ICRA

Background Paper

Harmonisation of PV Standards in ASEAN countries

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in collaboration with the NRSE-SSN

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Content:

1 Introduction

This background report on PV standards and harmonisation forms the basis for the policy orientation paper being recommended for the Renewable Energy Sub-sector Network (RE-SSN) of the ASEAN. It synthesizes the PV standards being adopted and implemented in the region, and analyses these PV standards status within the contexts of theirs harmonisation. The paper also presents best practices in other developed countries. Areas examined in the paper are the PV quality assurance and standards. The main findings present the issues and deficiencies in the adoption of PV standards in the region and in the world.

The background paper is one of the series of four background reports prepared under the project **Information for the Commercialization of Renewables in the ASEAN (ICRA)** co-financed by the EC-ASEAN Energy Facility. The main objective of the project is to contribute towards the further mainstreaming of RE applications in the region in collaboration with the RE-SSN by i) updating and expanding on the range of ACE RE information resources available, ii) contributing European experience and approaches to the regional dialogue on 4 key policy themes: framework conditions and policy instruments for fostering mainstreaming of renewables; harmonisation of PV standards; promotion of biomass technologies for electricity production; the potential role of carbon credits – looking specifically at the opportunities offered by the European trading scheme.

2 Quality Assurance and Standards

2.1 Terminology

Quality Assurance (QA) terminology is characterised by a wide number of specific terms that might generate reluctance and confusion among non-aware people in the PV sector. This section consists in a short reminder on QA terminology, which is often part of national PV design standards.
The common terms used in PV Quality Assurance issues are standards, certifications, labels, technical specifications, QA procedures, quality control, codes of practices, guidelines, recommended practices, standards requirements[1].

Standards and Guidelines are primarily established for PV hardware, both for PV system (SHS, BIPV, pumping systems) and for each PV component (module, charge regulator, inverter, battery, lighting, pumps, cabling and other accessories).
For example, the term « Standard » usually includes the following issues:

a. Functional characteristics (electrical, mechanical, thermal)
b. Environmental tests
c. Quality Assurance
d. Criteria for quality evaluation

Table 1 "Standards Content" illustrates common parameters /specifications identified for each PV component and for PV system.

In addition to standards and guidelines generally linked to hardware quality, specific QA procedures, best practices and recommendations are also requested for service quality at the different steps: design, sales, installation, acceptance, operation, maintenance, replacement, training, and monitoring.

In order to describe the degree of implementation of PV standards in a given country, we use the following terminologies : proposed, planned, under preparation, adapted, existing, published, implemented, applied, enforced.

The terminology set in the Universal Technical Standards (UTS) for SHS specifications: Suggested (S) – Recommended (R) – Mandatory/Compulsory (C), will also be useful to achieve a regional consensus on minimum standards for PV in ASEAN.

2.2 Activity boundary for the PV theme

The Quality Assurance issue is a wide subject, even for PV technology. It is important to define clearly on which topics and aspects the background paper focuses on :

- The PV systems targeted by this background paper concern mainly small individual and collective stand-alone PV systems (SAPV) that are below 1000 Wp. Other PV applications like Grid-Connected PV systems (GCPV) and Building Integrated PV systems (BIPV) are not considered in details in this paper although several ASEAN countries (Malaysia, Thailand, Singapore, Philippines) have potential market and some have ongoing experience that could add worthwhile value for the study. (see case study in Malaysia).

[1] Major terms are defined in Annexe 3

- Quality issues investigated in this project for all main PV components: PV module, battery, charge controller, inverter, lamps … They concern mainly Technical Specifications and Standards for PV products.
- Commonly, PV systems offered to rural dwellings are supplying DC power to appliances though some countries are now promoting also AC power even for their small stand-alone PV applications. Both DC and AC are considered in this project.
- In addition, the quality of PV services as installation, O&M, training through guidelines and codes of practices, is also crucial in quality assurance process but it will be considered to a lesser extent in this project.

Table 1 : Standard Content :

	Construction	***Performances***		***Safety***			
		Functional characteristics			**Qualification/testing proc.**		
	Design	**Electrical measurements**	**Mechanical & thermal tests**	**Environmental tests**	**Quality Assurance**	**Selection, Utilisation**	**Classification**
SAPV System	terminology; requirements; technology choice; dimensions;					general guidance	
SHS							
Refrigeration							
P Lighting							
BIPV	structural design; rooftop installation			electrical safety			
Pumping	design qualification	type approval tests	wind, hail, salt, theft, all hydraulic tests, …	lightning; safety;		general guidance	
Module	minimum requirements; thin films; AC modules; array	laboratory test; outdoor/on-site test; module & array performances;	wind, hail, salt, theft, …	lightning; safety;	warranties; performance guarantees; manuf. data sheet, certification & labeling information;	general guidance	Recommended – Mandatory - Compulsory - suggested
Battery	terminology; requirements; technology choice; dimensions; …	lab/on-site testing methods (faradic efficiency(?), self discharge, capacity, overcharge/discharge capability, cycle life, …);	storage; corrosion; transportation endurance; …	safety; recycling;	warranties; performance guarantees; manuf. data sheet & labeling information;	general guidance	
BCR	requirements;	efficiency measurement; protection test; protection set points; I & V rating; power consumption		lightning; humidity; safety;	warranties; performance guarantees; manuf. labeling	general guidance	
Inverter	requirements; module integrated	efficiency measurement; protection test		lightning; humidity; safety;	warranties; performance guarantees; manuf. labeling	general guidance	
Lighting	requirements; technology choice (lamp and ballast types);	general performances (efficiency, min. freq., max. voltage, cycling, protections,…)		EMC; lightning; UV; safety	warranties, labeling	general guidance	
Cabling, …	guideline (material, sizing, installation, …)	current rating; polarity protection;	fire test	UV; lightning; earthing; safety	warranties, labeling	general guidance	

3 PV Standards status in ASEAN

3.1 PV issues in ASEAN

The current status of solar rural electrification in developing and emerging countries is not very satisfactory although the PV market is growing rapidly. At the end of 2003, about 2.4 million households in the world benefit from solar home systems. From an extensive literature review (ref. 7 - TaQSolRE project), it was found that 63% of the installed solar home systems are still working well, and 15% are not working at all. Early failures are caused by different technical- and non-technical problems. Quality assurance activities have been implemented to a certain extent in a number of countries. But their impacts on actual quality levels are still under discussion.

A similar situation is found in the ASEAN region. An analysis of the PV status and quality issues in the different ASEAN countries is illustrated by table 2 and has shown that it is very difficult to identify common issues for all countries because quality issues are related to various factors :

- the QA Policy
- the PV application
- the PV technology
- the PV dissemination mode

1. Quality issues and QA Policy in ASEAN

Over the last decade, PV technology has substantially spread throughout ASEAN as rural electrification means. Nevertheless, many unsuccessful projects have faced technical difficulties with substandard products and/or inappropriate installations and O&M services. The lack of appropriate quality program/policy for solar products and services distributed in the ASEAN region including standardisation, certification, code of practices and awareness campaigns for buyers/end-users and service providers is a major reason for unsuccessful PV projects and for impeding the promotion of PV technology.

2. Quality issues and PV applications

The type of PV applications and system size promoted by a country are also affecting the final quality. For example, Malaysian PV market is mainly focussing on professional PV applications and grid-connected systems following strict specifications and where quality is usually under control. In rural electrification programme, large SHS supplying AC power like in Thailand are usually better designed than very small SHS systems found in poorer rural areas, like in Laos or Cambodia.

3. Quality issues and PV technology

The quality of PV products and systems in rural areas has progressively improved over the last decade in ASEAN, mainly because project implementers and international donors (WB, GTZ…) are more concerned about failures in Rural Electrification programmes and have reinforced their requirements on PV products and services. For PV professional applications, the quality is usually less questionable and system performances are rather good.

Nevertheless, the local availability of poor quality - but cheap - PV products (modules, batteries, BCR, inverters, lights, …) for small individual systems is a serious threat for the commercial marketing of the PV technology. The negative image of poor quality SHS systems spread in the remote areas is hard to straighten up afterwards. Substandard products are usually supplied on the local market by non-approved national manufacturers or from illegal imports.

Therefore, countries that implement small SHS for rural electrification are facing different quality problems than countries operating large PV systems because of different components and designs. The same is true when PV components are locally manufactured or imported.

Several ASEAN countries have local manufacturers of PV products which is definitely a good move toward cost reduction and after sale services (repairing, replacement). The use of locally manufactured products as batteries, lamps is also a good choice for enforcing warranties because imported products, even from a neighbouring country, can hardly be returned to the manufacturer in case of defect.

Solar module manufacturing requires more attention and quality control as the lifetime should be more than 20 years. The Philippines have recently started high efficiency PV cells and modules manufacturing facility but it is not sure yet that the selling price of this qualified product will allow sales in the region.

The table 2 shows also that most ASEAN countries are manufacturing other solar components as electronics and lighting systems. Only Cambodia and Laos are not manufacturing but emerging projects will most probably motivate private entrepreneurs to start local assembly.

Unfortunately, it is often reported that those local products are of somewhat lesser quality than imported ones and have no specific approval required by most project implementers and financiers. They are mainly appreciated by cash buyers who are more concerned by lowest prices than quality. But low quality products also undermine many "projects".

The general trend at PV manufacturers' place is definitely improving and many products coming from large producers as China and India are now certified and of acceptable quality.

Nevertheless not all imported products are eligible as "good" quality components; substandard products may still come from various places in the world. Their poor quality is either due to bad design and low quality of components or due to circulation of rubbish products from industry. Weakness in national quality control and importation policies can lead to real quality problems, in particular for commercial market very fond of cheap products.

Local manufacturing capability is nevertheless a key factor for country development and should definitely be encouraged. Local manufacturing is a first step and Quality Assurance is the next one. The case study on Indonesian experience presented further (see § 3.8.3) will show the importance of the right formulation and implementation of standards for local products.

4. Quality issues and PV dissemination modes

Quality control mechanisms and implementation motivations in commercial market are rather different than in project approaches.

Although end-buyers are little concerned by the quality of the products on the market, suppliers/dealers might understand the long-term issue for their business and they are progressively considering instruments to improve quality of PV products. Those instruments are more oriented toward product branding, warranties, domestic component testing, labelling and disclosure than standards and certification usually used in projects.

Nevertheless minimum quality standards are worthwhile for both approaches and can be promoted for commercial markets if awareness campaigns are organised for potential end-buyers.

Since the focus has mainly been on hardware sales in project approaches, the other aspects such as installation, training, commissioning, etc. have received relatively less attention. Consequently, there are lots of examples of donor projects in solar rural electrification that failed after installation.

Another important issue for the commercial approach is the tendency to sell “components” instead of complete systems, and the greater risk to have low quality and low performance “systems” that don’t give satisfaction to the users. The immediate advantage of this approach, also called “DIY” or do-it-yourself, is that the user can buy what he can afford; that means first a battery, later on a solar module and possibly a charge controller and/or an inverter.

Unfortunately, it is extremely difficult to educate and convince rural people about the advantages of the “Package” approach:

- ⇨ Long term cost savings (less design, lower production costs, lower installation and maintenance costs)
- ⇨ Technical maturity; Higher reliability (no component incompatibility, international experiences); More flexibility for extension; More favourable warranty terms

The contributions from each project partners and the national data collected on existing QA procedures and existing manufacturers and infrastructures concerned by quality have been gathered and summarised in the following table 2.

Table 2 : ASEAN PV Standard Status

Summary of Data collection for ICRA project

	kWp SHS installed <2005	kWp SHS planned 2005-10	Locally Manufact. Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Local services	Codes for services	Aware-ness campaign
Cambodia	> 86	480	N	Y	Pl (Mo, Ba, BCR)	Pl (Mo, Ba, BCR)	UP (Mo, Ba, BCR)	UP (exept Inv)	Pl	Y (expt training)	Pl (design)	Y
Indonesia	5000	?	Y (exept Mo)	Y	Y	Y	only Mo	IEC	SNI	Y	Y	Y
Laos	195	300	N	Y	N	N	Pl (lamps)	TIS (Ba & elect)	N / P?	Y	UP	N
Malaysia	>1500	n.f.a.	Y (exept Mo)	Y	N	Y (exept Mo)	Pl / Ex	IEC / Aus / PV GAP	Pl / Ex (Aus)	Y	UP (BIPV)	Y
Philippines	640	n.f.a.	Y	Y	BPS (Ba & elect)	PNS, TUV (Ba)	n.a.	IEC / JIS / …	Pl (UP: BCR, SAPV)	Y	Pl / UP	P
Singapore	100	n.f.a.	Y	Y	Y	N	N	Y	N	Y	N	Y
Thailand	18360	6000	Y	Only Ba, BCR, Inv	Ex	Y (exept Mo)	UP (Mo, BCR, Inv)/ Ex (elect)	IEC/UL/DIN	UP (exept TIS for Ba, elec)	Y	Pl / UP	Y
Vietnam	210	1250	Y (exept Mo)	Only Mo, Ba	Y	Y	Y (exept ...)	Y (…)	Pl / UP?	Y	N	Y

n.f.a. = no forecast available

Mo PV module
Ba Battery
BCR Battery Charge regulator
Inv inverter
elect electrical accesories
SAPV Stand Alone systems

Y yes
N no
Pl planned
P proposed
Ex existing
UP under prep.

