PVTRIN
INSTALLER CERTIFICATION

# TRAINING OF PHOTOVOLTAIC INSTALLERS

## Definition of installers' professional framework and development of the training methodology

# PV installers task analysis and defined professional framework

***(WP2 -D2.9, Working document)***

INTELLIGENT ENERGY EUROPE

Issued by TUC, Jan-11, Revised May -11

Contract N°: IEE/09/928/SI2.558379

**PVTRIN:** The PVTRIN project scope is the development of a training and certification scheme for technicians, according common accepted criteria and standards, focused on the installation and maintenance of small scale PV.

The expected results are: Accredited training courses and an operational certification scheme for PV installers in 6 participating countries; Practical training material/tools for installers and their trainers; Web portal with access to technical information on PV installation/integration; 8 pilot training courses implemented, a pool of skilled/certified PV installers; A roadmap for the adoption of the certification scheme across Europe.

Long term, PVTRIN will contribute to the PV/BIPV market growth in the participating countries, provide a supporting instrument for EU MS to meet their obligations for acknowledged certifications for RES installers till 31/12/2012 and enforce the MS efforts to achieve the mandatory target of a 20% share of energy from RES in overall Community energy consumption by 2020. The PVTRIN is co-financed by the Intelligent Energy - Europe (IEE) programme.


**PROJECT COORDINATOR**

Associate Professor Theocharis Tsoutsos, Renewable and Sustainable Energy Systems Lab.
Environmental Engineering Dpt., TECHNICAL UNIVERSITY OF CRETE (TUC)

**PROJECT PARTNERS**

| | |
|---|---|
| Agency of Brasov for the Management of Energy & Environment (ABMEE) | Romania |
| Building Research Establishment Limited (BRE) | UK |
| Energy Institute Hrvoje Požar (EIHP) | Croatia |
| European Photovoltaic Industry Association (EPIA) | EU |
| Scientific and Technical Chamber of Cyprus (ETEK) | Cyprus |
| Sofia Energy Centre (SEC) | Bulgaria |
| Technical Chamber of Greece –Western Crete (TEE) | Greece |
| Tecnalia Research & Innovation (TECNALIA) | Spain |

**WP LEADER**

Renewable and Sustainable Energy Systems Lab.
Environmental Engineering Dpt., TECHNICAL UNIVERSITY OF CRETE (TUC)

**DELIVERABLE EDITOR**

Renewable and Sustainable Energy Systems Lab.
Environmental Engineering Dpt., TECHNICAL UNIVERSITY OF CRETE (TUC)
Work Team: Theocharis Tsoutsos, Stavroula Tournaki, Zacharias Gkouskos (TUC)





pvtrin@pvtrin.eu, www.pvtrin.eu

# Contents

# 1 Introduction

Currently, the PV installation is not covered by relevant National Occupational Standards and also the professional framework for the PV installers is not clearly or not at all defined in the most of the targeted countries.

This task aims to identify the educational orientation and experience of the technical staff that currently activates on PV installation and maintenance, to record the characteristics, skills and deficiencies of PV installers in each participating country and to present a list of the qualifications required by the installers for efficient PV installation and maintenance.

The analysis of the tasks and subtasks that a PV installer has to perform is significantly important for the development of an appropriate training methodology and curriculum, and helps to establish the requirements for certified training courses; a thorough and common understanding of the installers' job has to be established.

Finally a draft structure and overview of the professional framework for the PV installers is provided, to be communicated to the appropriate authorities and stakeholder groups aiming to be used by the national bodies as a background supporting document to define the PV installers' professional framework and to institute National Occupational Standards, facilitating the route for accreditation of certification schemes.

The industrial and professional associations have been active involved in this task. The criteria set by the 2009/28/EC Directive (Article 14, Annex IV) are also taken into account.

*This is a working document, incorporating the consultation of NCCs and potential developments of the national legislation or other specific conditions.*

# 2 Current installers' workforce qualifications

## *2.1 Bulgaria – SEC*

PV installers are mainly electrical technicians (vocational schools). They have further training performed by the PV retailer/installer companies. In some cases these trainings are performed in specialised training centres, when the installers are hired by big international companies.

Two vocational schools provide courses for PV installers in Bulgaria: John Atanassov in Sofia and Konstantin Fotinov in Burgas. Both schools have implemented training for PV installers after involvement in EU projects under Leonardo da Vinci Programme. Both schools are oriented to electrical engineering and electronics. While in Sofia the profile of PV installer is a separate training, in Burgas the training for PV installations is part of a more general profile – RES installer (including PV, wind turbines, solar thermal, and heat pumps). In Sofia the educational programme for PV installers is running since 2 years, while in Burgas it is running since one year. There are still no graduated PV technicians from these schools.

In Bulgaria there is no certification for training. Training and education are provided by accredited organisations as vocational schools, high schools, training centres. These organisations are accredited by the Ministry of Education and Sciences. Such accreditation is given to organisations that can prove their capacity regarding the qualification of trainers, the availability of laboratories and all necessary facilities. Diplomas obtained from such organisations are obtained after theoretical and practical exams.

In the new "Law for Energy from Renewable Sources" (in force since 3rd May 2011) is stated:
Article 21 (1) The activities for installing and maintenance of equipments for biomass, solar thermal, PV, heat pumps and geothermal installations must be performed by qualified staff.
(2) The qualification necessary for the performance of the activities under par. 1 is acquired according to the conditions given in the "Law for professional education and training".
(3) The institutions that have accreditation for performing training for obtaining professional qualification must present each year to the Agency for Sustainable Energy Development (the former Energy Efficiency Agency) list of persons that have acquired the necessary qualification for performing the activities under par. 1.
(5) The requirements for the education and training necessary for obtaining professional qualification "installer" for the activities under par. 1, as well as the validity of the documents attesting this qualification, are defined with a regulation issued jointly with the minister of the education, youth and sport and the minister of industry, energy and tourism.

This new law will lead to a better qualification of installers and a clear profile of the profession. However, certification of courses is not mentioned.

### 2.2 Croatia - EIHP

PV installers are mainly: electrical installers (secondary craftsmen school) or electric technicians (secondary technical school). Many of installers are trained on PV related training courses outside of Croatia provided for them by companies they work for. Usually, these companies are mostly sales representatives. However, due to the new and partially unregulated profession, some of the PV systems are installed by low skilled staff for PV, such as plumber installers.

