniques, codes, and standards evolve.

Specific tasks in this document are classified as either *cognitive* or *psychomotor* skills for the purposes of identifying the types of training and assessment methods that generally apply. Cognitive skills require knowledge processing, decision-making, and computations, and can generally be assessed by a written examination. Psychomotor skills require physical actions and hand-eye coordination such as fastening, assembling, measuring, etc., and more appropriately assessed through qualified experience. The tasks are also ranked according to their priority or importance. *Critical* items are considered high priority tasks, and are expected competencies for all PV installers. These include items involving safety and other tasks with a high consequence and high chance of error. *Very Important* items are medium priority tasks, and are generally expected of all competent installers. *Important* items are considered lower priority tasks, but usually performed or understood by the quality installer.

Primary Objective for the PV Installer

Given basic instructions, major components, schematics, and drawings, the PV installer is required to specify, configure, install, inspect, and maintain a grid-connected PV system that meets the performance and reliability needs of the customer, incorporates quality craftsmanship, and complies with all applicable safety codes and standards by:

- 1. WORKING SAFELY WITH PHOTOVOLTAICS SYSTEMS**
- 2. INTERPRET SYSTEM DRAWINGS AND SYSTEM DESIGN**
- 3. DEMONSTRATING INSTALLATION TECHNIQUES FOR ALL SYSTEM COMPONENTS**
- 4. SPECIFYING ALL SYSTEM CABLING AND SYSTEM PROTECTION DEVICES**
- 5. DEMONSTRATE PRACTICAL CABLING AND FINAL SYSTEM INSTALLATION,**
- 6. TESTING AND COMMISSIONING PROCEDURES**
- 7. MAINTAIN AND TROUBLE SHOOTING SYSTEMS**

Working Safely with Photovoltaic Systems		
Task/Skill:	Skill Type:	Priority/ Importance:
As part of safety considerations associated with installing and maintaining PV systems, any PV installer must be able to		
Maintain safe work habits and a clean, orderly work area	Cognitive, <i>Psychomotor</i>	<i>Critical</i>
Demonstrate safe and proper use of required tools and equipment	Cognitive, <i>Psychomotor</i>	<i>Critical</i>
Demonstrate safe and accepted practices for personnel protection	Cognitive, Psychomotor	<i>Critical</i>
Demonstrate awareness of safety hazards and how to avoid them	Cognitive, <i>Psychomotor</i>	<i>Critical</i>
<i>The installer must be able to identify electrical and non-electrical hazards associated with PV installations, and implement preventative and remedial measures to ensure personnel safety.</i>		
Identify and implement appropriate codes and standards concerning installation, operation, and maintenance of PV systems and equipment	Cognitive, Psychomotor	Critical
Identify and implement appropriate codes and standards concerning worker and public safety	Cognitive, Psychomotor	Critical
Identify personal safety hazards associated with PV installations	Cognitive, Psychomotor	Critical
Identify environmental hazards associated with PV installations	Cognitive, Psychomotor	Critical

Interpret System Drawings and System Design		
Task/Skill:	Skill Type:	Priority/Importance:
Identify and describe all system components from those depicted in a system drawing	Cognitive,	<i>Critical</i>
Produce a procurement list of all system components from a system drawing	Cognitive,	<i>Critical</i>
Identify actual location for all equipment to be installed on site	Cognitive,	<i>Critical</i>
Verify that the array operating voltage range is within acceptable operating limits for power conditioning equipment, including inverters and controllers	Cognitive	Critical
Demonstrating installation techniques for all system components		
Task/Skill:	Skill Type:	Priority/Importance:
<i>To demonstrate that they have appropriate practical skills to carry out the installation of all system components the installer must be able to:</i>		
GENERAL		
Implement all applicable personnel safety and environmental protection measures,	Cognitive	Critical
Demonstrate an understanding of rules , regulations governing the installation of the equipment and the interconnection to the local electricity utility.	Cognitive	Critical
PV ARRAYS		
Demonstrate knowledge on how the modules are connected in series and parallel to suit the inverter chosen	Cognitive,	<i>Critical</i>