The main issues that can be drawn from the national contributions are :

- Detailed information on the quality issues and national standards are not easily available. Communication and information exchange is difficult.
- Awareness in Quality issues and PV standards within the ICRA partners is different from one country to another.
- There is a strong disparity of QA implementation levels between countries : standards, certifications and code of practices might be either existing, implemented, applied, enforced or only planned, proposed, under preparation, or not foreseen at all.
- The level of definition and implementation of standards is globally rather low in the ASEAN except for Malaysia and Indonesia. Only Indonesia has established real national PV standards; Cambodia, Thailand and Vietnam are also preparing national technical specs for stand alone PV systems. A quarter has already started the definition and implementation of PV standards; another quarter has planned to work in this field and the half left is still at a very early stage in the PV standardisation process.
- Most countries are manufacturing some components used in PV systems like batteries, electronics for charge controllers, inverters and fluorescent lamps, but majority of PV products are still imported.
- Interesting recent surveys have pointed out that the existence of standards is not synonymous with successful projects (cf. the Indonesian case study § 3.8.3). When applied, some standards might be not appropriate (too strict) and/or not well enforced (lack of resources and infrastructure). Consequently, disappointed local private actors risk progressively to withdraw or to disappear; all the PV sector (national and international) will ultimately suffer.
- From the early discussions, it seems that the lack of Standards is not yet perceived as a major barrier to the PV dissemination in the region.

In conclusion, there is no real common denominator on quality issues for the whole ASEAN region but there are several key issues that are common to sub-groups of countries on specific relevant subjects (see matrix in the chapter 5 : Conclusions)

3.2 Need for standards

In the ASEAN region, solar PV technology has been largely promoted by many projects for rural electrification (between 20Wp and 200Wp per households) and also by some private/commercial actions (< 50Wp).

The practice of selling inexpensive small systems makes PV systems more affordable to a wider segment of the population. But there is a higher incidence of system component failures and repairs in remote areas. If the systems have operational problems in some households – especially those of the early adopters – others may postpone or not purchase systems. This will inevitably restrain PV product acceptance.

Thus the lack of concern in Quality issues on PV product and services has negative consequences as :

- unreliable systems prone to failure
- large expenses to maintain systems in operation
- poor confidence from project developers, financers, service providers, end-users/buyers …
- hamper the market reputation and the development of PV technology.

In this context of proliferation and uncontrolled spread of PV systems, there is an urgent need for Standards and Specifications addressing and ensuring issues of quality and safety in manufacture, application, and use. Such standards should serve to build consumers' and other stakeholders' confidence, to reduce costs and to further the expansion of PV development.

The adoption of mandatory minimum standards and certifications of products is one important tool to reduce problems with quality and after-sales services. Such standards and certification procedures have already been introduced in several ASEAN countries (see previous table 2), but not necessarily applied and enforced. Technical specifications for tendering are still project related.

3.3 Need for harmonisation of standards

Worldwide efforts to improve quality in the solar rural electrification have focussed mainly on introduction of product standards. National standards have been formulated in a number of active countries (e.g. India, Indonesia, and Morocco) where they are used mainly to select suppliers for government projects. When one country has its own standards, this provides a barrier for international suppliers of hardware because specifications might be different from one country to another. PV-GAP is the main lobbying organisation to get international standards and quality marks generally accepted (see § 4 European Status).

As it is very difficult and a time consuming process to get a world-wide set of standards, the regional harmonised approach is a realistic approach that reinforces local economy and PV technology development, and protects end-users from low quality products and services. Nevertheless, there is little concern among ASEAN countries due to a lack of awareness regarding quality issues and its impact on the potential PV market.

3.4 Standard status for PV components and systems

At national level, the most active countries in national quality assurance schemes for PV technology are Malaysia and Indonesia where standards have already been defined and implemented to a certain extend for PV products. Indonesia was the first ASEAN country to develop a complete set of national standards for their solar components and systems as an accompaniment of the large WB project (RED) with 200.000 SHS. But as the project could not go as expected with the 1997 crisis, the standards were not really applied and enforced. Malaysia has devoted efforts in QA procedures and standards for the grid connected development. (See case studies in Malaysia and Indonesia hereafter).

Recently, another group, including Philippines and Vietnam, has started the preparation of national technical specs and/or standards to support new national PV programmes for Rural Electrification, based either on international standards (IEC) or on WB references for similar projects. Thailand, despite its ongoing 290.000 SHS project, has only national standards for common electrical devices but not specifically for solar. More modestly, Vietnam has planned between 10 and 20.000 SHS for the next few years and will prepare national specifications to accompany the PV programme.

The last group, including Cambodia, Lao and Singapore, has done very little in terms of PV quality actions. Sufficiently large-scale projects are just emerging in Laos (4000 SHS installed and 10.000 SHS planned) and in Cambodia (12.000 SHS planned), and this justifies new efforts in quality assurance and standards establishment. Obviously Singapore is a separate case because it has no off-grid market for PV technology but there is a new interest for building integration and grid connection. All ICRA partners have expressed their interests in exchanging information on quality aspects and harmonising the standardisation approaches inside the ASEAN.

Quality issues in ASEAN can also be classified per component :

- Modules : Except Thailand, most ASEAN countries are massively importing PV modules. IEC international standards are regionally approved.
- Battery : the different ranges of technologies used for SAPV systems and the different capability to locally manufacture make difficult to set regionally approved standards. Terminology should be fixed and minimum specs can be reached per sub-group of batteries and countries.
- Charge controller : same comment as for batteries. Very few standards exists. UTS and WB specs developed in China are a good start for harmonisation. But final settings depend of the battery choice (lifetime vs. cost).
- Inverter : only limited number of countries are using inverters in rural electrification programmes (higher standings). Moreover, few standards are developed for small SAPV systems. Minimum standards will be needed for community applications in all ASEAN countries.
- Lamps : lamps and ballasts are frequently manufactured locally but many international standards are too strict and look for high performances instead of reliability and durability.
- SAPV system : There is a wide range of PV systems and requirements for rural electrification. Technical specs and standards need to be designed specifically for each application.
- Installation, O&M : several recent initiatives have established guidelines and codes of practices for installers and service providers (O&M). Those documents are even more difficult to “standardise” because of the very large range of contexts that characterise rural areas, even within a country.

3.5 Major standards actors

At the ASEAN regional level, very few actors are involved in the formulation of PV standards. .

The following table 3 “Key Actors” summarises the main actors identified for each country in the PV field. The organisations or companies that are involved in Standards or Quality Assurance programme – are pointed out in “bold” in the table. (See also the case studies on Malaysia, Philippines and Indonesia). Detailed addresses and links are available on the ICRA website.

Table 3 : Some Key Actors

ASEAN								
ASEAN	Cambodia	Indonesia	Laos	Malaysia	Philippines	Singapore	Thailand	Vietnam
ACE	MIME	BPPT	MIH	Ministries	**DOE**		DEDP	**Inst of Energy**
NRSE-SSN	EDC	**MEMR**	DOE	**PTM**	DOST		NEPO	**SOLARLAB**
	EAC	RENI	EDL	**SIRIM**	DAR		EGAT	EVN
	REPSA	APETINDO	WB/GEF	CETDEM	DILG		PEA	AST
		BSN	SUNLABOB	FFM	NEA-AED		AIT	SELCO
		BUMN/BUMD	P-ESCOs	MIDA	REAP		**Sol En Cent**	NASO
		METI		INTEM	PEI		Solartron Co	solar dealers
		APSURYA		MORD	**UPSL**		MoE	battery manuf.
		GENI		MEWC	LEAD		WB/GEF	local banks
		WB/GEF		WB/GEF	PNOC			WB/GEF
		SUNDAYA		TNB	NPC			
				SESCO	CEBECO			
				LLS	CEPALCO			
					PSES			
					PHILRECA			
					21 ANECs			
					WB/GEF			
					ADB, UNDP			
					JICA, KfW, Ausaid			
					WWF, nNGOs			
					SEC			
					MATEC			
					BP SOLAR			
					SPP			

3.6 Guidelines and code of practices for PV services

As mentioned before, the quality of Services – design, assembling, installation, commissioning, O&M, and training – is also affecting strongly the performances and reliability of the systems. Little efforts have been devoted on this issue in ASEAN and the status is also very different from one country to another. In the framework of international and government supported PV projects, specific guidelines and codes of practices are more and more used, based on similar experiences but they are different from one project to another. Harmonisation of quality requirements - at least at national level - is highly recommended.

In ASEAN, only Indonesia has formulated a code for PV servicing for stand alone PV systems (SAPV). More recently, Malaysia has prepared electrical & mechanical installation codes for BIPV and GCPV applications. Other countries are also preparing similar documents for their rural electrification programmes (Lao, Cambodia, Philippines, Thailand). Better consultation between member countries could benefit all and initiate the drafting of a more regional guideline document, although local adaptation will always be necessary.

Several European projects such as CESIS (Certification and Standardisation Issues for Sustainable PV Market in DC) and TaQSolRE (Tackling with Quality of Solar Rural Electrification) have focussed on those quality and certification issues in developing countries and their outputs (project database, quality control procedures, guidelines, recommended practices, website) can be worthwhile to improve PV system performances and sustainability.

3.7 Training accreditation & awareness campaign

Training

Although training issues are essential for long-term sustainability, little detailed information and feedback from experience have been collected on training aspects in ASEAN countries. Beyond end-user training, installers and other operators really need appropriate and approved training to guarantee the quality of their work and increase the confidence of other implementing actors.

In some countries where the quality assurance process is more in advanced (Malaysia, Indonesia, Philippines, Thailand), there are usually both testing infrastructures and training centres approved by government or international organisations (see previous table 2). The first can certify the quality of some PV components or systems for domestic use and the second can deliver certifications to service providers after passing final tests. But there is often a discrepancy between infrastructure, procedures and documents on the one hand, and the real quality of installed systems and after-sales services on the other hand.

For instance, a testing facility like in **Malaysia** is not yet ready for specific PV testing; investment costs are usually very high to get all the necessary testing and measurement equipments. The implementation and accreditation of such testing laboratories is rather complicated, costly and time consuming. Only a regional approach is reasonable to verify standard compliance, to simplify logistics and to reduce testing costs.

In **Laos** for example, the World Bank project has initiated with the MIH a document “Best Practices in Laos” to accompany the first phase of the off-grid project (PV and hydro) with the implementation of Energy Service Companies (ESCOs) and Village Electricity Manager (VEM), but the quality of some SHS installations seems to be modest and specifications are not followed rigorously. Selection and training of installers remain a key issue, as well as the supervision and technical assistance. PV products are mainly coming from China and Thailand and have an acceptable quality, according to local suppliers. Substandard products have not been denounced yet but quality and performance control by an accredited laboratory is really a necessity. Another PV rural electrification project in Laos with JICA has been designed to provide installation training to local technicians as well as basic O&M training to the PV User Association. It is planned to train local technicians prior to start the project implementation and then to train further ‘on-the-job’ during installation. Strict system commissioning and skill evaluation should be considered for the long term success.

In **Indonesia**, in order to constantly improve the technical skill of the local PV operators, the chief technician provides re-training every six months in the replacement of spare parts. This should ensure that existing staff have refresher training but also that any staff changes are accommodated.

Feedback from experiences and information sharing between ASEAN countries is really a must for improving quality of PV installations and for harmonising training for PV services

<u>Public education and Awareness campaign</u>

A lack of awareness among end-users is often denounced by private operators but very little effort has been done to organise specific campaigns at national level in ASEAN countries. Such support is not only needed for buyers/end-users, but also for manufacturers and dealers, as well as for project implementers.

For example, buyers or end-users need to be informed about quality importance, cost/quality ratio, criteria to select qualified PV products and service providers, simple quality control procedures, performances and limitation of their systems, lifetime of components, hidden cost for repairing and replacement, etc.