There is no certification scheme, neither conventional secondary education that is related to the RES/PV systems installers. There are also several secondary schools that work on informal education for RES/PV systems. Under IPA (Instrument for Pre-Accession assistance) project "Implementation of new curriculums" that has been announced in November 2010 several schools applied for the financing of new educational programmes for renewable energy (Srednja škola Oroslavje – Secondary school Oroslavje, Srednja škola Vice Vlatković, Zadar – Secondary school Vice Vlatković, Zadar, Elektrostrojarska škola Varaždin – Secondary school for electrical and mechanical engineering Varaždin, Tehnička škola Slavonski Brod – Technical secondary school Slavonski brod).

Conventional education of most of current electrician/PV installers' workforce is done by secondary schools, either by Craftsmen secondary schools or Technical secondary schools. Craftsmen schools are secondary education schools with simpler education programme than technical schools, and are more directed to the practical work. Education in these schools last for 3 years. Because of very high share of practical work in which students actually work in companies or crafts after this education the student is prepared for work. Technical schools are secondary schools with large portion of theoretical education on relevant field (i.e. electrical engineering) and education lasts for 4 years. Students in these schools obtain very high knowledge about mathematics, physics and relevant field (electrical engineering), but their practical training is somewhat lower than in Craftsmen secondary schools. However, students that attend secondary technical schools can enrol on colleges and universities. After finishing both schools and two years of experience in field, students can enrol additional 1 year of education and achieve master exam (*majstroski ispit*) in relevant field.

There are several levels in order to obtaining license to practice as an installer.
First is at Croatian Chamber of Trades and Crafts where craft trade must obtain "Crafts permission" (in Croatian: *obrtnica* , *obrt* –craft). For obtaining Crafts permission, craftsmen must have master exam (*majstorski ispit*) and 3 years of work experience in the field.
Second is at Ministry of Environmental Protection, Physical Planning and Construction where craft trade obtain license: "Approval for construction activities". Requirements for this license depend of the level and complexity of the work, and are related to the crafts trade not to craftsman him/herself
Electrical installers are part of Construction guild in Croatian Chamber of Trades and Crafts.
PV installations are designed by electrical engineers who are registered in Croatian Chamber of Electrical Engineers.

### 2.3 Cyprus - ETEK

Usually the PV installers are electrical engineers/electricians or other technicians who work for the companies which trade photovoltaics. The design of photovoltaic systems usually prepared and supervised by electrical or mechanical engineers that have to be registered in ETEK (Cyprus Scientific and Technical Chamber) and have work license.

The installer's professional profile is clearly regulated and defined by the Cyprus Department of Electrical and Mechanical Services that operates under the Ministry of Communications and Works and acts as the main Certification Authority for electricity related professions. The Cyprus Department of Electrical and Mechanical Services regulates and gives licenses/ certifications to Electricians, Electrical Engineers, Senior Technical Electricians, Technicians specialized in Electrical Systems Maintenance and Contractors of Electric Installations.

A second regulating body is ETEK that regulates and certifies Electrical Engineers in conjunction with the Department of Electrical and Mechanical Services.

It is important to notice that in Cyprus a specialized license for installing Photovoltaic units does not exist. Both the Department of Electrical and Mechanical Services and ETEK follow the guidelines as they were given by the National Electricity Law chapter 170 (1941 - 2004) and the Electricity Regulations Law.

The minimum requirements vary depending on the type of license. In general the applicant has to graduate from an accredited educational institution, complete a year of work under a licensed certified professional and successfully pass qualifying exams that are governed by the Cyprus Department of Electrical and Mechanical Services. Again the above requirements vary depending on the type of license earned and the Cyprus Department of Electrical and Mechanical Services is the main Certification Authority for electricity related professions
The professional rights and obligations are governed by the license that the professional engineer/electrician obtains. Depending on the specialization strict guidelines exist that regulate almost every aspect of practicing any of the five electricity related professions. These professional rights are gained the moment a professional engineer/ electrician earns his certification. Again it is important to notice that in Cyprus a specialized license for installing Photovoltaic units does not exist. This fact allows all the qualified professionals to undertake projects and installations of Photovoltaic Systems.
Usually the PV installers are electrical engineers/electricians or other technicians who work for the Companies which importing and sell photovoltaics.

The design of photovoltaic systems usually prepared and supervised from electrical or mechanical engineers that have to be registered in ETEK (Cyprus Scientific and Technical Chamber) and have work license.

### 2.4 Greece - TUC

In Greece there is no official certification or accreditation scheme for PV installers. The national legislation has not yet incorporated the articles of the RES Directive regarding the training and certification of RES installers for small scale systems. There is still a quite vague context as concerns their qualifications and professional framework. Many authorities, plethora of laws and bodies were involved till now. Following to a recently established Presidential Decree (FEK.163), a new organisation will be established, as from 21/11/2011, the "National Organization for the Certification of Qualifications" (ΕΟΠΠΕΠ). The new framework is planned to conclude at the end of 2012. TUC is in contact with all involved parts and has informed about the PVTRIN's tasks and outcomes in order to support the project's aims.

The systems are installed by electricians or engineers (Electrical contractors) who have attended a seminar, workshop or course during their studies, related to PV installations. Moreover, there are many practical technicians, electricians etc, with no previous training -at any level who installs PV systems. In many cases commercial PV-firms offer a two-day training course to their personnel.

Electrical contractors are freelancers who have obtained license to practice by the competent Industry and Development Department of the Greek Prefectures. PV installations are included in the "*ΣΤ*" category of the Electrical Projects (ΣΤ category: *Electrical installations producing energy*).
ΣΤ category includes 5 other subcategories. Electricians can register initially in one of these categories depending on their studies and their experience.

- 1st: Installations up to 40 kW (250 V)
- 2nd: Installations up to 50 kW (250 V)
- 3rd: Installations up to 150 kW (1.000 V)
- 4th: Installations up to 250 kW (1.000 V)
- 5th: Unlimited power and voltage

The profession of the PV installer is not officially accredited, so the PV systems are installed by electricians registered in the ΣΤ' category (Installations producing energy) as defined in the Government Gazette: 113_26/4/1936). Depending on the studies and years of experience electrical contractors can register in 5 different categories as presented before. The license to design, implement and to maintain energy production installations of all categories is provided to the graduates of Technical Universities who have a degree on Mechanical or Electrical Engineering. In parallel those who hold a degree in Electrical Engineering and are graduates of:

- Technological Educational Institutes (TEI)
- Centres of Higher Technical Education (specialty electrician) (KATE)
- Higher Technical Schools (electrician – assistant engineer)

can register for a B' class degree (installations up to 250 kW) just after they have obtained their diploma. Four years later and at least one year experience in more than 1.000V installations, graduates of the previous three categories can register for an A' class degree (installations up to 250 kW, and unlimited power up to 1.000 V).

