

**Final Report:**

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**Continuation of Swiss Participation and Share in the  
IEA PVPS Task 9 Project Leadership**

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## Abbreviations

ADA	Austrian Development Agency
ADB	Asian Development Bank
AfDB	African Development Bank
AFD	Agence Francaise de Développement
ARE	Alliance for Rural Electrification
CERT	Committee on Energy Research and Technology (of the IEA)
EC	European Commission
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EE	Energy efficiency
ExCo	Executive Committee
FiT	Feed-in tariff
GIZ	German International Cooperation
IA / TCP	Implementing Agreement / now: Technical Cooperation Program
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
LCOE	Levelised cost of energy
MIC	Mission Innovation Challenge
OA	Operating Agent
OECD	Organisation for Economic Cooperation and Development
O&M	Operation and Management
PM	person month / expert month
PV	Photovoltaic
PVPS	Photovoltaic Power Systems Programme
R&D	Research and Development
RE	Renewable energies
REPIC	Renewable Energy and Energy Efficiency Promotion in International Cooperation
R&D	Research & development
SDC	Swiss Development Cooperation
SFOE	Swiss Federal Office for Energy
SHS	Solar Home Systems
SE4ALL	Sustainable Energy for All
SOC	State of charge
T&D	Transmission and Distribution
T9	PVPS Task 9

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## 1. Summary

The [IEA PV Power Systems Programme \(PVPS\)](#) is one of the largest Technical Cooperation Programs among approximately 40 programmes and has now 32 members worldwide (countries and industry associations). PVPS covers about 90% of the global PV activities (research, production and installation). Still most members are OECD countries. Cooperation is carried out in the form of various “Tasks”. [Task 9 “Deploying PV Services for Regional Development”](#) is the only group which specifically deals with PV in developing countries and has produced a large number of [relevant publications](#).

The Swiss participation in Task 9 took place through REPIC-Platform support. The aim was to increase the **quality of PV projects** in development cooperation, to facilitate **access to the growing markets** in developing countries for economic sectors concerned, to improve Swiss products and services **export opportunities** and to generate new projects. The objective for the new phase was to also intensify partnerships and strengthen Task 9’s visibility and thus to re-position its strategic direction.

Based on a tendered selection process Skat Consulting Ltd. together with INFRAS Research and Consulting had been mandated as Operating Agent (OA) for Task 9, for the period Oct 1, 2015 - Apr 30, 2017. This mandate was then extended by one year until Apr 30, 2018. It comprised the organisation of and representation of Switzerland at the IEA PVPS Task 9 expert meetings, shared project management including participation in IEA PVPS Executive Committee Meetings, development and implementation of a promising work plan to attract more PVPS member countries to Task 9, harmonisation of this plan with the prevailing topics of cooperation partners (SECO, SDC, GIZ and others) as well as the private sector, networking and communication with relevant national and international organisations and initiatives (e.g. IRENA, International Solar Alliance ISA, Mission Innovation Challenge MIC) and finally regular reporting to the REPIC Secretariat and Steering Group.

Experience from the preceding Task 9 phase had shown that SHS and pico appliances had become a highly commercial business. Simultaneously, **decentralised electricity supply systems and extension of the national grid** are playing a more and more important role also in developing and emerging countries. Thus, Task 9 decided to target its future contents on I) **PV in mini grids** (including hybrid systems) and II) **Distributed PV in bigger grids**. An intense exchange with development partners and private sector representatives showed the relevance of these topics. Task 9’s work is in line with practitioners’ problems in the field, with the needs of policy makers and other relevant stakeholders.

The five main Subtasks defined for the new working phase were: 1. PV in mini grids (including hybrid systems), 2. Deployment strategy for 100% RE on small islands, 3. Mainstreaming PV related training in national training institutions frameworks, 4. PV development as residential prosumers, 5. Outreach & dissemination and contribution to standardisation bodies. **Three of these Subtasks have been successfully completed** (3, 4 and 5), Subtask 1 has been started and Subtask 2 had to be given up due to lack of (funding) support.

AS a result of Subtask 3, Task 9 and the International Solar Energy Society (ISES) jointly published a **“Guideline to Introducing Quality Renewable Energy (RE) Technician Training Programs”**. It addresses the RE industry, multi-lateral and bi-lateral donors and government ministries/departments that want to introduce quality training programs for technicians. The guide helps to introduce RE courses into an existing quality training framework or, if one does not exist, to establish a process whereby the training being provided is following quality procedures.

The so-called **Prosumer Study** (result of Subtask 4) which will be published latest in June 2018 focuses on opportunities and challenges associated with producing and self-consuming electricity from grid-tied small PV-plants. It is based on the analyses and comparison of possibilities for net-metering in different countries (India, The Philippines, South Africa, Kenya, Cape Verde, Ghana, Benin and Burkina Faso). It presents main hindrances, best practices, importance of self-consumption compared to net-metering, as well as different “implementation models”. In addition to the main report, data sheets with summaries on relevant information are developed for each of the countries. One of the main results is the importance of involving utilities / distribution companies from the very beginning into the process.