For commercial sales markets, awareness campaigns should include specific education of potential buyers regarding quality of products and to give them appropriate means of component selection

Manufacturers should be informed about the benefits to improve quality. They should be assisted to improve quality of their products without increasing the manufacturing costs, to improve the cost-effectiveness of their business with more satisfied customers, etc. The case study on China in the § 4.7 presents shortly such efforts achieved to support the manufacturing sector

3.8 Case studies and feed-back from ASEAN experiences

3.8.1 Malaysia

Off-Grid systems (SAPV) :
Malaysia has initiated several off-grid PV projects in the past but rural electrification with SHS has not been a real success. Main barriers identified today are the high subsidy level of the government, the lack of capabilities of the private sector (management and O&M) and the lack of awareness on end-users. In addition, most of the SHS programmes have not paid much attention to quality of components and services and most SHS don't meet the rural needs (productive purpose…). Little detailed data are available for this off-grid system but it is estimated that about 1.5 MWp have been installed up year 2000, including SHS, telecom and other off-grid applications.
In the framework of the national goal to electrify the remaining 7% of the population (2002), the Ministry of Rural Development (MORD) has initiated and implemented since 1994 several PV projects with Siemens and BP Solar, totalling about 6400 SHS. Nominal power ranges from 160 to 240 Wp for AC systems with imported inverter. Only 5 systems over 40 are still working since their installation in 1994. The operating yield is about 30% since 1996. Major problems are related with battery and inverter quality and low awareness of users, and these have led MORD to improve the design (sealed batteries, locked box, special electronic device to limit the DOD) and to train rural users. Thus, national SHS programmes are very costly: imported components, "fee-for-services", all maintenance, replacement, rehabilitation are supported by MORD and MEWC (Ministry of Energy).
However, the recent trend is to design either hybrid systems combining PV/Diesel/battery sources or mini-grids with diesel gensets to respond better to the erratic need of power and energy in rural settlements. TNB for example, the largest Malaysian Utility, has been encouraged and supported by the government to develop in the renewable sector and to play a key role as PV designer, integrator, implementer in future projects. Thanks to their wide offices' network in the rural areas and their deep knowledge of rural needs, they are well designated for reliable O&M at low cost, compared to other private companies. Today, they have only few pilot hybrid systems under monitoring (TNB + MORD). They use their own specifications for product procurement, service tendering, and they use their own research centre for in-house testing.
Grid Connected systems (GCPV) :
Although Grid connection and Building Integration of PV generators (BIPV & GCPV) are not considered in this study, it is interesting to mention that this new market is emerging in Malaysia for urban applications and about 500 kWp have been installed since 1998 (14 installations). Quality is a major issue for the national M-BIPV programme to guarantee safety, reliability and performances of PV systems. A specific Quality Assurance programme is exclusively devoted to the MBIPV activities to meet national building mechanical and electrical codes. Adapted local testing and training capacity and infrastructures are under implementation. Although quality control issues are very different for remote application in rural areas, QA procedures, infrastructures and know-how will certainly benefit the stand-alone PV market.
PV Product market :

- Although many components of PV systems are imported on the Malaysian market, there are local infrastructures to assemble modules (BP Solar) and to manufacture batteries, electronic devices as BCR, ballasts, fluorescent tubes, and electrical accessories as cables, switches, plugs, meters, … Only inverters are not manufactured in Malaysia yet.

- Several PV products on the market have international certifications but from various sources. Some PV components may be Class II certified but without IEC, some may only be UL tested (safety).
- There are no national standards for specific PV products yet in Malaysia, except for electrical appliances and accessories, but standards for modules and inverters are planned in the short term to meet the need for Grid Connected PV systems (GCPV). In the past, most rural application projects were implemented by the government and therefore were subjected to the Government procedures and specifications. Most international standards have been adopted as IEC, UL, EN, AS and PV Gap. Although IEC standards are preferred in most cases, for remote application, PV GAP is frequently recommended until a better IEC standard becomes available.

<u>Standard needs and harmonisation</u> :

- Standards for PV products are presently on voluntary basis in Malaysia but in practice they are indirectly mandatory as most projects are run by the government and incentives shall only be given to products that comply with approved standards/specs. Nevertheless standards might become mandatory in future GCPV projects. For example, PV modules should have IEC/UL and Class II certificates. Electrical safety Class 2 is compulsory in building integration for safety reason.
- Based on Australian Standards, an expert team (PTM, TNB and SIRIM) is preparing national **technical specs and standards** for GCPV systems and to regulate the PV business. The installation standard will deal separately with technical performances and safety issues. National bureau of standards is not involved in this work as they have no PV experience. For Stand Alone PV Systems (SAPV), no specific work is planned, in particular for batteries and charge regulators.
- There is a national **testing facility** (SIRIM) that can control quality of various products but not yet for module and inverter performances. Additional investments are needed to allow verification of product standards compliance and recognition at regional level.
- Harmonisation of standards for the ASEAN region is useful but is not considered as a priority in Malaysia as the market for rural application is limited (by the high electrification rate) and the rare projects are run by government with their own rules and specs. Nevertheless, there is a real lack in information exchange between ASEAN countries and therefore there is a need to share experiences on quality issues for rural PV projects.

<u>PV Service availability</u>:

PV services from design to O&M can be found in a certain extend in Malaysia. Although many private companies are active in solar business in the country, most of them have low level of expertise and management capability. QA process does not exist yet for PV services.

National **codes of practices** for installation, training and commissioning will initially be implemented on voluntary basis. A Malaysian electrical code for installation is planned to be published by mid 2005, based on British, AS/SNZ, IEC, IEEE, UL standards (including requirements for protection, wiring, component, grounding, marking, documentation, commissioning, and maintenance). A working draft is already available.

It is also planned to have an national accredited **training centre** to qualify PV service providers and to deliver competency certificates.

In the whole QA process, it is foreseen to establish a **"watchdog" body** that will provide an independent check and verification of Standards and QA procedure implementation and enforcement. This quality control scheme requires additional budget that will need to be reflected in consumers' tariff.

Awareness Campaign:

Important awareness campaigns have been proposed under MBIPV programme for all stakeholders: suppliers/dealers, service providers and end-users/buyers.

Standard compliance/certification may increase cost of products/systems and therefore other positive aspects need to be highlighted to convince stakeholders and end-users.

Programmes shall educate private consumers to warn them about quality requirements, to inform them about the existence of standards for products and services and to select competent installer (code of practices, training, and documentation). With previous SHS programmes in remote areas (Sabah province), there was a real social problem with disrespectful end-users due to a lack of budget to give appropriate information and training. Technical failures in Sabah occurred during the 2nd year of operation and it is very difficult to change the end-users' mind after such time.

In general, technical as non-technical problems rarely occurs before few years of operation and therefore it is very important to consider all aspects (components, design, installation, and training) before and during the implementation phase to avoid failures or losses of performances.

3.8.2 Philippines

General context:

The Philippines has been the field of dozens of bilateral aids projects for various PV Solar applications (EIES, PRES, SPOTS, MSIP, AMORE, Pangan-An, Palawan, Shell-RESCO…). Some have already been implemented and others are still ongoing. Barangay Electrification programme counts today about 600 PV Solar Charging Stations, more than 1000 SHS and 300 hybrid systems installed. Beside its large Off-grid PV electrification, the Philippines is also experimenting the first large PV power plant (1 MW) connected to the power grid in combination with a hydro scheme (7 MW).

Key Actors:

With the long PV experience in the country and unfortunately a large number of unsuccessful projects (many grants!), it seems that the PV sector (both government and private actors) is now well aware about quality issues and is really concerned by quality improvement.

The country has a good infrastructure level with a bureau of standards, but not involved in PV yet, and 2 testing laboratories (at DOE and at University). Training programmes for approved technicians and accreditations are also considered by DOE and ANEC regional centres

For example, the recently started SPOTS project has already difficulties with end-user awareness level and social preparation before implementation. One reason could be the large number of involved actors (DAR – DOE – international and local companies) and unclear responsibilities between them.

Standard needs and harmonisation:

National technical specifications for solar home systems (SHS) are being prepared for the World Bank project (see further). National standards on lead-acid batteries are also considered under the WB project.

More recently, the elaboration of national standards for PV stand-alone systems has been embodied in a UNDP-JICA-DOE project dealing with CBREP "Capacity Building to Remove Barriers to Renewable Energy Development in the Philippines".

Barriers:

The main identified barriers for PV development in the Philippines are:

- High cost for the PV technology

- Awareness and acceptability limitations of consumers
- Low sense of ownership from consumers and low willingness to pay for electrical service
- Limited competent personnel in rural areas
- Standards and after sales services limitations
- Direct and indirect subsidies to conventional power generation in the island grid affect the competitiveness of solar energy in the area
- Lack of confidence from financiers and project implementers
- Divergences between Government and private sector.

WB Projects and "WB standards":

A preliminary draft titled "Specifications for Solar Home Systems" has been prepared by DOE under the WB assisted Rural Energy Project and was based on the World Bank model already developed in previous projects as Indonesia, Sri Lanka, Bangladesh, China. Any product as PV module, battery charge controllers, DC fluorescent lamps, and DC-AC inverters must have test certificate from an accredited testing and certification organization acceptable to the Republic of the Philippines and the WB stating that the PV System meets or exceeds the specifications. In the WB procedure, it is requested that only ISO 25 (or equivalent) accredited organisations can issue valid component certifications.

All SHS components or systems that bear PV Quality Mark or Seal or certified according to PVRS requirements, licensed by the PV GAP organisation (see § 4.3.4), will be acceptable for use in the WB SHS Project. Moreover PV components that have been tested and approved under previous WB project as Sri Lanka and China are on a qualified product list available at the Project Management Office and are eligible for use in the Philippines Rural Energy Project.

3.8.3 Indonesia

(with the courtesy of F. Nieuwenhout – ECN – Taqsolre project)

General context :

- Good potential of solar energy, with the daily average intensity of 5 kWh/m2/day.
- Current installed capacity of solar photovoltaic in Indonesia is estimated to be about 5 MW.
- Developing the national ability in manufacturing solar photovoltaic module
- Increasing the use of the PV-system, both in rural and urban areas
- Establishing the mechanism of PV-system opportunity for grid connection.

Key Actors:

In Indonesia, PV deployment programmes are strongly government supported: mainly by MEMR, with other institutions and universities, in close collaboration with the National Standardisation Bureau (BSN). Government institutions usually deal with :

- Policy and regulation maker
- Research, development and study
- Education and training
- Standardisation

Some major state owned enterprises (BUMN, BUMD …) share the business market with other small private companies, cooperatives, and banking institutions.

Barriers : for PV development

- High investment cost
- Out sourcing dependency
- Higher energy cost
- The market is still limited
- Low human resource capability

- Less supporting infrastructures
- Less support on capability of service and industry.

WB Project experience:

In the early nineties, the World Bank/ GEF assisted Renewable Energy Development (RED) project was conceived. The solar component had a target of 200.000 solar home systems. When everything was ready for the start of implementation, the financial crisis of 1997 made the provision of loans in rural areas impossible. Economic recovery in Indonesia was very slow and project design was not flexible enough to cope with these adverse circumstances. End of 2003 the project was stopped after about 7.000 solar home systems had been distributed. One of the positive outcomes of the project is the establishment of a comprehensive quality assurance infrastructure.

Business plan:

To become eligible for support through the RED project, companies had to submit a business plan containing a description how they intend to install the systems and establish a local service infrastructure. Through the Project Management Office, companies could receive support in formulating these business plans and obtain training in business development.

Technical standards:

Technical specifications were formulated. Originally, the Staff Appraisal Report stated a minimum module capacity of 50 Wp. Modules have to meet the internationally recognised standards. Batteries were required to meet an Indonesian battery standard (SII 0160-77). Use of locally made car batteries is allowed. For the remaining BOS components standards were formulated. An existing solar energy laboratory (LSDE) was assisted to obtain official ISO Guide 25 accreditation as a certified solar component-testing laboratory. Post-installation monitoring was foreseen through random audits [World Bank, 1996].

Test and quality control:

The first round of component testing was done by UL because LSDE was still preparing their testing facilities. Somewhat unexpectedly, the fluorescent lights had most problems in passing the tests. Fluorescent lights from four local manufacturers were submitted for qualification. A high quality, high-cost fluorescent light was the only one that immediately passed the UL tests. ECN was asked to assist the other three manufacturers to improve their designs. One was a simple one-transistor design that could not be improved to meet the standards. Adoption of a complete new design was the only alternative. The two others were based on the same principle. They were good quality designs, but both did not meet the efficiency requirement by a few percent. One of these designs had been in production already in Indonesia for years and more than 100.000 units had been sold at that time. The other design was a prototype that was not yet in large-scale production. Optimising the electrical component values resulted in a slightly higher efficiency, but still just below the requirement. Only when the cheap diode would be replaced by a much more expensive varistor, the efficiency requirement could be met. Due to the absence of a substantial project demand at the time of the ECN design assistance (1998), none of the manufacturers implemented the ECN recommendations. When the RED project eventually took off, the two fluorescent lights obtained a certificate from LSDE. This illustrates the need for well defined standards that prevent sales of low quality products, but not necessarily target at achieving the highest efficiency levels [Unpublished ECN laboratory work in 1998]

Monitoring:

Some years later, ECN became involved in monitoring a follow-up activity of a large, Australian funded solar home system project in Indonesia (the AusAid project). We encountered many problems with the fluorescent light inverter, which was produced by the company of which the prototype design just did not meet the requirements in the beginning. They had discarded their original design and instead were producing a modified version of the expensive design of another company, which immediately passed the UL test before. Some electrical components were replaced by cheaper ones. One of these components has a design value that is very close to the maximum current level that can be expected in the inverter. Consequently, the failure rate due to burned inverters is substantial. At least 120.000 of these inverters have been produced for the AusAid project and local government projects [field findings monitoring visits BPPT-ECN 2000-2003].

Impact of standards:

The overall impact of introducing standards for fluorescent light in solar home systems in Indonesia on the quality of fluorescent light inverters in the field has been negative. The low-quality producer stopped production before the RED project actually took off as a consequence of the financial crisis of 1997. The local producer for the government projects replaced its basically good design for a bad imitation of an expensive high quality design. The other local producer continued to produce his un-modified design, mainly for export. More than 1.000.000 have been sold at the end of 2003, which indicates that this design is meeting customer requirements.