For the rest of the electricians their professional qualifications for ΣΤ' categories are summarized in the following table:

| | ΣΤ' Specialty | | | |
|---|---|---|---|---|
| **Graduate of…** | **1st category** | **2nd category** | **3rd category** | **4th category** |
| Lower School for Electricians | - At least 26 years old<br>- 6 year traineeship certificate<br>- Written and oral exam | - At least 30 years old<br>- 10 year traineeship certificate<br>- Written and oral exam | Cannot register | Cannot register |
| Secondary Technical School for electricians | - At least 22 years old<br>- 1 year experience in ΣΤ' category<br>- Written and oral exam | - At least 24 years old<br>- 3 year experience in ΣΤ' category<br>- Written and oral exam | - At least 25 years old<br>- 5 year experience in ΣΤ' category<br>- Written and oral exam | - At least 30 years old<br>- 8 year experience in ΣΤ' category<br>- Written and oral exam |
| Technical professional High School (ΤΕΛ) / Technical Vocational Institute (ΤΕΕ) / Vocational High School (ΕΠΑΛ) | - At least 22 years old<br>- 1 year experience in ΣΤ' category<br>- Written and oral exam | - At least 24 years old<br>- 3 year experience in ΣΤ' category<br>- Written and oral exam | - At least 25 years old<br>- 5 year experience in ΣΤ' category<br>- Written and oral exam | - At least 30 years old<br>- 8 year experience in ΣΤ' category<br>- Written and oral exam |
| Technical Vocational School (ΤΕΣ) | - At least 22 years old<br>- 3 year experience in ΣΤ' category<br>- Written and oral exam | - At least 24 years old<br>- 5 year experience in ΣΤ' category<br>- Written and oral exam | - At least 25 years old<br>- 7 year experience in ΣΤ' category<br>- Written and oral exam | - At least 30 years old<br>- 10 year experience in ΣΤ' category<br>- Written and oral exam |
| Practical electrician | - At least 30 years old<br>- 12 year traineeship certificate<br>- Written and oral exam | Cannot register | Cannot register | Cannot register |

Basic common skills of a PV installer:
- Use and apply protection and hygiene procedures
- Ensure compliance with standards and security tools
- Install according to initial plans
- Select the necessary equipment
- Estimate the cost of work and equipment used
- Monitor and coordinate group of technicians
- Maintain and repair modules.

### *2.5 Romania - ABMEE*

The PV installers in Romania are electrical engineers or electricians who work for importers and resellers of PV systems. They usually receive training from the producers of the PV equipment – this is the case of big companies that work with trusted equipment. There is also the situation in which the equipments are not EU authorized and are installed by untrained staff.

In 2010 the SunE Association (New Energy Sources) made efforts to introduce formal qualification in the Occupations Code of Romania (COR) the "***Photovoltaic system installer"*** in the Construction Electricians category of the COR – (COR code for base groups: 7137 Construction electricians / 713702 Photovoltaic systems installer). SunE proposes courses following this structure: 600 hours - of which academic pursuits 190 hours and 410 hours of practical activities.

The installers must comply with the following requirements:

- They must be certified electricians – group II B (authorized for executing, checking and exploiting electrical installations below 1 kV)

- Graduating a training course of 600 hours, of which 190 hours of theory and 410
- practical activities comprising of lab works, practical applications and on construction sites training
- Common skills of a PV installer:
  - Technical communication
  - Hygiene and safety
  - Teamwork
  - Organization of the workplace
  - Customer satisfaction
  - Factors of influence on the performance of photovoltaic generators
  - Photovoltaic systems: coupling the ohm generator, energy storage
  - Integration of photovoltaic systems in buildings
  - RES role in building energy efficiency, environmental impact
  - Mastering specific technical documentation
  - Handling equipment electronic specific
  - Maintenance and repair of solar photovoltaic equipment
  - Related to communication in a European language

In no. 27 of 12 January 2011 of the Official Gazette, Order no. 1759/2010 of the Labour Ministry for the completion of the Classification of Occupations in Romania, by which 62 new occupations were introduced, among which those related to solar:

- Installer of solar photovoltaic systems: code - 713 702
- Installer of solar thermal systems: code - 713 614

By law (Ordinance 29/2010) the certification schemes or systems of qualifications must be in accordance with the following guidelines:

- Being a certified electrician
- A training program to provide an electrician specific qualification, equivalent to 3 years of training in photovoltaic systems installer, including class and workplace learning
- The theoretical part of the training for PV equipment installers must deliver an overview of the solar products market situation, a comparison between cost and profitability that includes environmental aspects, components, characteristics and dimensioning of solar systems, selecting accurate systems and dimensioning of components, determination of the energy requirements, fire protection, related equipment, as well as design, installation and maintenance of solar photovoltaic installations
- Training should also provide knowledge of European standards and certification technology, such as Solar Keymark, as well as related national and Community standards

The skills required for the installer:

- Ability to work safely, using appropriate tools and equipment while following safety codes and standards and the ability to identify hazards related to electricity, and other risks associated with solar installations
- Ability to identify specific components and systems for active and passive systems, including their mechanical design, and ability to determine the extent of component and system configuration plan

- Ability to determine the area required for installation, orientation and inclination of the solar photovoltaic cell, taking into account the shade, the sun access, the structural integrity, the installation opportunity in terms of building or climate and identifying the different installation methods suitable for roof types and the size of the necessary equipment for the installation of the system
- The ability to adjust power schemes, including the determination of projected nominal currents, the selection of denominations and locations for equipment and related subsystems and selecting an appropriate interconnection point

Certification should be given for a limited period of time and in order to ensure the continuity of certification periodic training courses or workshops are recommended.

Currently, the Ministry responsible for the accreditation of qualifications schemes, in accordance with Ordinance 29/2010, is the Regional Development and Tourism Ministry, Civil Construction department.

At present there are no training schemes approved for PV system installer in Romania.

### *2.6 Spain-Tecnalia*

At national level in Spain, installers of these systems can be classified into two groups: professionally qualified installers and authorised installers.

According to the legislation professionally qualified installers are those who have accredited professional installation skills acquired through vocational and continuing training, training and employment programmes and apprenticeship contracts.
Each professional qualification under the CNCP now comes with a list of professional skills needed for employment which can be acquired through modular training, other types of training and through on-the-job experience.

Some of these professional qualifications serve as credentials allowing these professionals to work as installers within the scope of the 2011-2020 NREAP. In this connection, eight professional qualifications have been identified for persons working as installers of small-scale biomass boilers and stoves, solar thermal and photovoltaic systems, shallow geothermal systems and heat pumps.