<p>Demonstrate sound mounting design and techniques for attaching modules to the array frame and the array frame to its supporting structure</p> <p>use of appropriate bolts or screws, including gauge, penetration</p> <p>fixing of external timber or metal battens to the roof sub frame</p> <p>weather sealing of array to building or other support mechanism</p> <p>Note: If BIPV systems installer must be able to install as per specifications.</p>	Cognitive, Psychomotor	<i>Critical</i>
Assess a site in relation to information from published wind data, and the suitability of the array frame and mounting techniques to meet wind loading requirements	Cognitive,	<i>Critical</i>
Assemble modules, panels, and support structures as specified by module manufacturer or design	Psychomotor	Very Important
Demonstrate a working knowledge of the pitch and condition of different roof claddings systems, and apply appropriate mounting techniques the roofs typical within the country of installation	Cognitive, Psychomotor	<i>Critical</i>
<p>Explain how to recognise and avoid corrosion problems arising from contacting dissimilar metals in mounting systems / roof claddings</p> <p>use of rubber grommets, non-metallic membranes</p> <p>use of appropriate bolts (stainless steel etc.)</p>	Cognitive,	<i>Critical</i>
Visually inspect and quick test (measure open-circuit voltage) PV modules as required	Psychomotor	Critical
Balance of System Components		
General		
<p>Demonstrate the positioning and fixing of all system components (eg Inverter and meters) in place to:</p> <p>minimise cable lengths between all components</p> <p>provide an ergonomic system layout</p> <p>provide a safe working environment and safe installation for the system owners</p>	Cognitive, Psychomotor	<i>Critical</i>
<p>Layout and secure system components in position</p> <p>Demonstrate diagrammatically and in practice the layout of system components in ergonomic and economic positions</p> <p>Discuss the reasons for optimal system component layout</p> <p>Demonstrate the use of appropriate fixing systems to secure system components in place</p>	Cognitive, Psychomotor	<i>Critical</i>

Specifying all system cabling and cable and system protection devices		
Task/Skill:	Skill Type:	Priority/ Importance:
<i>To demonstrate that they have a working knowledge of cable specification and cable and system protection devices the installer must be able to:</i>		
Determine the design currents for any part of a PV system electrical circuit	Cognitive,	<i>Critical</i>
Explain the reasons why excessive voltage drop can be detrimental to system performance	Cognitive,	<i>Critical</i>
Discuss current carrying capacity and the implications for cable selection ∴	Cognitive,	<i>Critical</i>
Demonstrate the calculation and measurement of voltage drop in a conductor	Cognitive,	<i>Critical</i>
Demonstrate the measurement of current through a conductor	Cognitive, Psychomotor	<i>Critical</i>
Demonstrate the use of tables to calculate the current carrying capacity of a conductor and the factors which influence CCC	Cognitive,	<i>Critical</i>
Apply voltage drop and current carrying capacity calculation to select cables for all circuits in a grid connect PV system	Cognitive,	<i>Critical</i>
Specify appropriate protection for all conductors in a circuit	Cognitive,	<i>Critical</i>
Determine appropriate size, ratings, and locations for earthing, surge suppression, and associated equipment	Cognitive	Critical
Determine appropriate size, ratings, and locations for all system overcurrent and disconnect devices	Cognitive	Critical
Select an appropriate utility interconnection point, and determine the size, ratings, and locations for overcurrent and disconnect devices	Cognitive	Critical