This example of a negative effect of introduction of product standards on the market in Indonesia is likely to be an un-typical case. However, it illustrates that formulation and implementation of standards does not necessarily always lead to the desired quality improvements. There is a need for sufficient flexibility that allows reacting on field findings of badly performing equipment that nonetheless have obtained an official certificate.

4 EC Status and international State of the Art

4.1 Needs in QA, Standards and Harmonisation

Over the last decade, PV technology has shown a rapid growth in Europe, Japan and United States of America. The consecutive development of Quality Assurance programmes with appropriated standards and certifications has strongly improved the image of this new technology and has allowed a massive dissemination throughout industrialised countries. Although most activities in quality assurance and standards have been oriented for their own market (i.e. mainly BIPV and grid-connected), the experiences and the lessons learnt are worthwhile for the implementation of appropriate standards in developing countries for stand alone application.

Standards are usually the result of voluntary agreements between all interested parties. They are developed at either national, European or international level. It has been ascertained that the existence of non-harmonised national standards for similar technologies in different countries or regions can contribute to so-called ‘‘technical barriers to trade’’. Export-minded industries have long sensed the need to agree on supranational standards to help rationalise the international trading process. Harmonisation diminishes trade barriers, promotes safety, allows interoperability of products, systems and services, and promotes common technical understanding.

In practice in the European PV sector, the benchmark in terms of PV standards is certainly the international standards from IEC, more than the European CENELEC standards dealing with PV in Europe, unless several IEC lacunae. In many developing countries, the World Bank has somehow the leadership in formulating technical specifications for large scale project bidding and promoting national standards and certifications. Nevertheless, Asian countries are also strongly influenced by QA programmes from Japan and Australia. Details are given in the “Actors” section § 4.3.

4.2 PV Standards Review

Several important investigation works have been achieved to identify and analyse the different existing standards throughout the world. One of the most recent international analyses is the work done by the T3 group of experts (IEA) “Survey of National and International Standards, Guidelines and QA Procedures for SA PV Systems” – 2004. This thorough examination focuses exclusively on Standards established by member countries (including USA) but refers also to some QA Best Practices in Developing Countries. The table 4 “PV Standard Review” summarizes the existing standards and standards under development in major active countries, as it has been found in the literature. The status of existing Guidelines, Recommended Practices and QA procedures is more difficult to find. The first part of the table refers to IEA members with USA and to ASEAN but other key countries have been added in the right hand side of the table (Asia, Africa and South America).

A similar list has been developed by GTZ where they have analysed each existing standard and they present their relevance level in a scale from 1 to 6. (ref 3)

Table 4 : PV Standard Review (non exhaustive; data on Africa and South America have been removed)

	IEA members													ASEAN								Rest of Asia						
	International	International	International	EC	Japan	Australia	Canada	USA	USA	USA	Germany	France	UK	Cambodia	Indonesia	Laos	Malaysia	Philippines	Singapore	Thailand	Vietnam	Nepal	China	India *	Bangladesh	Sri Lanka	Korea	
Existing Standards	**IEC**	**ITU-D**	**PVGAP**	**EN**	**JIS**	**AS**	**CSA**	**UL**	**NREL**	**IEEE**	**DIN**	**NF**	**BS**		**SNI**					**TIS**								
System	8	1	3		1	3			2	1														3				
SHS															3								1		1	2		
BIPV - GCPV	?					?											*AS*											
Pumping	1																											
Cells & Module	16		2	1	6	1	1	1			1				7		*IEC*	*IEC*		*IEC*				5				
Battery	17		1	1	2	6	1			4	1	2			1		*IEC*	Y		*DIN*								
BCR	1		1		2			1							1		*IEC*			*UL*			1					
Inverter			1														*IEC*			*UL*			1					
Lighting	8		1										2		1	*TIS*	Y	Y	Y	*TIS*								
Cabling, …																*TIS*	Y	Y	Y	*TIS*								
	51	**1**	**9**	**2**	**11**	**10**	**2**	**2**	**2**	**5**	**2**	**2**	**2**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**8**	**1**	**2**	**0**	**0**
Standards under devel.	**IEC**	**ITU-D**	**PVGAP**	**EN**	**JIS**	**AS**	**CSA**	**UL**	**NREL**	**IEEE**	**DIN**	**NF**	**BS**															
System	7				2																							
SAPV																		X										
BIPV																	X	X										
Pumping	1																											
Module	9			2										X			PI				PI							
Battery														X							PI							
BCR	4													X							PI							
Inverter				1													PI	X			PI							
Lighting														X							PI							
Cabling, …														X							PI							
	21	**0**	**0**	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

4.3 Major standards actors

As mentioned earlier, primary standards and specifications for common products are usually implemented by recognised national institutions but they can also be developed at other levels.

4.3.1 At project level:

In countries recently involved in PV technology, quality issues are often related to subsidised or government projects. In countries where quality is not a national concern, solar PV electrification project implementers (government, national or international agencies, NGOs …) have to set themselves appropriated technical specifications for procurement and quality control mechanism. Experiences and models of specifications from neighbour countries or international projects are often used and adapted. This work has to be repeated and adapted regularly for each project due to technological progress and specific local context and could be the basic material for future national standards.

4.3.2 At a national level:

Most countries have an official standard body that defines, implements and controls standards for products and services; like, for example, Association Française de Normalisation (AFNOR), American National Standards Institute (ANSI), British Standards Institution (BSI), China State Bureau of Quality and Technical Supervision (CSBTS), Deutsches Institut für Normung (DIN) or Standardiseringen i Sverige (SIS). However, for PV technology, not all of them are involved in standard drafting and enforcing, due to a lack of internal competency or interest. National situation regarding the PV standards might be very different from one country to another, depending of different factors: willingness to have own national standards or to adopt other ones; actual processes by which formal standards are established and enforced; size and degree of expansion of the PV technology business (production, sales and/or installations).

For example, the Deutsche Elektrotechnische Kommission (DKE) actively represents the German interests in the international and/or European standardisation organisations IEC, CENELEC and ETSI, in particular for PV. The results of the standardisation work in IEC, CENELEC and ETSI are transposed into harmonised German standards (DIN and VDE) and published by DKE. Few DIN standards have however been identified for PV technology.

On the other hand, Australia and Japan have a large number of Standards related to SHS and PV components. Due to proximity and closer relations, several ASEAN countries refer to those standards in their project implementation (ex. Malaysia, Philippines, Indonesia). 19 Japanese standards are related to PV cells and modules measurements and 8 to PV array, structures and systems; only 2 are for solar batteries and 3 are for power conditioning for PV. In a recent publication (ref. 4), Australian AS standards have been compared with IEC Standards.

4.3.3 At the European level,

In Europe, there are basically three standards bodies: the European Committee for Standardisation (CEN), the European Committee for Electro technical Standardisation (CENELEC) and the European Telecommunications Standards Institute (ETSI). Their mission is to develop and achieve a coherent set of voluntary standards as a basis to a Single European Market without internal frontiers for goods and services inside Europe. Their work is carried out in conjunction with world-wide bodies and the national standards bodies in Europe.

The European standards bodies have the task of drawing up the corresponding technical specifications meeting the essential requirements of the EC Directives, compliance with which will provide a presumption of conformity with the essential requirements. Such specifications are referred to as ‘‘harmonised standards’’. Compliance with harmonised standards remains voluntary, meaning that manufacturers are free to choose any other technical solution that provides compliance with the essential requirements.

The main standard body involved in PV technology is the CENELEC (European standardisation body for electro technical issues on European level) responsible for harmonising the electrical engineering standards in the framework of European Union and since 1995 has been mandated to establish its own task force to prepare European PV standards. This task force was later changed in a Technical Committee, known as CLC/TC 82. Although the standard making process is similar to the IEC, the EC organisation has a less developed working programme with only 3 different working groups : (i) cells and modules; (ii) inverter and grid connection; (iii) Building-Integrated PV (BIPV). About 90% of the CENELEC standards are taken over directly or with joint European amendments from the results of the IEC's work. The standards ratified by CENELEC (identical numbers as IEC Standards) are recognised by the 18 member countries as the only valid national standards. Today, CENELEC has published only 2 standards on module and stationary battery, and 3 are under development for modules and inverter. There is a rather low level of effort devoted for developing stand-alone and SHS system standards.

On the other hand, the European Joint Research Centre JRC (ESTI-ISPRA) is worldwide recognised for the development of specific test procedures for PV technologies. This testing centre has worked jointly and closely with IEC, in particular to control performances of PV cells and modules.

4.3.4 At the international level,

IEC, ISO, ITU

IEC, the Standard organisations for electro technical issues, elaborates and passes electrical engineering standards at international level. Today the 49 National Committees of the IEC represent over 80% of the world's population and over 95% of the world's consumption of electrical energy. The IEC standards are applied in over 100 countries and especially in international trade. ISO and ITU are respectively Standard organisations for non-electrical/electronic issues and for telecommunication technologies.

IEC is establishing the norms, standards and is developing with JRC (ISPRA) the test procedures. In Europe, certificates are delivered by TÜV and ARSENAL to PV products that comply with IEC Standards. To verify the certification and avoid fake paper, IEC is publishing the list of certified products on their website. IEC is issuing well-known performances standards for PV modules which are accepted internationally, including in Bank-funded projects.

Safety issues are usually considered in various standards as IEC, UL and Class II. Several countries worried about safety for their grid connected applications, are also using mixture of IEC/UL/Class II Standards.

One of the main drawbacks of the IEC standardisation is that standard establishment is complex (international consensus) and the procedure takes in average more than 40 months. Technical Specifications and Publicly Available Specifications (PAS) are faster alternatives for specific and urgent needs.

PV GAP (Global Approval Program for Photovoltaics)

PV GAP is another recognised international organisation based in Geneva, dedicated to the sustained growth of global photovoltaic (PV) markets to meet energy needs worldwide in an

environmentally sound manner. It promotes the utilization of quality PV products and distinguishes them from products of unknown quality.
PV GAP has a close working relationship with the IEC. The PV GAP approval system relies on the IEC standards, but can also accept national standards as Recommended Specifications for PV (**PVRS**) often considered equivalent or complementary to IEC Standards or IEC Publicly Available Specifications (PAS). This was already demonstrated by PV GAP accepting the specifications for PV controllers and inverters established under the Bank/GEF-assisted China Renewable Energy Development Project (see further case study § 4.7.2).
In addition, PV GAP has developed Quality **Marks and Seals** for PV products that comply with the quality standards the Bank Group. This should eliminate, for products so marked, the review of the credentials of each product a PV manufacturer wants to sell for a project supported by the World Bank. And it also should simplify administrative procedures, reduce cost to suppliers, give the buyers a greater confidence in the quality of the products, and encourage inter-country trade.
Despite this optimistic announcement, it seems that PV GAP recommended specifications and quality Marks/Seals have been little used in worldwide projects until now. Some Standard experts are criticising this approach and have pointed out that most PVRS are module oriented and little towards the BOS. And even when it is the case, as the recommended specifications from NREL - PV GAP used in China, the requirements are rather too low.
Manufacturers might be worried by restrictive procedures to certify PV products (IECEE Conformity Assessment Certificate2), too sophisticated tests requiring high technologies, high cost for labelling, or simply by non-appropriateness for developing countries; as for example, international quality labels can hardly being implemented for locally manufactured batteries.

PV GAP has also formal liaison with **IECQ**, the IEC's Quality Assessment System for Electronic Components, which is currently providing product approval services for PV GAP. This includes the review and approval of accreditation certificates of PV testing laboratories and thereby provides reciprocity, i.e. testing results of a laboratory in one country are accepted in other countries. IECQ product approval requires also, that the manufacturer holds a valid ISO 9000 certification.
After IECQ approves a manufacturer's PV products, the function of PV GAP is to issue a license for the manufacturer to apply the PV Quality Seal on PV systems and the PV Quality Mark on PV components. This visual recognition simplifies for customers the selection of quality products. It also eliminates the need of country-by-country re-certification, as the credentials of the PV manufacturer and the product were established by PV GAP (IECQ). It also satisfies the World Trade Organization's "Agreement on Technical Barriers to Trade," which makes standardization and the assessment of conformity to standards an important part of the global trade agenda and cites IEC as one of the major partners in establishing standardization.

<u>The World Bank Group</u>

[2] IECEE CAC :

- Quality Management System (QMS) and factory inspection (ISO 9001:2000 certificate)
- Comply fully with the applicable IEC PV Standard, or an IEC PAS or if any, a PVRS.
- Use of accredited PV testing laboratories (ISO/IEC 17025)
- Follow Re-testing requirements according to Blank Detail Specification
- Comply with auditing and factory inspection requirements

The Bank Group is supporting PV projects in many countries, as India, Indonesia, Sri Lanka, China, Vietnam, Philippines, Lao PDR, Morocco, Argentina, Mexico, Honduras, Togo, Benin, Cape Verde, Uganda, Kenya... Since the broad application of the technology is at a relatively early stage, the projects have led efforts to develop and apply quality standards for PV components and systems where international or national standards were unavailable. As such, these standards, sometimes called "WB PV Standards", were project- and country-specific.