It is important to note that with the exception of installers of solar thermal and photovoltaic systems, the CNCP does not provide for a specific professional qualification for small-scale biomass boilers and stoves, shallow geothermal systems or heat pumps. However, other more general qualifications which totally or partially cover the skills needed to work as an installer are laid down in Article 14(3) of Directive 2009/28/EC. The CNCP thus specifies the following professional qualifications for professionals with recognised skills to work as photovoltaic installers.

Skill-based professional qualifications recognised for working as a photovoltaic installer within the framework laid down by Directive 2009/28/EC.

| References | Professional qualification | General competence | Units of competence |
|---|---|---|---|
| • Vocational family:<br>• Energy and Water<br>• Level: 2<br>• Code: ENA261 | Assembly and maintenance of photovoltaic solar installations | Perform the assembly, commissioning, operation and maintenance of PV solar installations, to required quality and safety standards and in accordance with current regulations | UC0835_2: Laying-out of photovoltaic solar installations<br>UC0836_2: Assembly of photovoltaic solar installations<br>UC0837_2: Maintenance of photovoltaic solar installations |
| • Vocational family:<br>• Energy and Water<br>• Level: 3<br>• Code: ENA263 | Organisation and projects for photovoltaic solar installations | Promote installations, implement projects and administer the assembly and maintenance of isolated and grid-connected photovoltaic solar installations, applying the requisite techniques and procedures in each case, and optimising the available human and material resources, to the requisite quality standards, in compliance with current regulations and in conditions of safety | UC0842_3: Determine the viability of solar installation projects<br>UC0843_3: Implement photovoltaic solar installation projects<br>UC0844_3: Organise and control the assembly of photovoltaic solar installations<br>UC0845_3: Organise and control the maintenance of photovoltaic solar installations |

Each qualification is assigned a general skill where the professional's essential duties and function are briefly defined.
Each professional qualification also includes a description of the professional environment in which the qualification can be achieved, the appropriate productive sectors and the relevant occupations or job posts to which the qualification gives access.

Each of these skill units is associated with training modules, each composed of a number of training units.
An installation company is any natural or legal person who, on the basis of theoretical-practical knowledge and in accordance with applicable law, is authorised to render services and perform works in a specific sector (electricity, climate control, plumbing, etc.). The professional activities required for certain industrial installations are recognised by installer licenses issued by the regional authority competent in matters of industry. Nowadays installer can work with the conformity declaration, which one gives the same legal recognition.

An authorised installer's license is an administrative authorisation that is required for anyone to install, and in some cases design, all electrical installations, on industry and dwellings.

Within the groups of installers referred to in the 2011-2020 NREAP and pursuant to regulations currently in force, authorised companies can be divided into two groups:

a) Qualified installation companies whose professional scope is governed by the Regulation on Thermal Installations in Buildings and its Technical Instructions approved by Royal Decree 1027/2007 of 20 July 2007. The installation of small scale biomass boilers and stoves, solar thermal systems, shallow geothermal systems and heat pumps is included in this group of qualified installers. This whole set of renewable energy systems is considered as thermal systems in buildings within the meaning of Royal Decree 1027/2007 of 20 July 2007.

b) Installation companies whose professional scope is governed by the low voltage electro-technical Regulation and its Technical Instructions approved by Royal Decree 842/2002 of 2 August 2002. Photovoltaic systems are included in this group, in the category specialist authorised installers for low voltage generating installations of authorised installers.

Within the group of photovoltaic installations. According to ITC-BT-04 of the low voltage electro-technical Regulation, the size of the installation will determine whether an authorised installer is needed (pursuant to Royal Decree 560/2010 of 7 May 2010) at the different stages of a project for a new generator or converter installation. In this connection, for purposes of official processing of a photovoltaic installation, two different cases are possible depending on the size:

1) When the electrical rating is 10 kW or less, the installation must be designed, calculated, installed and tested by an installation company or competent certified technician, who will then have to draft a technical design report (Sp. acronym MTD) for official authorisation, which must be drawn up in accordance with the procedure specified by the Regional Government in question and filed once the installation is complete.

2) Installations whose electrical rating **exceeds 10 kW** must also be performed by installation companies, but these require a preliminary project and must be supervised by a competent technician(s).

**Principal agents involved in the various stages of implementation of projects for photovoltaic installations**

| | Type of installation | 1. Calculation and design | 2. Execution | 3. Construction supervision | 4. Final tests | 5. Compulsory maintenance |
|---|---|---|---|---|---|---|
| Photovoltaic installations | Installation with electrical capacity of less than 10 kW | Installation company | Installation company | Not required Installation company | Installation company | Installation company |
| | Installation with electrical capacity greater than 10 kW | Holder of appropriate qualification (engineer or technical engineer) | Installation company | Holder of appropriate qualification (engineer or technical engineer) | Installation company supervised by project supervisor | Installation company |

# 3 PV installers task analysis

The PV installers' task analysis will help to:

- define the requirements for the assessment and credentialing of practitioners
- establish the requirements for accrediting training and educational programs

- develop the PVTRIN curriculum.

An analytical list of the potential qualifications and skills expected for any qualified PV installer for efficient PV installation and PV systems maintenance follows. In order to decide on the appropriate training structure, to establish the basis for training curricula, to identify appropriate methods of training and assessment and to develop the appropriate training tools an analysis of the tasks and subtasks that a PV installer has to perform is needed; a thorough and common understanding of the installers' job has to be established.

This content integrates the attitudes and advice of the key stakeholders.

| **1. Working Safely with Photovoltaic Systems** |
|---|
| ***As part of safety aspects, associated with installing and maintaining PV systems, the PV installer must be able to*** |
| 1.1 Maintain safe work habits |
| 1.2 Demonstrate safe and proper use of required tools and equipment |
| 1.3 Demonstrate safe and accepted practices for personnel protection |
| 1.4 Demonstrate awareness of safety hazards and how to avoid them |
| ***The installer must be able to identify electrical and non-electrical hazards associated with PV installations, and to take preventative measures to ensure personnel safety*** |
| 1.5 Identify and implement appropriate codes and standards concerning, grid systems, installation, operation, safety and maintenance of PV systems and equipment |
| 1.6 Identify personal safety hazards associated with PV installations |

| **2. Conducting a Site Assessment** |
|---|
| ***In conducting site surveys, the PV installer shall be able to*** |
| 2.1 Identify tools and equipment required for conducting site surveys for PV installations, and to demonstrate the appropriate skills in their use |
| 2.2 Determine suitable location with proper orientation, sufficient area, adequate solar access, and |