Demonstrate practical cabling and final system installation		
Task/Skill:	Skill Type:	Priority/Importance:
<i>To demonstrate that they can carry out installation of cabling, the installer must</i>		
Demonstrate cable termination techniques	Cognitive, Psychomotor	<i>Critical</i>
Demonstrate the installation and replacement of circuit protection	Cognitive, Psychomotor	<i>Critical</i>
Demonstrate safe techniques for laying and securing cables in place	Cognitive, Psychomotor	<i>Very Important</i>
Demonstrate the use of appropriate physical protection for installed cables	Cognitive, Psychomotor	<i>Very Important</i>
Install module array interconnect wiring; implement measures to disable array during installation	Psychomotor	Very Important
Install cabling between modules , inverter and switchboard	Psychomotor	Critical
<i>To complete the installation the installers must be able to:</i>		
Complete final assembly, structural attachment, and weather sealing of array to building or other support mechanism	Psychomotor	Critical
Install and provide required labels on inverters, controls, disconnects and overcurrent devices, surge suppression and earthing equipment, junction boxes, batteries and enclosures, conduit, and other electrical hardware	Psychomotor	Critical
Label, install, and terminate electrical wiring; verify proper connections, voltages, and phase/polarity relationships	Psychomotor	Critical
Verify continuity and measure impedance of earthing system	Cognitive, Psychomotor	Very Important
Program, adjust, and/or configure inverters and controls for desired set points and operating modes	Cognitive	Critical

Interpreting Technical Standards		
<i>Task/Skill:</i>	<i>Skill Type:</i>	<i>Priority/Importance:</i>
<i>To demonstrate that they are familiar with relevant standards (if applicable) the applicant must be able to:</i>		
Apply all relevant standards	Cognitive, Psychomotor	Critical
Own or have reasonable access to relevant Standards and country guidelines Note: All standards and guidelines available within the country are to be included..	Cognitive, Psychomotor	Critical

Testing and Commissioning		
<i>Task/Skill:</i>	<i>Skill Type:</i>	<i>Priority/Importance:</i>
<i>After completing the installation of a PV system, as part of system commissioning, inspections and handoff to the owner/operator, the installer shall be able to</i>		
Visually inspect entire installation, identifying and resolving any deficiencies in materials or workmanship	Cognitive, Psychomotor	Very Important
Check system mechanical installation for structural integrity and weather sealing	Cognitive, Psychomotor	Critical
Demonstrate the use of multimeters and other test equipment when undertaking the testing	Cognitive, Psychomotor	Critical
Check electrical installation for proper wiring practice, polarity, earthing, and integrity of terminations	Cognitive, Psychomotor	Critical
Activate system and verify overall system functionality and performance; compare with expectations	Cognitive, Psychomotor	Critical
Demonstrate procedures for connecting and disconnecting the system and equipment from all sources	Cognitive, Psychomotor	Critical

Identify and verify all required markings and labels for the system and equipment	Cognitive	Critical
Identify and explain all safety issues associated with operation and maintenance of system	Cognitive	Critical
Identify what documentation is required to be provided to the PV system owner/operator by the installer	Cognitive	Very Important

Maintaining and Troubleshooting a System		
Task/Skill:	Skill Type:	Priority/Importance:
In maintaining and troubleshooting PV systems, the practitioner shall be able to		
Identify tools and equipment required for maintaining and troubleshooting PV systems; demonstrate proficiency in their use	Cognitive, Psychomotor	Very Important
Identify maintenance needs and implement service procedures for modules, arrays, power conditioning equipment, safety systems, structural and weather sealing systems, and balance of systems equipment	Cognitive, Psychomotor	Very Important
Measure system performance and operating parameters; compare with specifications and expectations, and assess operating condition of system and equipment	Cognitive, Psychomotor	Very Important
Perform diagnostic procedures and interpret results	Cognitive, Psychomotor	Very Important
Identify performance and safety issues, and implement corrective measures	Cognitive, Psychomotor	Critical
Verify and demonstrate complete functionality and performance of system, including start-up, shut-down, normal operation, and emergency/bypass operation	Cognitive, Psychomotor	Critical
Compile and maintain records of system operation, performance, and maintenance	Cognitive	Very Important