These "WB standards" have definitely led to improvements in quality and importantly, a greater awareness and acceptance of PV product quality requirements. Nevertheless, it would be more efficient and cost-effective if internationally- or regionally-recognized quality measures were adopted where appropriate.

To be eligible for use in Bank-assisted projects, PV components or systems should either comply with: (a) relevant standards issued by IEC, ISO or similar standards/certification organizations of international standing, (b) appropriate national standards, or (c) bear the PV GAP Mark or Seal.

Example: WB Technical Specifications for SHS, Bangladesh, 2002

In the framework of the Rural Electrification and Renewable Energy Development Project (REREDP) funded by IDA/GEF, technical specifications have been prepared by Technical Standards Committee for photovoltaic modules and other SHS equipments.

Salient features include Hardware Description, Component Specifications, Certification Requirements, Recommended Practices, Users & Technicians Manuals, Packaging and Delivery, Maintenance.

Universal Technical Standard for Solar Home Systems, 1998

Another pioneering initiative for sound technical specifications of different RETs components is the Universal Technical Standard (UTS) that has been prepared by European partners in 1998 based on a world-wide review of existing technical standards for SHS. It is intended to provide a basis for technical quality assurance procedures, to the extent that meeting the specified requirements will produce a SHS that will perform adequately. Therefore, it is aimed to provide a quality reference for procurement specifications issued by National Governments, donors and investors. Adaptation to local condition is of course recommended. The document can also be used as a design guideline for SHS manufacturers and installers.

Until now, many developing countries as Nepal, Malawi, Philippines, Morocco, India, Indonesia, Mali, Peru, Bolivia … have utilised the UTS-SHS as baseline in the preparation of specifications for project bidding documents, even for several WB projects.

Quality Program for Photovoltaics, 2000

QuaP-PV is a quality programme that has mainly developed and applied in 2000 a set of training modules. Under the leadership of the WB and in partnership with PV GAP and ISP, this programme involved the design of training courses and the delivery of training in the design, manufacture, testing, installation, and maintenance of PV products using quality standards and processes.

Other tasks included a review of international quality processing procedures, accreditation and licensing procedures, and a study to harmonize China's PV standards with international standards.

Four downloadable manuals (ref. 10) have been produced under this programme to cover the quality issues at each step of the supply chain, which are:

- Quality Management in Photovoltaics: Quality Control Training Manual for Manufacturers

- Training Manual for Quality Improvement of Photovoltaic Testing Laboratories in Developing Countries
- Certification for the PV Installation and Maintenance Practitioner: Manual for Implementing Qualified Certification Programs
- Solar Home Systems: Manual for the Design and Modification of Solar Home System Components

Quality Standards for Solar Home Systems and Rural Health Power Supply, 2000

This standard document, prepared by GTZ in 2000, provides an overview of standards that are relevant for Solar Home Systems (SHS) and in Rural Health Power Supply Systems (RHS). It is intended to facilitate the selection of PV systems and components, especially in tenders, and to provide the impetus for a standardisation of PV systems on a scale that is as broad as possible.
Salient features include an overview of existing specifications and recommended specifications for SHS and RHS (design, components, installation, O&M, income-generating services.

By way of conclusion, several pragmatic initiatives as WB specifications, UTS standards, GTZ recommended specs, JICA specs, etc. have been promoted for SHS and SAPV systems over the last decade to remedy the slowness and the lack of appropriateness of global approaches (IEC …). Many other technical specs and standards are also designed and promoted by donors and project implementers. No one has succeeded to become the main reference for SAPV projects in developing countries yet.

4.4 Standard status for PV Components and Systems

As mentioned before the harmonisation of standards is needed to:

- diminishes trade barriers for “export minded” industries, allows economic growth
- promote safety
- allow inter-operability of products, systems and services
- promote common technical understanding (economies of design…)
- improve production and delivery efficiency

In spite of the enormous efforts to harmonise standards in EC and internationally, there is still a chaos surrounding the many different certificates for PV components. A new trend is to move toward Quality Labels on both products and servic es (PV GAP labels, German RAL QA mark, TUV.COM) to make process easier for the customers and for the manufacturers/suppliers. For example, in Germany, best-practices guideline is defined in four areas (components, design, installation, O&M) and makes use of available IEC/EN Standards. Member companies commit themselves to compliance with the guideline. And customers also can make the RAL criteria part of a contract (purchase, installation, maintenance…).

Safety Standards are commonly related to national regulation. However, TÜV has developed an international concept for safety of electrical and electronics systems and has established a class II standard for PV modules while IEC equivalent standard is not ready yet.

Some countries have developed their own national standards in areas where European or International Standards are lacking (or not readily published). But usually local legislation contains a multitude of detailed technical specifications and becomes very vulnerable. It should be noted that drafting technical specifications is a timely and costly operation that has to be repeated and adapted regularly to technical progress.

The State of the Art of standards for PV components is described in the IEA - T3 "Survey of International Standards" and its annexes (cf ref. 2). There are several standards relating to Stand Alone PV systems and components.

IEC has only a few standards that cover those **SAPV system** aspects (over-voltage and lightning protection, characteristic parameters, performances, measurement methods, irradiation measurement …). Japanese JIS PV Standard gives quite comprehensive requirements for stand-alone PV system design. The guidelines and Technical Reports cover system classification, selection of DC or AC system, performance, output power of PV array; output power of PV system and maximum expected consecutive days of cloudy weather; as well as operational characteristics of the PV system. They include PV system components, and the structural design of a PV system. Performance test methods are outlined and the inspection procedure of the system installation. The labelling of a system is also described. Two Australian standards provide guidelines for the installation, maintenance and safety of remote power systems, including SAPV systems.

The best globally accepted standard for **PV modules** are the well-known IEC 61215 for c-Si and 61646 for thin films (a-Si …). More than 12 other international IEC standards are dealing with measurement devices and methods (indoor and outdoor). Additional Japanese standards and guidelines cover the design and the performance measurement of PV arrays for both c-Si and a-Si modules (not covered by IEC yet). UL specification (USA) and Canadian standard include some specific requirements on design, construction, performance, labelling and safety test procedures for PV modules to comply with the local regulation. German and European have developed similar standard (DIN and CENELEC) that specifies data sheet and labelling information to be provided by PV module manufacturers.

Very few standards are specifically developed for **Power Conditioners** (BCR, SA inverters). IEC has published a first standard to measure performances of power conditioning units. Japanese have similar standards. UL standards clearly deal with the construction, performance and safety test procedures for inverters, charge controllers and AC modules.

Many standards have been set for automotive **batteries** (including general requirements, test methods, dimensions and safety aspects) and they are usually relevant for PV applications. Only one IEC standard deals specifically with solar batteries; several aspects are not covered yet as battery sizing, methods of charge, regulation types (shunt / series / PWM). Two Japanese standards are also dealing with batteries for PV applications: testing of batteries discharged over a long period of time, and measurement procedures to determine the residual capacity of lead-acid batteries in PV systems. France has also a specific standard for PV batteries; IEEE has published recommended practices on lead-acid batteries for PV.

Fluorescent lamps and other electro-technical components are also covered by IEC standards applicable for SAPV systems.

By way of conclusion, there are worldwide a large variety of standards and technical specs developed for PV components. The main concerns from some ASEAN partners, as well as many other DC countries, are that firstly it is difficult to select the most appropriate standards or technical specifications for each PV component among all the existing ones and secondly adopting standards to control quality of products could increase equipment prices and administration costs.

4.5 Certification status and code of practices for PV services

Very few international documents have been published regarding recommendations and code of practices to ensure quality of PV services (installation, maintenance …). The same survey from T9-IEA as above has also listed and described some guidelines and recommended practices developed for SAPV applications by IEC, CEDRL-Canada, DRE-EDF-France, SNL-USA, GTZ, APAS-EC, PVMTI, . They largely focus on design and technical specifications for components, but some of them include recommendations for installation, operation, maintenance and best utilisation of the systems or components.

Certification of individual trainers and service providers remains a national task; each country develops its own criteria and procedures to select, to train, to assess and finally to approve the qualified candidates.

4.6 Training accreditation & awareness campaign

The Institute for Sustainable Power, Inc. (ISP) is one of the main references for the quality improvement of the PV workforce for sustainable, local jobs. This non-national and non-profit organisation was created in 1996 with the goals of improving the quality of renewable and sustainable energy projects. ISP provides (i) a quality infrastructure framework for the accreditation of renewable energy, energy efficiency, and distributed generation training programmes; (ii) the certification of renewable energy, energy efficiency, and distributed generation trainers; and (iii) the registration of programme evaluators and auditors. The intention is that ISP will work in close collaboration with PV GAP. The accreditation will give funding organisations a third party assurance of the professional skills and capabilities of any training centre or course active in the PV industry.

Today, very few training institution have already been accredited by ISP : only one in Africa (CDER); one in Asia (Renewable Energy Development Centre – Beijing); 2 in Europe (UK and Germany) and 4 in North America.

Training centres should not only deliver programmes for PV technicians but also for PV socio-economical experts. The latter are really needed for education and awareness campaigns.

As an example for Private sector awareness, QA can directly impact positively the profitability of the PV business. Significant cost savings can be achieved if high-volume procurements of high-quality components are secured (cf. experiences in China and Sri Lanka). On the contrary, when volumes of production or installation are low, local assemblers/suppliers currently purchase cheap and low quality components. Loss of time in additional testing, in warranty services, in replacement of returns is considerable and leads quickly to dissatisfaction of consumers and to restriction of their market. Profitability can therefore being substantially improved.

4.7 Case studies and feed-back from experiences

Experiences on PV standards and harmonisation in industrialised countries are essentially related with grid-connected applications. Nevertheless, those countries have strongly supported, or even initiated, Quality Assurance procedures including standards for stand-alone PV applications in developing countries. Many relevant experiences could be mentioned in South America, Africa or Asia. Among them, we have selected one case study on commercial sales and one on large subsidised project.

4.7.1 Southern and East Africa

In Southern and East Africa (ref. 17), PV technology has widely spread in rural areas through both project approach and commercial sales. The dynamic has start in 4 driving countries (South Africa, Kenya, Zimbabwe and Botswana), followed by other neighbours (Tanzania, Uganda, Ethiopia, Namibia …). Most experiences have faced quality problems with components, systems, installations, after-sales services …

After a first regional workshop in Kenya in 1992, where ideas and observations on Quality issues were exchanged, a second workshop was organised in South Africa in 1997 first to review the standards within the region and secondly to investigate effective methods and actions to upgrade the quality of SHS in the region. For various reasons (climate, geography, economy, political …), the implementation of enforceable harmonised standards was considered to be extremely difficult and the consortium of experts has proposed overall recommendations for specifications, standards, codes, … Where single set of recommendations was not possible, they have proposed various alternatives to be adaptable for each country. Dissemination workshops were afterwards organised in each countries.

Today, the Kenyan experience in PV technology dissemination is strongly business model oriented. The country is recognised for its well developed commercial sales, its local battery manufacturing and assembling facilities, but also for its rather low quality products on the market and its large network of unreliable and inexperienced dealers. And yet the country has a bureau of standards with implemented PV standards, testing and training facilities, conscious government and project implementers, consumer and industrial associations … Despite a more strict quality control environment, some cases of fraudulent module certificate have been declared in Kenya to by-pass the rules and control.

4.7.2 China

In China, the PV systems that are being sold are mainly small systems of less than 20 watts. The practice of selling inexpensive systems makes systems affordable to a wider segment of the population. Less expensive systems are affordable, but there is a higher incidence of repairs and system component failures in areas with many small systems. This can be very costly in terms of product acceptance. If the systems have operational problems in some households - especially those of the early adopters - others may postpone or not purchase systems. The adoption of mandatory standards and certification of products has been found to be an important way to reduce the quality and after-sales service problems. Such standards and certification procedures have been introduced during the preparation of the large China Renewable Energy Development Project (REDP) co-funded by World Bank/GEF.

In 2000, ISP (Institute for Sustainable Power) signed a Memorandum of Understanding with the Brightness Program in China (ref. 11 & 13) to support the development and implementation of a Chinese national renewable energy training accreditation and practitioner certification framework, in alignment with the ISP framework standards. ISP has worked with the Brightness Program, qualifying three ISP-Certified Master Trainers; in July/August 2002; one accredited PV Solar Home System Training Program; and, six Chinese Program Auditors to evaluate in-country trainers and training programs. ISP has assisted China in establishing Technical Committees for qualifying training content standards for Solar Home System installers and Wind/PV Hybrid Village Power Systems installers, as well as activities to develop certification examinations for those taking the training courses.

The Project Management Office (PMO) of the REDP has established a system of standards, testing, and quality certification for solar home systems and has published in 1999 an information package containing specifications and test procedures for prospective suppliers. The system has been established to be used for REDP, but has also become the main quality control method for PV projects in China’s solar home system market and is well known and accepted by end users. PMO is providing also design assistance. Overall, the standards, testing, and certification system established under the project has improved the quality of PV systems, including modules and other components, both for REDP and for China as a whole.