| |
|---|
| structural integrity for installing PV array |
| 2.3 Determine suitable locations for installing inverters, control, batteries, and other balance-of-system components |
| 2.4 Illustrate possible layouts and locations for array and equipment, including existing building or site features |
| 2.5 Identify and assess any site-specific safety hazards associated with installation of system |
| 2.6 Obtain and interpret solar radiation and temperature data for site for establishing performance expectations and use in electrical system calculations |
| 2.7 Identify opportunities for the use of energy efficient equipment/ appliances, conservation and energy management practices, if applicable |

| **3. Selecting a System - Sizing and Design** |
|---|
| ***Based on results from the site assessment and customer needs, the installer shall be able to*** |
| 3.1 Estimate and/or measure the peak load demand and average daily energy use for loads directly connected to inverter-battery systems for purposes of sizing equipment |
| 3.2 Determine requirements for installing additional subpanels and interfacing PV system with electrical supply network and/or other generation sources as applicable |
| 3.3. Determine the design currents and voltages for any part of a PV system electrical circuit |
| 3.4. Determine the capacity of system conductors, and select appropriate sizes based on design currents, voltages and safety factors |
| 3.5. Determine appropriate size, ratings, and locations for earthing, surge suppression, lightning protection and associated equipment |
| 3.6. Identify a mechanical design, equipment (including fixings and mounting brackets) to be used and installation plan that is consistent with the environmental, architectural, structural, code requirements, and other conditions of the site |
| 3.7. Identify appropriate module/array layout, orientation, and mounting method for ease of installation, electrical configuration and maintenance at the site |
| 3.8 Identify and select major components and balance of system equipment that meet the sizing requirements |
| 3.9 Estimate annual energy performance of proposed system |

| **4. Applying the Electrical and Mechanical Design during the Installation** |
|---|
| ***In applying the electrical design, the PV installer shall be able to*** |
| 4.1 Install module array interconnect wiring; implement measures to disable array during installation |

| |
|---|
| 4.2 Label, install, and terminate electrical wiring; verify proper connections, voltages, and phase/polarity |
| 4.3 Use appropriate and correctly labelled D.C. junction boxes and isolation switches |
| 4.4 Verify continuity and measure impedance of earthing system |
| 4.5 Program, adjust, and/or configure inverters-controls for desired set points and operating modes |
| ***In applying the mechanical design, the PV installer shall be able to*** |
| 4.6 Utilise drawings, schematics, instructions and recommended procedures in installing equipment |
| 4.7 Assemble modules, panels, and support structures as specified by design |
| 4.8 Complete final assembly, structural attachment, and weather sealing of array to building or other support mechanism |
| ***After completing the installation of a PV system, as part of the system inspections and checkout, the installer shall be able to*** |
| 4.9 Visually inspect entire installation, identifying and resolving any deficiencies in materials or workmanship |
| 4.10 Check system mechanical installation for structural integrity and weather sealing |
| 4.11 Check electrical installation for proper wiring practice, polarity, earthing, and integrity of terminations |
| 4.12 Activate system and verify overall system functionality and performance; compare with expectations |
| 4.13 Demonstrate procedures for connecting and disconnecting the system and equipment from all sources |
| 4.14 Explain safety issues associated with operation and maintenance of system |

| **5. Maintaining and Troubleshooting a System** |
|---|
| 5.1 Analyse the technical documentation/manuals of PV installations, determining actions and resources required for the maintenance process |
| 5.2 Identify maintenance needs, to design a typical periodical maintenance plan and to select the appropriate required tools |

| |
|---|
| 5.3 Analyse the past production report and -potential- fault reports |
| 5.4 Identify typical installation mistakes/failures. To perform diagnostic procedures and to interpret results |
| 5.5 Use the proper measurement techniques; Measure system performance and operating parameters; compare with specifications and assess operating conditions |
| 5.6 Visually inspect entire installation, check mounting systems, ventilation, cable runs and connections/junction boxes |
| 5.7 Check system mechanical installation for structural integrity and weather sealing |
| 5.8 Check electrical installation for proper wiring practice, polarity, earthing, and integrity of terminations according to appropriate regulations |
| 5.9 Identify performance and safety issues, and implement corrective measures |
| 5.10 Compile and maintain records of system operation, performance, and maintenance |

| **6. Quality management and customer care** |
|---|
| ***In applying quality management principles the practitioner shall be able to*** |
| 6.1 Understand all quality parameters as regards quality management, efficiency and functional controls, quality assurance during the installation process |
| 6.2 Recognize and understand all EU standards associated to the system components and processes |
| 6.3 To understand and apply all necessary customer care activities as concerns pre-sales and contracts, delivery, final testing and handover, as well as after sales activities: warranties, service, repairs and complaints handling |

# 4 Definition of appropriate professional framework

## 4.1 Introduction

The world PV market has shown a continuous growth during the last ten years. The annual market has developed from less than 1 GW in 2003 to more than 16.5 GW in 2010. Despite the difficult financial and economic circumstances, the PV market grew by almost 130% in 2010 compared to 2009 and the total power installed raised to almost 40 GW worldwide. The robust growth is expected to continue in the coming years, according the industry's scenarios.

Europe is leading the way, representing 74% of the world cumulative PV power installed at the end of 2010. PV applications are supported by different regulatory frameworks at European level. Moreover, many countries have already adopted appropriate support policies and they have defined favourable support schemes and financial mechanisms into their national laws, in order to fulfil certain targets; feed in tariffs mechanisms have played an important role to the market's awakening. The EU PV market has been booming over the last decade and reached slightly more than 29 GW of cumulative installed power at the end of 2010 with a record 13.2GW installed during the 2010. According to the industry's forecasting scenarios, this trend will continue during the next years.

## 4.2 Section A "Title and definition of the professional"

### 4.2.1 A.1 Proposed Title

The proposed title for the professional is "Photovoltaic Installer" or "PV installer". The work of a PV installer can range from installing panels on the roof of homes or on the roofs and facades of larger commercial buildings or in designated solar panel areas at ground level. Their work will involve assembling the complete solar panel mounting and support structure and securely mounting the modules on the structure. They will ensure the stability and the safety of the whole structure as well as the correct orientation and angle of the panels to make sure the panels are generating as much clean electricity as possible. They are technicians who install, inspect, and maintain PV systems, including grid-connected/stand-alone systems, on ground/BAPV/BIPV[1] with or without battery storage, in order to meet the performance and reliability needs of customers complying with all applicable codes, standards, and safety requirements.