10. Appendix D: Australian Renewable Energy Units of Competence

The following is the list of Australian Renewable Energy Units of Competence. Further information can be found from the website: <https://training.gov.au/Home/About>

If the full Unit Descriptor is required for a particulate unit of competence individual one it can be assessed using the following web address and the XXXX at the end is replaced by the last 4 numbers and letter of the unit:

<https://training.gov.au/Training/Details/UEENEEKXXXX>

For example for the first unit descriptor would be available from:

<https://training.gov.au/Training/Details/UEENEEK101A>

Unit Number	Unit Title
UEENEEK101A	Maintain safety and tidiness of remote area power supply systems.
UEENEEK102A	Work safely with remote area power supply systems.
UEENEEK103A	Conduct periodic maintenance of remote area power supply battery banks
UEENEEK104A	Conduct periodic maintenance of remote area power supply generator sets
UEENEEK105A	Conduct periodic maintenance of remote area power supply photo voltaic arrays
UEENEEK106A	Conduct periodic maintenance of remote area power supply wind generators
UEENEEK107A	Conduct checks in the demand side use of remote area power supplies (RAPS)
UEENEEK108A	Plan periodic maintenance schedules of remote area power supplies (RAPS)
UEENEEK109A	Attend to breakdowns in remote area power supplies (RAPS)
UEENEEK110A	Co-ordinate maintenance of renewable energy (RE) apparatus and systems
UEENEEK111A	Assemble and connect remote area power supplies
UEENEEK112A	Provide basic sustainable energy solutions for energy reduction in residential premises
UEENEEK114A	Promote sustainable energy practices in the community.
UEENEEK116A	Maintain and repair remote area power generation facilities.
UEENEEK117A	Maintain and repair facilities associated with remote area essential service operations
UEENEEK118A	Maintain and monitor remote area essential service (RAPS) operations
UEENEEK120A	Maintain operation of remote area power generation plant
UEENEEK121A	Manage renewable energy (RE) projects
UEENEEK122A	Plan renewable energy (RE) projects
UEENEEK123A	Carry out basic repairs to renewable energy apparatus
UEENEEK124A	Solve basic problems in micro hydro systems
UEENEEK125A	Solve basic problems in photovoltaic energy apparatus and systems
UEENEEK127A	Diagnose and rectify faults in renewable energy control systems
UEENEEK128A	Solve problems in stand-alone renewable energy systems.
UEENEEK129A	Design renewable energy (RE) heating systems
UEENEEK130A	Solve problems in wind energy conversion systems rated up to 10 kW
UEENEEK131A	Design wind energy conversion systems (WECS) rated to 10 kW.
UEENEEK132A	Develop strategies to address environmental and sustainability issues in the energy sector
UEENEEK133A	Design hybrid renewable power systems

UEENEEK134A	Install ELV stand-alone photovoltaic power systems
UEENEEK135A	Design grid connected photovoltaic power supply systems.
UEENEEK136A	Install, configure and commission LV micro-hydro systems rated upto 6.4 kW
UEENEEK137A	Install, set up and maintain ELV micro-hydro systems rated up to 6.4 kW
UEENEEK138A	Design micro-hydro systems rated to 6.4 kW
UEENEEK139A	Design stand-alone renewable energy (RE) systems
UEENEEK140A	Develop engineering solutions to renewable energy (RE) problems
UEENEEK142A	Apply environmentally and sustainable energy procedures in the energy sector
UEENEEK143A	Install small wind energy conversion systems rated up to 10 kW for ELV stand-alone applications
UEENEEK144A	Install, configure and commission LV wind energy conversion systems rated up to 10 kW
UEENEEK145A	Implement and monitor energy sector environmental and sustainable energy policies and procedures
UEENEEK146A	Design energy management controls for electrical installations in buildings.
UEENEEK148A	Install, configure and commission LV grid connected photovoltaic power systems 2

11. Appendix E: Examples of introduction of renewable energy training and/or certification programs into various countries

This appendix is not intended to be an exhaustive list of all the renewable energy technician training being provided globally, it is included to provide examples of the different types of programs that have been introduced particularly in recent years.