Another tool from REDP to improve quality of products has been to allocate private companies cost-share grants after approval of their “Technology Improvement” projects. The

grants, given to 58 projects by the end of 2003, have been effective in improving the quality of PV products, while at the same time reducing production costs.
Through the project's encouragement of market competition and technical improvements, the price of PV systems in China has dropped significantly. In 5-7 years, the price of off-grid PV systems has been reduced by 30 to 40 percent.
Nevertheless, the first certified PV modules were still of poor quality. The Chinese standard for module had to be upgraded to comply with IEC standard and to be approved abroad.
For other components for stand alone PV systems as Battery Charge Controllers, fluorescent lighting systems, SAPV inverters, the Chinese REDP project has established detailed technical specifications and testing procedures for balance of system that have been adopted by PV GAP in its PV Recommended Standards - PVRS n°6, 7, 8.
As for other World Bank/GEF assisted projects, the PV components to be financed must be; (a) In accordance with this specification; b) Meet national and/or international safety and reliability standards; and (c) Tested and certified by an organization acceptable to the Government of China and the World Bank.
Any qualified testing institutions who are candidate for providing testing and certifying services for components to be used in the project should be accredited according to ISO-25 requirements and are encouraged to send applications to the PMO.
Warranties on components and system have been strictly specified in the REDP project. The supplier provides at a minimum a one-year system warranty against defects, workmanship and installation. During this period, the supplier is responsible for parts, labour, repair, replacement, transport of the system components. After the system warranty, the supplier is responsible only for component replacement, but not associated labour or transport cost, during the manufacturers' warranty periods for the key components indicated hereafter. Warranty is minimum 10 years on modules greater than 20Wp and 5 years on modules of 20Wp and lower; minimum 2 years on charge controllers and inverters; and 1 year for automotive or sealed batteries lower than 100Ah and 2 years for industrial stationary batteries and other batteries greater than 100 AH. All manufacturer warranties must be effective and transferable to the end-user at time of the installation.

By way of conclusion*, these 2 last examples shows that quality issues can "more easily" be anticipated and managed within projects than in cash sales and commercial market.*
In large government supported programme (cf. China) a lot of effort can be put into the project design and to improve:

- *<u>quality of products</u> through the implementation of (i) a complete system of standard, technical specs, testing procedures, certification and (ii) a cost share grant system for private sector to improve technology and quality without increasing costs;*
- *<u>quality of PV services</u> through appropriate training programmes, certified trainers, approved training content, all supervised by Chinese auditors*

In commercial sales (cf. Africa), all stakeholders involved in PV dissemination should actively participate to improve the quality in the supply chain. Setting technical standards, control procedures and testing facilities are usually not enough; a sustained effort to inform and to "educate" both private sector and consumers about quality issues is of the utmost importance. The main barrier is the lack of skill and money to implement large awareness campaigns and watchdog activities to control quality; extra costs can not be supported by the sellers' network and/or the consumers.

5 Findings and Conclusions

5.1 Data collection, Web forum discussions & Workshops

The data collection should have been facilitated by the preparation of a one-page template to be filled by each country but the national contributions have been long-awaited though regular electronic reminders. Countries' visits have been necessary to reinforce links between partners and to collect the final data on existing QA procedures, PV manufacturers, PV service providers and infrastructures.

Several PV issues regarding quality and standards have been loaded on the ICRA Web-forum for technical discussion with project partners; but again very low responses have been noticed after few months' operation.

On the other hand, the participation to the PV workshop, held in Lao in April 2005, has been very successful and has been a real opportunity to discuss about quality issues for PV technology and to share experiences.

Communication and information exchange between partners are difficult without regular workshops.

5.2 General Status of Photovoltaic (PV) and Quality Assurance (QA)

5.2.1 Status in ASEAN

- Except Singapore, all ASEAN countries have been using PV systems in their rural electrification programmes. Frequent early failures have been caused by different technical- and non-technical problems. Today the PV market in ASEAN is rapidly growing and quality control has become a real necessity.
- Quality assurance activities have been implemented to a certain extent in a number of countries, but impacts on actual quality levels is still mitigated. ASEAN countries are also characterised by a disparity of QA awareness levels.
- The way each country deals with its PV quality problems depend of the national policy currently in force for standards and duties, of the technological choice for selected applications (dwellings, community infrastructures, water supply, telecoms, …) and of the prevailing dissemination mode (government project or commercial sales).
- Thus, the review of PV activities in ASEAN has shown that quality issues are not similar for all the countries and that options and recommendations should be adapted to sub-group of countries.

5.2.2 Status in the Rest of the World (RoW)

- In spite of the enormous efforts to harmonise standards in EC and internationally, there is still a chaos surrounding the many different standards and certificates for PV components.
- Moreover, there are many different actors involved in QA process at various geographical level (project, country, region, international).
- Beside the main international standards of IEC, several more pragmatic initiatives have been recently promoted for SAPV systems as UTS standards, WB specifications, GTZ recommended specs, JICA specs, etc. and are in application in many developing countries. This indicates also that major international donors have played a key role in news specs

and standards elaboration for PV components and in global quality improvement of PV projects.

- Unfortunately, very few comparative studies have been done on various national and international standards and technical specs available worldwide, making difficult the final choice for national project implementers.
- Feed back from DC experiences have demonstrated that methodology to improve quality is different for government supported projects and for commercial sales. The first usually requires appropriate project design with special focus on quality of PV products and services and on interrelation between actors. The second needs additional education and awareness campaigns for consumers and private sector, as well as quality control activities all along the supply chain; main barrier is the availability of skills and finances for those activities.
- Another field where EC and ROW experiences can be very fruitful for ASEAN is the Testing and Training domain (procedures, certifications, infrastructures, trainers …).

5.3 Common Issues in ASEAN (or main Quality Issues)

The main finding that can be pointed out from the previous standard review in ASEAN is that regional harmonisation will be very difficult for the whole region because of 4 main factors that differ from one country to another: (i) awareness level, (ii) quality concerns and requirements, (iii) standards formulation and QA implementation and (iv) national contexts.

- Awareness level
  - Awareness on quality issues and PV standards can be very different and usually not much developed.
  - The lack of Standards and QA procedures is not yet perceived by some countries as a major barrier to the PV dissemination in the region.
- Quality concerns and requirements
  - The standard content and the minimum level of standard requested vary according to the technological choice as PV system size, AC/DC supply, individual or centralised … that will be used for specific applications (see next table).
  - Several countries have expressed the difficulty to select the most appropriate standards or technical specifications for each PV component among all the existing ones in the world, when the choice is not dictated by the donors.
  - Most ASEAN countries are manufacturing some components used in PV systems like batteries, electronics for charge controllers, inverters and fluorescent lamps, but majority of PV products are still imported. Several countries suffer from lack of skills and infrastructures to test performances and to control quality of both national and imported products.
  - Another concern is that the adopting of standards to control quality of products could increase equipment prices and administration costs.
- Standards formulation and QA implementation
  - Depending on the countries, standards and certifications of PV products might be either existing, implemented, applied, enforced or only

planned, proposed, under preparation, or not foreseen at all. Several ASEAN countries are still at a very early stage in the PV standardisation process.

- The elaboration of Guidelines and Codes of practices for installation, O&M and training is more recent for all ASEAN countries and is generally less developed.
- Public education and awareness campaigns on quality issues are also implemented at various levels, starting from non existing to well organised campaigns .

o National contexts

- National contexts and renewable energy policies are perceptibly different between ASEAN countries. Government support is requested for an effective implementation of standards and for continuous quality control, in the light of what is done in the neighbour countries.

In conclusion, there is no real common denominator on quality issues for the whole ASEAN region and therefore the harmonisation of standards is rather complicated and premature. But there are several key issues that are common to sub-groups of countries for specific relevant subjects and where partial harmonisation can play a role.

The following matrix gives an example of possible sub-group of countries that can be considered to design common standards for specific PV systems.

Relevant subjects for ICRA project

	Small SHS	Medium SHS	Large or AC SHS	Community Systems	Water pumping	Professional applicat.	Hybrid systems	BIPV / GCPV
Cambodia	x	x		x		x		
Indonesia		x	x	x	x	x		(x)
Laos	x	x		x		x	x	
Malaysia			x	x		x	x	x
Philippines		x	x	x	x	x	x	(x)
Singapore						x		x
Thailand		x	x	x		x	x	(x)
Vietnam	x	x		x		x	x	

5.4 Main Recommendations

The main recommendations, that can be suggested in the framework of this paper to improve the quality of PV systems and to remove trading barriers for PV commercialisation, can be summarised as follow:

1. **Awareness** :

➢ To promote regional cooperation on solar PV quality issues via NRSE-SSN and ACE

- To develop awareness on quality and standard issues; to promote exchange of information on QA procedures and policies,; to promote sensitisation campaigns and public education …

2. **Capacity building** :
   - To establish a regional strategy to harmonise regulatory frameworks, policies for standards and duties, consumer protection, training, R&D…
3. **Incentives and financial** :
   - Define specific incentives and financing mechanisms to promote cash sales market and simultaneously to control quality of products and services locally available (e.g. financial support only if compliance with quality requirements).
   - Support R&D, PV industry and infrastructures (testing, training…) development related to quality improvement.
3. **Technical** :
   - As mentioned above a "partial harmonisation" can be initiated for some PV components, in particular for electronic components (charge controller, inverter, ballast) and lamps, and for some sub-group of countries – for example Cambodia, Laos, Vietnam have more similar requirements in terms of product quality for small stand alone PV systems. This requires intensive work between ASEAN PV experts to review the different options for each PV component and for stand-alone PV systems (Technical Specs and Standards).
   - A similar harmonisation work should be started simultaneously for PV services as installation, O&M and training (Guidelines, Code of Practices).
   - The final formulation of Regionally Harmonised Minimum of Standards (RMS) for PV components and systems should be considered only at a later stage when all ASEAN countries have a common strategy / policy to deal with quality issues and commercialisation of PV products.
     - Design and implementation of appropriate regional QA procedures to establish PV standards, specifications, codes of practices, testing procedures, quality labels, and other documents based on regional experiences.
     - Appropriate formulation and flexible implementation of regional standards. A minimum standard level should guarantee end-user protection without threatening the private sector's business.
     - Establishment of a regional strategy to enforce QA procedures and Technical Standards (procedures, infrastructures, qualified workforce, and watchdog scheme).

Annexe 1 : Abbreviations

AC / DC	Alternative Current / Direct Current
ACE	ASEAN Centre for Energy
ASEAN	Association of South East Asian Nations
BGP	Background Paper
BIPV	Building Integrated PV system
DC	Developing Countries
EC	European Commission
ESCO	Electricity Service Company
GCPV	Grid-Connected PV system
GTZ	German Technical Cooperation
IEC	International Electrotechnical Commission
ISP	Institute for Sustainable Power, Inc.
JICA	Japan cooperation
NRSE-SSN	New and Renewable Sources of Energy – Sub-Sector Network
O&M	Operating and Maintenance
POP	Policy Orientation Paper
PV	Photovoltaic
PV GAP	Global Approval Program for Photovoltaic
QA	Quality Assurance
RE	Rural Electrification
RMS	Regionally harmonised Minimum of Standards
ROW	Rest of the World
SAPV	Stand-Alone PV system
SHS	Solar Home System
SOME	Senior Officials Meeting on Energy
UTS-SHS	Universal Technical Standard for Solar Home Systems
VEM	Village Electricity Manager
WB	World Bank
Wp, kWp, MWp	Watt Peak

Annexe 2 : List of ASEAN representatives and official contacts

Country	Themes	Names	Designation	Address/Contact #	Email Address
Cambodia	PV	Mr. Toch Sovanna	Head of RE Office	Ministry of Industry, Mines and Industry (MIME) Department of Energy Technique #47, Preah Norodom Blvd. Phnom Penh, CAMBODIA	tsovanna@hotmail.com mimedet@forum.org.kh
Lao PDR	PV	Mr. Khanthara SISAMOUTH	Electrical Engineer	Ministry of Industry and Handicrafts, Department of Electricity Nong bone Rd. P.O. Box 4708, Vientiane, LAOPDR	ksisamouth@yahoo.com
Indonesia	PV	Fitri Astuti Firman	MEMR-DGEEU	Ministry of Energy and Mineral Resources – Directorate General of Electricity and Energy Utilization Jln HR Rasuna Said X-2, Kav. 07-08, Jakarta 12950, Indonesia	Fitria_af@yahoo.com
Malaysia	PV	Ms. Azah Ahmad	Research Officer	Pusat Tenaga Malaysia, Level 8, Bangunan Sapura@Mines, 7, Jalan Tasik, The Mines Resort City, 43300 Seri Kembangan, Selangor Darul Ehsan	azah@ptm.org.my
Philippines	PV	Mr Ronnie Sargento	research specialist	Department of Energy, Renewable Energy Management Division, Energy Centre, Merritt Road, Fort Bonifacio, Taquig Metro, Manila , Tel: 632-840 1817	ronniesargento2000@yahoo.com
Singapore	PV	Mr. Andy Wong Yew Loong	Engineer	National Environment Agency 40 Scotts Road, Environment Building, #11-00, Singapore 228231 - Tel: 65-9789-2644	andy_wong@nea.gov.sg
Thailand	PV	Mr. Suree Jaroonsak	Senior Engineer	Department of Alternative Energy Development and Efficiency (DEDE) 17 Rama1 Rd. Patumwan, Bangkok	Suree_j@dede.go.th
Vietnam	PV	Nguyen Tien Long	General Manager of Department R&D of Solar and Wind Energy	Institute of Energy No. 6 Ton That Tung Str Dong Da District, Hanoi City, Vietnam Tel: 844 8523739 - Fax: 844 8523311	longp17@fpt.vn
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Annexe 3 : Glossary

As the PV market is growing, consciousness of technical standards, training accreditation and PV practitioners' certification is becoming more and more important to increase the reliability and performance of PV systems [IEA PVPS T9, ref. 18]. Unfortunately, many stakeholders from developing countries perceive QA concerns as developed for rich countries (high level and heavy procedures) and not relevant for poor countries [TaQSolRE, ref. 7].