### 4.2.2 A2. Areas of occupation and types of enterprises

PV installers can work in:

- construction companies
- companies engaged in supplying and installing PV systems
- PV systems service companies
- companies selling PV systems
- power corporations.

### 4.2.3 A3. Trends and perspectives

According the PV industry estimations, around 30 jobs are created per MW installed, of which approximately 18 jobs for the production of the components of PV systems and about 12 for the installation, operation and maintenance of the PV plants. In 2010, almost 500,000 people were employed directly by the global PV industry. Following the Accelerated Scenario in Solar Generation VI (a joint publication of EPIA and

[1] BAPV: PV installations are simply applied onto the existing roof (Building Applied PV)
BIPV: PV systems take on the role of primary building elements (Building Integrated PV)

Greenpeace, published in January 2011), more than 2.5 million full-time jobs could be created globally in 2030 thanks to the development of PV; the scenario corresponds to a cumulative installed power of slightly over 1,000 GW in the same year. The above figures illustrate that the fast growing PV penetration is a challenge for the PV industry as the need for an adequately skilled workforce for PV installation and maintenance is highly necessary and becoming more and more important.

As such, there is a clear need for establishing common qualification frameworks, appropriate training methodology and tools as well as a transparent and clearly defined accreditation route to validate the competence of the installers. Furthermore, stakeholders such as developers, designers of PV systems and even PV owners increasingly seek/demand for acknowledged standards, skills, certification and quality assurance.

### *4.2.4 A4. Current Status*

In many European countries where the PV market is still to take off, there are few or none existing relevant training and accreditation schemes. In other countries where the PV market has known a larger growth (such as Germany and Italy), the existing training and certification schemes are very diverse and at this stage not yet acknowledged in other countries. Training opportunities are currently very limited or inexistent in most of the countries participating to the project. Moreover, existing training opportunities provided by manufacturers are mainly for their own products.

Ideally, a team responsible for the installation of a PV system should consist of an electrician and a roofer. The electrician should manage the electrical DC connections as well as the connection to the grid, whereas the roofer should have sufficient experience to manage the installation of the panels mechanically on the roof and make the interconnections between the modules on the DC side. Ideally; electricians, roofers and other construction workers are to bring their knowledge together in a new kind of job description which could be called “solar installer”.

The need for qualified installers for PV systems results from the significant differences that PV systems have when compared to standard electrical and roofing practices in the building industry. On the electrical side, there is a need to work with direct current (DC) series connections rather than alternate current (AC) parallel connections. On the roofing side, roofers should be capable of making the connections between modules during the installation on the roof. They also need to be able to deal with special mounting procedures (especially in the case of BIPV).

Furthermore, the long lifetime of PV products (a proven lifetime of 30 years for mature module technologies) requires installers to follow correct mechanical installation procedures to ensure that the PV arrays remain safely on the roof and do not damage the supporting roof structure due to overloading under strong winds and heavy snow load conditions.

The output of PV modules is DC power. In order to be able to connect the system to the grid, an inverter is needed to transform the DC power into AC power. PV modules are connected in series to form strings and then connected in parallel. The voltage of one module is typically between 25 V and 100 V and does not exceed 120V. Hence, when handled correctly, it does not present any danger to the installer. However, after

having interconnected the PV modules in series, the voltage grows significantly up to a maximum allowed system voltage of 1,000 V.

The combination of all the specificities listed above implies that installers must clearly understand the procedures and carry them out; hence the need for competent and knowledgeable installers.

### *4.2.5 A5. Associations relevant to the profession*

- Federation of Electrical Contractors Associations,
- Engineers Associations',
- Technical Chamber,
- RES associations',
- Crafts and trades associations,
- Union of Contractors of Electric Installations,
- Guild of Metal Workers,
- Solar Energy Industrialists,
- PV Industry Association.

### *4.2.6 A6. Working Conditions*

Hygiene and safety indicative table

| Frequency | Very often | Frequently | Sometimes | Rarely | Never |
|---|---|---|---|---|---|
| **Standing** | | | | | |
| **Use of heavy machinery** | | | | | |
| **Intense muscular effort** | | | | | |
| **Moving load** | | | | | |
| **Accident risk** | | | | | |
| **Conditions of tension and pressure** | | | | | |
| **Exposure to dust odours, etc.** | | | | | |
| **other** | | | | | |

### *4.2.7 A7. Brochures and other media*

Indicative list of Books for PV installers:

- Study guide for photovoltaic system installers, North American board of certified energy practitioners, NABCEP Version 4.2 – April 2009
- StandAlone-Photovoltaic-Systems-A-Handbook-of-Recommended-Design-Practices, Photovoltaic design assistance centre Sandia National Laboratories Albuquerque, New Mexico, Vermont
- Building-Integrated Photovoltaic Designs for Commercial and Institutional Structures. A Sourcebook for Architects Patrina Eiffert, Ph.D. Gregory J. Kiss
- Planning and Installing Photovoltaic Systems A guide for installers, architects and engineers, second edition, Copyright © The German Energy Society (Deutsche Gesellshaft fur Sonnenenergie (DGS LV Berlin BRB), 2008
- Photovoltaic (PV) module safety qualification — Part 2: Requirements for testing, British Standard is the UK implementation of EN 61730-2:2007.
- Practical Handbook of Photovoltaics: Fundamentals and Applications, Tom Markvart and Luis Castafier, Elsevier Science Inc.
- Photovoltaics: Design and Installation Manual, Solar Energy International
- Photovoltaics in Buildings, Guide to the installation of PV systems, DTI Sustainable Energy Programmes, Crown (provided by BRE, 2006
- Plug & play quick connect installation, Leonardo Energy ,2010
- Solar Electricity Handbook, 2010 Edition: A Simple Practical Guide to Solar Energy - Designing and Installing Photovoltaic Solar Electric Systems, Michael Boxwell
- A guide to photovoltaic (PV) system design and installation, California energy commission, consultant report
- EN 61730-1:2007, CEI 61836:1997, Live working standards

Indicative list of Websites

- www.iea-pvps.org
- www.nabcep.org
- www.energy.ca.gov
- www.electrical-installation.org
- www.epia.org

## 4.3 Section B "Knowledge –Skills"

### 4.3.1 B1. Formal or institutional conditions for the profession practice

Solar PV installers need mechanical and electrical skills and must be able to work with the power tools and hand tools used to construct and fasten equipment. Electrical knowledge and an understanding of basic math are essential, as are good problem-solving abilities. Attention to detail is important, because completing an installation often requires following diagrams and instructions. Heavy lifting is also required at times. Installers should be proficient at working at height.