ECREEE

Source: IRENA, Quality Infrastructure for Photovoltaic Systems, Abu Dhabi.

ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) with support from the International Renewable Energy Agency (IRENA), GIZ and other partners is working on the establishment of a voluntary regional certification scheme (RCS) for solar PV installers, which will eventually also cover other RE and EE professions. ECREEE is aligning the scheme to the ISO 17024 standard and will decide about a possible accreditation according to the standard at a later stage.

The establishment of the RCS started with the development of the Job Task Analysis (JTA) for installers of off-grid solar PV systems, which was first presented at a regional workshop organized by IRENA and the West African Economic and Monetary Union (UEMOA) in April 2015. During the workshop, it was agreed to extend the certification scheme to the entire ECOWAS region. ECREEE therefore organized another workshop for the remaining ECOWAS member states, which was held in Accra in July 2015. These two workshops marked the start of national consultation processes in all 15 ECOWAS member states to review the content of the JTA. The results of these consultations were then integrated into the final French and English versions of the JTA which were validated at a regional workshop with all 15 ECOWAS member states held in Praia, Cabo Verde on December 14-15, 2015. After the workshop, the JTA was also translated into Portuguese.

ECREEE is currently establishing a Technical Committee (TC) with representatives from all 15 ECOWAS member states that will oversee and support ECREEE in establishing and operating the certification scheme. ECREEE is also preparing a call for Expressions of Interest (EoI) for selecting up to ten training institutions (TIs) from up to five different member states that will participate in the pilot phase of the RCS; with one partner institution in each of these countries selected to organize the exams for the first batch of certified installers on behalf of ECREEE. It is also planned to create a second level certificate for solar PV technicians that are able to design and install more complex off-grid as well as small and medium-size on-grid PV systems in 2016/2017.

FRANCE

For electricians and installers there exists a specific qualification (Involves training, audit and follow-up). This qualification RGE in French “Reconnu Garant de l’Environnement” (meaning recognized with an environment warrantee) is required to be held by an electrician who installs a RE system for a client who then benefits from the feed in tariffs.

In the RGE label there is a specific one dealing with renewable energies (Qualit’EnR).

Within Qualit'EnR there are various declinations for PV, wind, thermal, biomass. Inside Quali'PV there are two different qualifications, one for building integrated PV, one for superposition or ground PV (for pure electricians); **these various qualifications concern only grid connected PV.**



In order to have this qualification, the enterprise must prove its competencies or follow (with success after an exam) a recognized training course in a state recognized training centre (engineering offices, associations ...). After its qualification, for 4 years, the enterprise can be audited or subject to a knowledge actualization.

More information can be found on the following web site:

<http://www.qualit-enr.org/>

INDIA

The National Skills Qualifications Framework (NSQF) is a competency-based framework that organizes all qualifications according to a series of levels of knowledge, skills and aptitude. These levels, graded from one to ten, are defined in terms of learning outcomes which the learner must possess regardless of whether they are obtained through formal, non-formal or informal learning. NSQF in India was notified on 27th December 2013.

After the fifth anniversary (27 December 2018) date of the notification of the NSQF,

- It shall be mandatory for all training/educational programmes/courses to be NSQF-compliant
- All training and educational institutions shall define eligibility criteria for admission to various courses in terms of NSQF levels.

The National Institute of Solar Energy (NISE) has established the Solar Energy Training Network (SETNET) institutions across India to build skills and capacities to ensure the availability of qualified solar energy professionals to meet the national solar deployment targets.