Quality concept of PV systems has already been defined in the chapter 1 in terms of product quality and service quality (see also the "definition" box beside). Some specific case studies in developing countries have also been presented to illustrate the complexity of QA procedure implementation. It is generally acknowledged that a lack in quality, in terms of PV product, installation and service quality as well as in organisation and management of implementation programmes is often responsible of PV project failures.

Quality assurance (QA): All those planned or systematic actions necessary to provide adequate confidence that a product or service is of the type and quality needed and expected by the customer. Technical standards need to be really applied but standards alone are not sufficient to improve efficiently quality levels; to implement successfully a PV programme in the long term, one should pay attention to quality through the whole implementation process, from PV components to final services for end-users.

Quality assurance system: a QA system should be developed at least at national scale to control the quality level at different stage of a project and to ensure real satisfaction of all stakeholders, from end-users to private sector and funding agencies if any.

QA procedure: The implementation of a QA system requires that components and systems meet international or national recognised standards, that the personnel for PV design, installation, commissioning, training, maintenance and management is recognised or certified and that quality control mechanism by a independent organism is put in place in the country.

Quality control: The operational techniques and the activities used to fulfill and verify requirements of quality. In an efficient QA system, it is crucial to control regularly the compliance of circulating products with established standards or norms through local or regional recognised testing laboratories and the skill of individual local practitioners.

Standards 1: Standards are documents containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose. They contribute to making life simpler, and to increasing the reliability and effectiveness of the goods and services.

Standards 2: A recognised set of standards usually help to increase quality of a product and contribute to reduce project failures. Draft international technical standards (IEC and CENELEC) for some components exist already for some time. For whole systems a first IEC draft is being circulated. A number of countries have implemented national standards for government supported projects (for example in India, China, and Indonesia). Major work is done to develop "recommended" standards, practices and guidelines throughout the world, but not always in a harmonised way.

Certification: The procedure by which a third party gives written assurance that a product, process, or service conforms to specified requirements. For example, the recognition granted to an individual trainer.

Accreditation: The procedure by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks. For example, the recognition granted to a program or institution.

Technical Specifications: A document that states the technical requirements to which a given product or service must conform.

More on : http://www.worldbank.org/astae/qpp/PVGAP/glossary.pdf ; http://www.w3.org/QA/glossary .

Annexe 4 : Main References

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Annexe 5 : Data collected per country

Country : **CAMBODIA** Date : 2005
Organisation : MIME Name :

Population : 13 Millions GNP :
Ref. Year : 2004 Electr. Rate (%pop)* : 17% *(*) precise if other rate!*

	1: PV Penetration Status	Date (indicative)	SHS *	Telecom *	Other Off Grid *	Grid connection *	Comments, Remarks	Code
Existing & Projection	Installed systems	1998						Ex
		1999						P
		2000						NP
		2001						UP
		2002						Im
		2003						Ap
		2004	85.8kWp	1,050.0 kWp	N/A	N/A		En
	Projections and National Plans	...						n.a.
		2010	480 kWp	N/A				Y
								N

(*) Ideally, numbers should be in kWp installed

	2: Standard Status on PV products	Locally Manufactured Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Components	Module	N	Y	UP	UP	UP	UP	UP		
	Battery	N	Y	UP	UP	UP	UP	UP		
	BCR	N	Y	UP	UP	UP	UP	UP		
	Inverter	Some	Y	N	N	N	N/A	N		
	Ballast	N	Y	N	N	N	UP	N		
	Fluorescent Tube	N	Y	N	N	N	UP	N		
	Cable	N	Y	Y	N	N	UP	N		
	Electrical accessories	Some	Y	Some	N	N	UP	N		
Syst	Stand Alone systems	N								
	Grid connected systems	N								

(**) indicate the country/organisation

	3: Standard Status on PV Services	Local Services	Imported Services	National Standard Bureau	National Certification Facilities	National Code of Practices, Procedures	International Stand./Certif. **	National Stand./Certif.	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Services	Design	Y	some	UP	UP	UP	UP	UP		
	Assembling	Some								
	Installation	Y								
	Training	Some								
	Commisioning	Y								
	Operating	Y								
	Maintenance	Y								
	Replacement	Y								

(**) indicate the country/organisation

4: Awareness Campaign for :	Proposed	Applied
Suppliers / dealers		
Service providers		
End-users / buyers		

5: Other Documents to supply

- List of National Standard Agencies/Bureaus
- List of Testing and Certifying Laboratories
- List of available Standards Documents, Procedures, Codes of Practices, …
- List of relevant National manufacturers of PV components
- List of relevant Institutional Organisations for Standards

Country :	**Indonesia**	Date :	January 1, 05	Population :	GNP :	
Organisation :	DGEEU	Name :		Ref. Year :	Electr. Rate (%pop)* :	*(*) precise if other rate!*

	1: PV Penetration Status	Date (indicative)	SHS *	Telecom *	Other Off Grid *	Grid connection *	Comments, Remarks
Existing & Projection	Installed systems	1998	Yes	Yes	No	No	Existing
		1999	Yes	No	No	No	Existing
		2000	Yes	No	No	No	Existing
		2001	Yes	No	No	No	Existing
		2002	Yes	No	No	No	Existing
		2003	Yes	No	No	No	Existing
	Projections and National Plans	2004	Yes, about 5 MW	No			Existing
		2005	Yes, about 5 MW				
		...					

(*) Ideally, numbers should be in kWp installed

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	2: Standard Status on PV products	Locally Manufactured Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Standards Requirement	Comments - Description of barriers, p appropriatness, ..
PV Components	Module	No	Yes	BSN*	BPPT-LSDE	50 Wp	IEC	SNI		Because the module still imported, the
	Battery	Yes		BSN	BPPT-LSDE		IEC	SNI		energy is very expensive.
	BCR	Yes	Yes	BSN	BPPT-LSDE		IEC	SNI		
	Inverter	Yes					IEC	SNI		There's no services supported for PV
	Ballast	Yes			Sucofindo		IEC	SNI		
	Fluorescent Tube	Yes					IEC	SNI		
	Cable	Yes		BSN	PLN-JTK		IEC	SNI		
	Electrical accessories	Yes	Yes	BSN	PLN-JTK		IEC	SNI		
Syst	Stand Alone systems	Yes								
	Grid connected systems	Yes	Yes							

(**) indicate the country/organisation

	3: Standard Status on PV Services	Local Services	Imported Services	National Standard Bureau	National Certification Facilities	National Code of Practices, Procedures	International Stand./Certif. **	National Stand./Certif.	Standards Requirement	Comments - Description of barriers, p appropriatness, ..
PV Services	Design				DGEEU					Please find at the attac
	Assembling			PT LEN	DGEEU					Please find at the attac
	Installation				DGEEU		IEC			Please find at the attac
	Training			Pusdiklat EKTL	DGEEU					Please find at the attac
	Commisioning				DGEEU					Please find at the attac
	Operating			KUD	DGEEU					Please find at the attac
	Maintenance			KUD	DGEEU					Please find at the attac
	Replacement				DGEEU					Please find at the attac

(**) indicate the country/organisation

4: Awareness Campaign for :	Proposed	Applied
Suppliers / dealers		yes
Service providers	yes	
End-users / buyers		yes

5: Other Documents to

- List of National Standard Agencies/Bureaus
- List of Testing and Certifying Laboratories
- List of available Standards Documents, Procedures, Codes of Practices, …
- List of relevant National manufacturers of PV components
- List of relevant Institutional Organisations for Standards

Note:
BSN: Badan Standar Nasional - Bureau of National Standardization
BPPT: Badan Pengkajian dan Penerapan Teknologi
DGEEU-MEMR: Directorate General of Electricity and Energy Utilization-Ministry of Energy and Mineral Resources
KUD: Koperasi Unit Desa
PT LEN: PT Lembaga Elektronik Nasional
PLN-JTK: Perusahaan Listrik Negara-Jasa Teknik Kelistrikan
Pusdiklat EKTL: Pusat Pendidikan dan Pelatihan Energi dan Ketenagalistrikan (under MEMR)

Country :	**Lao PDR**	Date :		Population :	5,5	GNP :	
Organisation :	MIH	Name :		Ref. Year :	2002	Electr. Rate (%pop)* :	36% *(*) precise if other rate!*

	1: PV Penetration Status	Date (indicative)	SHS *	Telecom *	Other Off Grid *	Grid connection *	Comments, Remarks	**Code**
Existing & Projection	Installed systems	1998						**Ex**
		1999						**P**
		2000						**NP**
		2001						**UP**
		2002	32,84					**Im**
		2003	90,45					**Ap**
		2004	72					**En**
	Projections and National Plans	...						**n.a.**
		...						**Y**
								N

(*) Ideally, numbers should be in kWp installed

	2: Standard Status on PV products	Locally Manufactured Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Components	Module	N	Y	N.A	N.A	N.A	N.A	N.A	Y	
	Battery	N	Y	N.A	N.A	N.A	TIS	N.A	Y	
	BCR	N	Y	N.A	N.A	N.A	N.A	N.A	Y	
	Inverter	N	Y	N.A	N.A	N.A	N.A	N.A	Y	
	Ballast	N	Y	N.A	N.A	P	N.A	N.A	Y	
	Fluorescent Tube	N	Y	N.A	N.A	P	N.A	N.A	Y	
	Cable	N	Y	N.A	N.A	N.A	TIS	N.A	Y	
	Electrical accessories	N	Y	N.A	N.A	N.A	TIS	N.A	Y	
Syst	Stand Alone systems	N	Y	N.A	N.A	N	NA	N.A	Y	
	Grid connected systems	N	Y	N.A	N.A	N	N.A	N.A	Y	

(**) indicate the country/organisation

	3: Standard Status on PV Services	Local Services	Imported Services	National Standard Bureau	National Certification Facilities	National Code of Practices, Procedures	International Stand./Certif. **	National Stand./Certif.	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Services	Design	Y	N	N.A	N.A	N.A	N.A	N.A	Y	
	Assembling	Y	N	N.A	N.A	N.A	N.A	N.A	Y	
	Installation	Y	N	N.A	N.A	N.A	N.A	N.A	Y	
	Training	Y	N	N.A	N.A	N.A	N.A	N.A	Y	
	Commisioning	Y	N	N.A	N.A	N.A	N.A	N.A	Y	
	Operating	Y	N	N.A	N.A	N.A	N.A	N.A	Y	
	Maintenance	Y	N	N.A	N.A	N.A	N.A	N.A	Y	
	Replacement	Y	N	N.A	N.A	N.A	N.A	N.A	Y	

(**) indicate the country/organisation

4: Awareness Campaign for :	Proposed	Applied
Suppliers / dealers		
Service providers		
End-users / buyers		

5: Other Documents to supply

- List of National Standard Agencies/Bureaus
- List of Testing and Certifying Laboratories
- List of available Standards Documents, Procedures, Codes of Practices, …
- List of relevant National manufacturers of PV components
- List of relevant Institutional Organisations for Standards

* TIS - Thai Industrial Standard

Country :	**Malaysia**	Date :	15-oct-04	Population :	24. 5 mil
Organisation :	PTM	Name :	Azah Ahmad	Ref. Year :	2002

GNP : real - RM 202.1 bil, nom. RM 336.4 bil

Electr. Rate (%pop)* : 93 *(*) precise if other rate!*

	1: PV Penetration Status	Date (indicative)	SHS *	Telecom *	Other Off Grid *	Grid connection *	Comments, Remarks
Existing & Projection	Installed systems	1998				3,2	
		1999				6	
		2000				6,2	
		2001				381,3	
		2002				48,2	
		2003					
	Projections and National Plans	2004					Note: Off grid installed capacity recorded is 1.5 MWp (no detail info.)
		…					
		2010				1.500	Forecasted through the MBIPV project

(*) Ideally, numbers should be in kWp installed

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	2: Standard Status on PV products	Locally Manufactured Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Standards Requirement	Comments - Description of barriers, difficulties, appropriatness, .
PV Components	Module	Y (assembled)	Y	n.a.	UP	P	IEC	P	Y	Note: National testing facilities - manufact
	Battery	Y	Y	n.a.	Ex	-	IEC	-	Y	Note: PV products, locally assembled
	BCR	Y	Y	n.a.	Ex	-	IEC	-	Y	
	Inverter	N	Y	n.a.	P	P	IEC	P	Y	
	Ballast	Y	Y	n.a.	Ex	Ex	-	Ex	Y	
	Fluorescent Tube	Y	Y	n.a.	Ex	Ex	-	Ex	Y	
	Cable	Y	Y	n.a.	-	-	-	Ex	Y	
	Electrical accessories	Y	Y	n.a.	-	-	-	Ex	Y	
Syst	Stand Alone systems	N	Y	n.a.	n.a.	n.a.	n.a.	n.a.	Y	
	Grid connected systems	N	Y	n.a.	n.a.	UP	Australia	UP	Y	