More specific PV installers should:

- have a high school diploma
- be able to make simple arithmetic calculations
- have an electrical contractor or have an engineering degree

### 4.3.2 B2. General Qualifications

The PV installer should be able to[2]:

- work safely with PV systems ( safe and proper use of tools and equipment, identify electrical and non-electrical hazards associated with PV installations e.g. DC as well as AC circuits, etc),
- conduct a site Assessment (Establish suitable location with proper orientation, sufficient area, adequate solar access, and structural, establish suitable locations for the rest of the equipment, quantify the customer electrical load and energy use, estimate annual energy performance etc),
- determine sizing requirements for major components,
- verify/adapt the Mechanical Design,
- verify/adapt the Electrical Design,
- inspect the entire installation, identify and resolve any deficiencies,
- identify tools and equipment required for maintaining and troubleshooting PV systems.

[2] The Key Competences base on the *Directive 2009/28/EC - Annex IV are: "*The installer should demonstrate the following key competences:

(i) the ability to work safely using the required tools and equipment and implementing safety codes and standards and identify plumbing, electrical and other hazards associated with solar installations;

(ii) the ability to identify systems and their components specific to active and passive systems, including the mechanical design, and determine the components' location and system layout and configuration;

(iii) the ability to determine the required installation area, orientation and tilt for the solar photovoltaic and solar water heater, taking account of shading, solar access, structural integrity, the appropriateness of the installation for the building or the climate and identify different installation methods suitable for roof types and the balance of system equipment required for the installation; and

(iv) the ability to adapt the electrical design, including determining design currents, selecting appropriate conductor types and ratings for each electrical circuit, determining appropriate size, ratings and locations for all associated equipment and subsystems and selecting an appropriate interconnection point.

Also: training as a plumber or electrician and have plumbing, electrical and roofing skills, including knowledge of soldering pipe joints, gluing pipe joints, sealing fittings, testing for plumbing leaks, ability to connect wiring, familiar with basic roof materials, flashing and sealing methods as a prerequisite."

#### 4.3.3 B3. Skills

- Technical skills and the ability to work with all types of hand tools.
- capable of comprehending designs layouts of mounting structures.
- ability to follow instructions and complete an installation according to the national standards.
- work a variety under harsh of environmental conditions e.g. heat, cold, rain etc in distant areas and should be interested in project-orientated work.
- ability to lift heavy materials (panels and mounting structural parts) and to carry out manual labour.
- problem solving skills.

#### 4.3.4 B4. Responsibilities

A PV installer will design, supply, install, set to work, commission, inspect and maintain solar PV systems for customers, will assess the environment, and detect and mitigate any hazards associated with installation. The PV installer will map out where everything will go, and then place components according to those diagrams. Installers also seal the system against weather, using safety codes and manufacturer specifications. After labelling, installing and terminating electrical wiring, they test the system and measure grounding systems and make any adjustments to the controls.

### 4.4 Section C "Education/Training"

#### 4.4.1 C1. Proposed routes for acquiring skills

The permission to design, implement and maintain energy production installations can be provided to electrical contractors. In addition to a high school diploma, PV installers should have backgrounds in electrical engineering, electrical technology or electrical construction through an apprenticeship or formal degree program.

Depending on their educational background, the years of experience and the specialized training course they have attended PV installers should be qualified to install PV systems of different sizes.

#### 4.4.2 C2. Training

Contractors should enter the field after successfully passing written and practical examinations following workshops or classes in the basics of designing and installing PV systems, including safety and site assessment (Vocational training). Specific training in PV installation and maintenance is important to become a PV installer. PV installer should attend special training courses. Classroom courses as well as practical training including dynamic and passive loading (for example on different kind of mounting system and different PV module technologies) (including wind uplift, weather tightness and fire safety in BIPV systems) are important for a candidate PV installer.

Specific education and on-the-job-training of electrical contractors should be the first step in order to be capable of installing PV systems. Of course, because technology specifications and other requirements are rapidly changing (especially in the field of BIPV), it is important to regularly upgrade these skills.

### *4.4.3 C3. Courses Outline*[3]

A training course should cover the design, installation, commissioning, inspection and maintenance of PV systems, and involve actual hands-on work with PV systems and equipment. Courses will be addressed to electricians, technicians, and other practitioners, as well as to engineers with an overall goal of developing "system-knowledgeable" professionals, to ensure the safety quality and robustness of PV system installations.

Courses should cover the following learning objectives:

- PV markets and applications, (including BIPV),
- safety basics,
- electricity basics,

[3] *Based on the RES Directive: "The theoretical part of the solar photovoltaic and solar thermal installer training should give an overview of the market situation of solar products and cost and profitability comparisons, and cover ecological aspects, components, characteristics and dimensioning of solar systems, selection of accurate systems and dimensioning of components, determination of the heat demand, fire protection, related subsidies, as well as the design, installation, and maintenance of solar photovoltaic and solar thermal installations. The training should also provide good knowledge of any European standards for technology, and certification such as Solar Keymark, and related national and Community law"*

*Based on PVTRIN project (BRE analysis) the basics expected of PV installers¨Basics expected of PV installers –BRE*

- How PV modules and systems work, e.g. types of PV module, effect of ambient conditions on performance
- PV product testing and approvals, quality marks, certification schemes
- System design, e.g. site survey, static and dynamic loads, solar resource assessment, irradiance, shading, orientation, estimate of annual energy performance,
- System components, e.g. PV panels, mounting systems , flashings, sealing kits, roof penetrations, inverters, metering, display panels
- System installation, e.g. panel fixing techniques, on-roof and in-roof systems, cables, junction boxes, safety devices, warning labels
- System testing, diagnostics/fault finding, measurement of open circuit voltage and short circuit current, commissioning, maintenance
- Documentation, e.g. commissioning certificate – including test results, inverter protection settings, user instructions, maintenance requirements, warranties, system information, electrical schematic, troubleshooting guide including present and future overshading issues (trees, new structures etc.) , start up and shut down procedures

- solar energy fundamentals,
- PV module fundamentals,
- system components,
- PV system sizing,
- PV system electrical design,
- PV system mechanical design, including static and dynamic loading (wind, snow etc.) and weather tightness
- performance analysis and troubleshooting,
- permitting and inspection,
- connecting to the utility grid,
- maintenance procedures,
- performance analysis and troubleshooting,
- permitting and inspection,
- connecting to the utility grid
- maintenance procedures

Upon Completion of these courses, PV installer should have the ability to:

- Identify the types of solar energy systems and describe the advantages and disadvantages of each type,
- identify opportunities for grid-interactive residential and commercial solar systems,
- describe photovoltaic system components and configurations
- describe battery, generator and other types of backup systems and how they are integrated into a grid-interactive solar system,
- describe the features, functions, and specifications of inverters used in grid-interactive systems, identify and configure electrical balance of system components,
- analyze load demands and calculate system requirements,
- conduct a site survey and specify system components and design,
- calculate array and inverter size for grid-interactive solar systems, both with and without backup components,
- describe various mounting systems and perform mounting procedures of PV modules and electrical components,
- perform commissioning, maintenance, and troubleshooting procedures for installed systems,
- demonstrate proper and safe use of required tools and measurement instruments necessary to conduct a thorough site survey and system installation,
- describe inspection, permitting and documentation requirements for grid-interactive solar systems,
- describe the risks and safety issues.