The four major courses under this program are:

- Aryabhatta Certificate (for high level designers)
- Konark (graduate engineer project management course)
- Surya (for solar field technicians)
- Bhaskar (for Business/ Financial Programs)

Through a competitive process, NISE has identified 35 SETNET partners across the country which are empanelled by NISE to provide the above four skill development courses. Several programs are launched across India.

KENYA

The Energy Regulatory Commission gazetted the Solar PV regulations in December 2012. The regulations have been developed with the intention of improving the delivery of products and services within the solar PV sector.

The regulations require that only licensed technicians are allowed to design and install solar PV systems; and to be licensed, technicians shall be required to have undertaken a solar training course allowing them to practice within the following parameters:

- Class T1, which shall entitle the holder to carry out solar PV system installation work for single PV module or single battery DC system of up to 100 Wp.
- Class T2, which shall entitle the holder to carry out solar PV system installation work for medium size PV systems i.e. multiple modules of up to 300 Wp or multiple batteries which may include an inverter.
- Class T3, which shall entitle the holder to carry out solar PV system installation work for advanced, including grid connected and hybrid solar PV systems.

Nationally accredited training curriculums have been developed for all three Classes of technicians.

MALAYSIA

As part of their roof top grid connected PV program in 2007 Malaysia developed a training course that was based on the ISP Job Task Analysis developed for the ASEAN region and the training course was accredited at the time by the Institute for Sustainable Power. Courses are still being conducted.

PACIFIC REGION

The European Union Pacific Technical and Vocational Education and Training on Sustainable Energy and Climate Change Adaptation (PACTVET) project is a 53-month project that started in July 2014 covering 15 countries. After undertaking gaps and needs assessments and stakeholder consultations during late 2014 and 2015, in late 2015 the Sustainable Energy Industry Standards Advisory Committee was formed and during 2016 curriculums were developed for Sustainable Energy Certificates 1 through to 4.

SINGAPORE

Skills Future Singapore (formerly Workforce Development Agency) has two nationally accredited Competency Standards:

- Perform Design and Installation of PV Systems
- Perform Maintenance of PV Systems

The Sustainable Energy Association of Singapore (SEAS) is an Approved Training Organization (ATO) and has conducted training courses based on these units since 2012.

SOUTH AFRICA

In August 2016, South Africa approved The Photovoltaics Service Technician Qualification. The course development was supported by the Quality Council for Trades and occupation (QCTO) ; South Africa Qualifications Authority (SAQA) and the South African Renewable Energy Technology Centre (SARETEC).

The 18 month course is aimed at school leavers and covers such topics as electrical basics. Health and safety, inverter, transformers, PV basics etc.. It breaks down as :

- Knowledge modules (41%)
- Practical modules (29%)
- Work experience modules (30%)

UNITED KINGDOM

Source: IRENA (forthcoming), Quality Infrastructure for Photovoltaic Systems, Abu Dhabi.



Micro-generation Certification Scheme (MCS) is a nationally recognized quality assurance scheme, supported by the Department of Energy and Climate Change. MCS certifies micro-generation technologies used to produce electricity and heat from renewable sources. MCS is also an eligibility requirement for the Government's financial incentives, which include the Feed-in Tariff and the Renewable Heat Incentive.

MCS is a mark of quality and demonstrates compliance to industry standards that companies strive to meet. It highlights to consumers that companies are able to consistently install or manufacture to the highest quality every time.

MCS is an industry-led and nationally recognised quality assurance scheme, supported by the Department of Energy and Climate Change (DECC). MCS itself is a BS EN ISO/IEC 17065:2012 Scheme and was launched in 2008.

MCS certifies micro-generation products used to produce electricity and heat from renewable sources. MCS also certifies installation companies to ensure the micro-generation products have been installed and commissioned to the highest standard for the consumer. The certification is based on a set of installer standards and product scheme requirements which are available in the MCS Standards section of this website.

<http://www.microgenerationcertification.org/mcs-standards/installer-standards>



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