(**) indicate the country/organisation

	3: Standard Status on PV Services	Local Services	Imported Services	National Standard Bureau	National Certification Facilities	National Code of Practices, Procedures	International Stand./Certif. **	National Stand./Certif.	Standards Requirement	Comments - Description of barriers, difficulties, appropriatness, .
PV Services	Design	Y	Y	n.a.	n.a.	n.a.		n.a.	Y	
	Assembling	Y	Y	n.a.	n.a.	n.a.		n.a.	Y	
	Installation	Y	Y	n.a.	n.a.	P		n.a.	Y	
	Training	Y	Y	n.a.	P	P		n.a.	Y	
	Commisioning	Y	Y	n.a.	n.a.	P		n.a.	Y	
	Operating	Y	Y	n.a.	n.a.	n.a.		n.a.	Y	
	Maintenance	Y	Y	n.a.	n.a.	n.a.		n.a.	Y	
	Replacement	Y	Y	n.a.	n.a.	n.a.		n.a.	Y	

(**) indicate the country/organisation

4: Awareness Campaign for :	Proposed	Applied
Suppliers / dealers	P - under MBIPV	
Service providers	P - under MBIPV	
End-users / buyers	P - under MBIPV	

5: Other Documents to supply
List of National Standard Agencies/Bureaus
List of Testing and Certifying Laboratories
List of available Standards Documents, Procedures, Codes of Practices, …
List of relevant National manufacturers of PV components
List of relevant Institutional Organisations for Standards

Country : **Philippines** Date : févr-05 Population : 82.7M GNP : Php1484.8B

Organisation : DOE Name : Ref. Year : 2004 Electr. Rate (%pop)* : 92.41% *(*) precise if other rate!*

	1: PV Penetration Status	Date (indicative)	SHS *	Telecom *	Other Off Grid *	Grid connection *	Comments, Remarks
Existing & Projection	Installed systems	1998	138	0,75	45		All Operational, (PV-BCS, CL, BH for other off-grid)
		1999	10	6,75	4,35		All Operational, (PV-BCS, CL, BH for other off-grid)
		2000	7	0,5	60		All Operational, (PV-BCS, CL, BH for other off-grid)
		2001	8	0,62	99		All Operational, (PV-BCS, CL, BH for other off-grid)
		2002	n.a.	n.a.	62		All Operational, (PV-BCS, CL, BH for other off-grid)
		2003	n.a.	n.a.	91		All Operational, (PV-BCS, CL, BH for other off-grid)
		2004	477	n.a.	83	956	All Operational, (PV-BCS, CL, BH for other off-grid)
	Projections and National Plans	…					
		…					

(*) Ideally, numbers should be in kWp installed

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	2: Standard Status on PV products	Locally Manufactured Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Components	Module	?	Ex		TUV	n.a.	IEC 625	n.a.	n.a.	Im, En
	Battery	Ex	Ex	BPS	PNS					Im, En
	BCR									On-going establishment of standard
	Inverter	Ex	Ex							UP
	Ballast									On-going establishment of standard
	Fluorescent Tube	Ex	Ex							Im, En
	Cable	Ex	Ex	BPS						Im, En
	Electrical accessories	Ex	Ex	BPS						Im, En
Syst	Stand Alone systems									UP
	Grid connected systems									UP

(**) indicate the country/organisation

	3: Standard Status on PV Services	Local Services	Imported Services	National Standard Bureau	National Certification Facilities	National Code of Practices, Procedures	International Stand./Certif. **	National Stand./Certif.	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Services	Design	UP								P; Lack of Guidelines & incorrect Desi
	Assembling	UP								P
	Installation	UP								P; Lack of Guidelines & incorrect Insta
	Training	UP							Best Practice	CBRED-Lack of Training
	Commisioning	UP								
	Operating	UP								JICA Program - Lack of Training
	Maintenance	UP								JICA Program - Lack of Training
	Replacement	n.a.								

(**) indicate the country/organisation

4: Awareness Campaign for :	Proposed	Applied
Suppliers / dealers	CBRED (IEC)	
Service providers	CBRED (IEC)	
End-users / buyers	CBRED (IEC); JICA (Promotion of Training & Manuals)	

5: Other Documents to supply

- List of National Standard Agencies/Bureaus
- List of Testing and Certifying Laboratories
- List of available Standards Documents, Procedures, Codes of Practices, …
- List of relevant National manufacturers of PV components
- List of relevant Institutional Organisations for Standards

Country :	Singapore	Date :	2004	Population : 4.19 million	GDP at 1995 Market Price: SGD 164,265.9 million
Organisation :	National Enviro	Name :	Andy Wong	Ref. Year : 2003	Electr. Rate (%pop)* : 100% (*) precise if other rate!

	1: PV Penetration Status	Date (indicative)	SHS *	Telecom *	Other Off Grid *	Grid connection *	Comments, Remarks
Existing & Projection	Installed systems	1998	N	N	1	1	Grid refers to Internal-grid
		1999	N	N	1	1	Grid refers to Internal-grid
		2000	N	N	1	4	Grid refers to Internal-grid
		2001	N	N	2	6	Grid refers to Internal-grid
		2002	N	2	8	8	Grid refers to Internal-grid
		2003	N	2	12	11	Grid refers to Internal-grid
		2004	N	2	17	12	Grid refers to Internal-grid
	Projections and National Plans						

(*) Ideally, numbers should be in kWp installed

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	2: Standard Status on PV products	Locally Manufactured Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Standards Requirement	Comments - Description of barriers, appropriatness,
PV Components	Module	N	Y							
	Battery									Barrier: require maintenance and repl
	BCR									Barrier: require maintenance and repl
	Inverter									
	Ballast									
	Fluorescent Tube									
	Cable									
	Electrical accessories									
Syst	Stand Alone systems									
	Grid connected systems									Barrier: no regulations for grid connec

(**) indicate the country/organisation

	3: Standard Status on PV Services	Local Services	Imported Services	National Standard Bureau	National Certification Facilities	National Code of Practices, Procedures	International Stand./Certif. **	National Stand./Certif.	Standards Requirement	Comments - Description of barriers, appropriatness,
PV Services	Design	Y	Y							Barriers: lack
	Assembling	Y	Y							
	Installation	Y	N							
	Training	N	N							Barriers:
	Commisioning	Y	N							
	Operating	N	N							
	Maintenance	Y	N							
	Replacement	Y	Y							

(**) indicate the country/organisation

4: Awareness Campaign for :	Proposed	Applied
Suppliers / dealers	Seminars, conferences, events	Seminars, events
Service providers	Seminars, conferences, events	Seminars, events
End-users / buyers	Websites, seminars, events	Seminars, events

5: Other Documents to supply
List of National Standard Agencies/Bureaus
List of Testing and Certifying Laboratories
List of available Standards Documents, Procedures, Codes of Practices, …
List of relevant National manufacturers of PV components
List of relevant Institutional Organisations for Standards

Country :	THAILAND	Date :	3 Feb. 2005	Population :	63.08 M	GNP :	144,16 BUSD.
Organisation :	DEDE.	Name :		Ref. Year :	2003	Electr. Rate (%pop)* :	7,99 *(*) precise if other rate!*

Existing & Projection	1: PV Penetration Status	Date (indicative)	SHS *	Telecom *	Other Off Grid *	Grid connection *	Comments, Remarks
	Installed systems	1998					
		1999					
		2000					
		2001					
		2002					
		2003	9,74	1.083,30	4.152,27	753,10	- Total wattage of PV was installed in Thailand
	Projections and National Plans	2004	18.360,00	n.a.	359,00	960,00	since 1985-2003;
		2005	17.640,00	n.a.	358,00	n.a.	

(*) Ideally, numbers should be in kWp installed

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	2: Standard Status on PV products	Locally Manufactured Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Components	Module	5	N	UP	UP	UP	IEC	N	Y	
	Battery	4	Germany, Italy	UP	Ex	UP	DIN	N	Y	- Presently, The deep cycle battery donot have
	BCR	1	Australia	P	Ex	UP	UL	N	Y	any national standard, but vehicle battery are
	Inverter	1	Australia	P	Ex	UP	UL	N	Y	avialable.
	Ballast	3	N	Ex	Ex	Ex	IEC	Ex	Ex	
	Fluorescent Tube	2	N	Ex	Ex	Ex	IEC	Ex	Ex	
	Cable	3	N	Ex	Ex	Ex	IEC	Ex	Ex	
	Electrical accessories	many	Japan	Ex	Ex	Ex	JIS, DIN	Ex	Ex	- Consist of consumer unit, switch, acceptable
Syst	Stand Alone systems	N	-	n.a.	n.a.	n.a.	n.a.	n.a.	Y	
	Grid connected systems	N	-	n.a.	n.a.	n.a.	n.a.	n.a.	Y	

(**) indicate the country/organisation

	3: Standard Status on PV Services	Local Services	Imported Services	National Standard Bureau	National Certification Facilities	National Code of Practices, Procedures	International Stand./Certif. **	National Stand./Certif.	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Services	Design	Y	N	P	P	UP	N	UP	Y	
	Assembling	Y	N	P	P	UP	N	UP	Y	
	Installation	Y	N	P	P	UP	N	UP	Y	
	Training	Y	N	P	P	UP	N	UP	Y	
	Commisioning	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	- Not have any data
	Operating	Y	N	P	P	Up	N	UP	Y	
	Maintenance	Y	N	P	P	UP	N	UP	Y	
	Replacement	Y	N	P	P	UP	N	UP	N	

(**) indicate the country/organization

4: Awareness Campaign for :	Proposed	Applied
Suppliers / dealers	Y	Y
Service providers	n.a.	n.a.
End-users / buyers	Y	Y

5: Other Documents to supply

List of National Standard Agencies/Bureaus
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List of relevant Institutional Organizations for Standards

Country :	**Vietnam**	Date :	23/10/2004	Population : 80.902.400	GNP : 605.586 bill. (VND)
Organization :	Government	Name :	I.E	Ref. Year : 2003	Electr. Rate (%pop)* : over 80% *(*) precise if other rate!*

	1: PV Penetration Status	Date (indicative)	SHS *	Telecom *	Other Off Grid *	Grid connection *	Comments, Remarks
Existing & Projection	Installed systems	1998					
		1999					
		2000					The data are not available
		2001					
		2002					
	800 kWp	2003	160 kWp	250 kWp	390kWp		Most of projects are funded by Gov. or international assistance
		2004					
	Projections and National Plans	…					
		…					

(*) Ideally, numbers should be in kWp installed

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	2: Standard Status on PV products	Locally Manufactured Product	Imported Product	National Standard Bureau	National Testing Facilities	National Technical Specs	International Standards **	National Standards	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Components	Module	N	Y	Y	n.a	n.a	n.a	Y	Y	
	Battery	Y	Y	Y	Y	Y	Y	Y	Y	Currently, Vietnam has no National St Components, however, AST Co. Ltd h standards for their products (BCR, Inv annually checking by National Agency and Quality based on these standards
	BCR	Y	N	N	Y	N	N	n.a	n.a	
	Inverter	Y	N	N	Y	N	N	n.a	n.a	
	Ballast	Y	N	Y	Y	Y	Y	Y	Y	
	Fluorescent Tube	Y	N	Y	Y	Y	Y	Y	Y	
	Cable	Y	N	Y	Y	Y	Y	Y	Y	
	Electrical accessories	Y	N	Y	Y	Y	Y	Y	Y	
Syst	Stand Alone systems	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	
	Grid connected systems	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	

(**) indicate the country/organisation

	3: Standard Status on PV Services	Local Services	Imported Services	National Standard Bureau	National Certification Facilities	National Code of Practices, Procedures	International Stand./Certif. **	National Stand./Certif.	Standards Requirement	Comments - Description of barrier difficulties, appropriatness
PV Services	Design	Y	N	n.a	n.a	n.a	n.a	n.a	n.a	
	Assembling	Y	N	n.a	n.a	n.a	n.a	n.a	n.a	Because of small market, these is no management organizations for PV se Vietnam.
	Installation	Y	N	n.a	n.a	n.a	n.a	n.a	n.a	
	Training	Y	N	n.a	n.a	n.a	n.a	n.a	n.a	
	Commisioning	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	
	Operating	Y	N	n.a	n.a	n.a	n.a	n.a	n.a	
	Maintenance	Y	N	n.a	n.a	n.a	n.a	n.a	n.a	
	Replacement	Y	N	n.a	n.a	n.a	n.a	n.a	n.a	

(**) indicate the country/organization

4: Awareness Campaign for :	Proposed	Applied
Suppliers / dealers		Y
Service providers		Y
End-users / buyers		Y

5: Other Documents to supply

- List of National Standard Agencies/Bureaus
- List of Testing and Certifying Laboratories
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- List of relevant National manufacturers of PV components
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