***Indicative Courses outline***

| Courses Objectives | Minimum numbers of hours per training course | | | | | | |
|---|---|---|---|---|---|---|---|
| | Level 1 | | Level 2 | | Level 3 | | … |
| | Teor. | Pract. | Teor. | Pract. | Teor. | Pract. | |
| PV markets and applications | | | | | | | |
| Safety basics | | | | | | | |
| Electricity basics | | | | | | | |
| Solar energy fundamentals | | | | | | | |
| PV module fundamentals | | | | | | | |
| System components | | | | | | | |
| PV system sizing | | | | | | | |
| PV system electrical design | | | | | | | |
| PV system mechanical design | | | | | | | |
| Performance analysis and troubleshooting | | | | | | | |
| Permitting and inspection | | | | | | | |
| Connecting to the utility grid | | | | | | | |
| Business and economics of solar | | | | | | | |
| TOTAL | | | | | | | |
| | | | | | | | |

## 4.5 Section D "Indicative methods for evaluating"

Skills can be assessed only by applying weighted and reliable tools. Indicative ability tests are the following:

- Differential Aptitude Test (DAT)
- General Aptitude Test Battery (GATB)
- Comprehensive Ability Battery (CAB)
- SRA Mechanical Aptitude etc

Indicative methods for evaluating the skills of a candidate PV installer.

- Written Exams
- Oral Exams
- Multiple Choice Test
- Project Implementation
- Practical exams
- Demonstration of skills
- Others

## 4.6 Section E "Certification"

Certification assures the public, employers and practitioners that a nationally certified professional in the fields of PV technologies possess the skills and knowledge necessary to properly design, install set to work, commission, inspect and maintain a PV system. A nationally acknowledged awarding body should set

competency standards for professionals who install PV systems, after a consultation process with the PV industry stakeholders.

Installers who choose to become certified must demonstrate their competence in the field and their commitment to upholding high standards of ethical and professional practice and pass an examination to become certified. Candidates should complete continuing education and annual installation inspections to maintain certification

Certification of the PV professionals will:

- promote the status and credibility of renewable energy practices PV installations both in terms of safety as well as performance
- promote consumer confidence in renewable energy technologies
- promote worker safety and skills advancement
- advance uniform professional standards by holding certified installers to a Code of Ethics
- commit certified installers to continued professional development through maintenance of the credential.

## *4.7 Section F "International experience"*

### *4.7.1 F1. USA, NABCEP*

The NABCEP PV installer certification is a voluntary certification that provides a set of national standards by which PV installers with skills and experience can distinguish themselves from their competition. Certification provides a measure of protection to the public by giving them a credential for judging the competency of practitioners. It is not intended to prevent qualified individuals from installing PV systems nor to replace state licensure requirements.
The target candidate for NABCEP certification is the person responsible for the system installation (e.g., contractor, foreman, supervisor, or journeyman).

### *4.7.2 F2. France, QualiPV*

Qualit'EnR is a non-profit association created in 2006 by professional organizations and industrial associations.
Qualit'EnR manages quality labels for installers of small-scale RES:
- Qualisol for solar thermal installations
- QualiPV for photovoltaic installations
- Qualibois for biomass systems
- QualiPAC for heat pumps

In November 2007: QualiPV was be launched, based on the Qualisol success experience

Key points

- Choice to be QualiPV-E for Electricity services and/or QualiPV-B for building services (roofers)
- A Previous experience or a specific solar PV training to become QualiPV (E and/or B)
- 3 days training for QualiPV-E and 1 day training for QualiPVB

The quality scheme is a voluntary certification process. The label is delivered to the company which commits for a 3-year-period. The label should be renewed every year over the commitment period.

### *4.7.3 F3 UK, MCS*

MCS is an EN45011 Scheme which is focused on ensuring the quality of renewable technology installations and products. It has been developed over the last three years and is an industry led and funded scheme. The MCS Technical Working Groups develop the MCS Standards and Scheme documents which are based on international and European standards already in existence.

Key points:

- MCS PV installer requirements are published in MIS 3002
- Certification includes both office (quality management) and installation assessments
- Membership of a consumer code of conduct is required
- Certification is maintained through surveillance assessments (usually annual)
- Certification may only be issued by UKAS (or equivalent) accredited certification bodies that are licensed to operate MCS schemes.

Further details of MCS and other European PV installer schemes are contained in PVTRIN deliverable D5.1

## Indicative References

1. Global Market Outlook 2015: http://www.epia.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/EPIA_docs/publications/epia/EPIA-Global-Market-Outlook-for-Photovoltaics-until-2015.pdf&t=1305740891&hash=b98674a830e5bc6f33488b39f442c7f3
2. Solar Generation VI: http://www.epia.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/EPIA_docs/documents/Solar_Generation_6__2011_Full_report_Final.pdf&t=1305740891&hash=b188f8f3df9476e722898d22aafaa677
3. http://www.bls.gov/opub/ooq/2009/fall/yawhat.pdf
4. EKEPIS, Professional framework for “Solar Applications manufacturing technician"
5. http://www.nabcep.org/
6. Candidate Information Handbook For NABCEP Solar Photovoltaic Installer Certification
7. http://www.qualit-enr.org
8. QualiCert Manual - A common approach for certification or equivalent qualification of installers of small-scale renewable energy systems in buildings
9. http://www.rescompass.org/english,1/job-profiles,14/technicians,37/photovoltaic-module-installer,217.html
10. http://www.coseia.org/newsite/pv-task-analysis.html
11. http://www.qualityinfo.org/olmisj/ArticleReader?itemid=00007321#Table%201
12. http://www.iseek.org/news/fw/fw7302FutureWork.html
13. http://www.niceiccertification.com/Uploads/File1856.pdf
14. http://www.ontility.com/solar-pv-solar-thermal-courses/s101-solar-pv-technician
15. www.ehpa.org/eucert