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## 2. Starting Point

Task 9 focuses primarily on the analysis of technical as well as non-technical aspects relevant for dissemination and sustainable operation and management of PV technology in developing and transition countries. In the past, Task 9 had produced publications on e.g.: Solar Home Systems (SHS), pico PV systems, recommended practices and lessons learned in various PV applications, policy recommendations for improved sustainability of rural (PV) water supply systems, rural electrification with PV-diesel systems, innovative business models and PV for rural health facilities. These publications offer a wide range of concrete project experience, contributed by Task 9 members' professional experience in developing countries. These analyses **benefit PV projects and programs in developing countries**.

**Task 9** explicitly **targets emerging and developing countries** and strives to address topics of relevance for such countries based on the know-how and expertise of its members and close relations to relevant multilateral and bilateral organisations.

One difficulty of Task 9 has been the fact that the main target group – developing and emerging countries – are mostly neither member of PVPS (thus not represented in the PVPS Executive Committee) nor in Task 9. Compared to other Tasks under PVPS, Task 9 therefore always had a rather limited participation. Still today, most PVPS members are OECD countries and only a very few (new) members represent emerging countries (Chile, China, Malaysia, Mexico, Morocco, South Africa, South Korea, Thailand, Turkey), whereas developing countries are not represented at all. Ministries and institutions in OECD countries which normally support R&D activities are often less interested in topics specifically relevant for developing countries.

## 3. Objective, Work Plan and Participation in Task 9

### 3.1. Overall objective

The general aim of the Swiss contribution to Task 9 was to indirectly contribute through the Task 9 work to **improved quality of projects and programs** which include PV within development cooperation, to facilitate access to the growing markets in developing countries for economic sectors concerned, to improve **Swiss products and services export opportunities** in this field and to generate promising new projects. **Partnership with related organizations** should be intensified and Task 9's **visibility** should be strengthened within the global environment. This means that the future strategic direction of Task 9's activities shall be repositioned.

### 3.2. Approach and Work Plan

To achieve the above mentioned objective, it was considered crucial to develop a "demand-oriented" approach and a work plan which addresses the most relevant topics in currently implemented projects and programs. In November 2015 in Istanbul, a general **overall strategy** of the Task and a first rough **draft work plan** were developed. Both were then presented and discussed at the "**Stakeholder Workshop**" organised by Task 9 in Zurich / Switzerland in March 2016 with development partners, international organisations and private sector actors to:

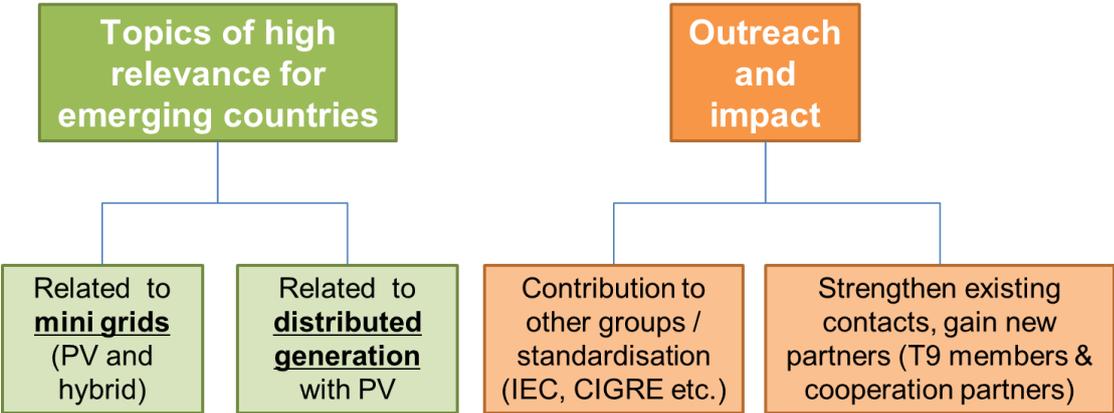
1. Inform on the Task 9 work and future plans to ensure demand-orientation (consistency with most relevant PV topics in development cooperation)
2. Exchange among participants on PV-related projects/programmes in emerging and developing countries (ongoing activities, challenges, perspectives, needs and opportunities...)
3. Discuss possibilities for cooperation (what can Task 9 contribute and how can others support Task 9)

Based on the various feedbacks, the following vision, objective and general approach of Task 9 as well as Subtasks were concluded:

*The vision of Task 9 is to act as a facilitator for large scale deployment of PV in emerging and developing regions to foster a sustainable economic and social transition process and regional development. Through its impartial and best of class research work and active dissemination of research results Task 9 significantly contributes to this vision. By cooperating with other PVPS Tasks and national and international development partners, the outreach of Task 9 outputs is leveraged and research activities and field work of co-operating institutions are complemented and strengthened.*

To enhance the “Deployment of PV Services for Regional Development” in emerging and developing countries includes the improvement of the reliability of isolated and grid-connected PV systems and hybrid systems by collecting, analyzing and disseminating information on their technical performance and failures, providing a basis for their assessment, and developing practical recommendations.

The **new Work Plan (April 2016 to March 2018)** focuses on the main fields of activities as shown in the following figure.



The following Subtasks were defined in the Work Plan:

- Subtask 1:** PV in mini grids (including hybrid systems) led by Germany
- Subtask 2:** Deployment strategy for 100% RE on small islands proposed by Australia, no lead defined
- Subtask 3:** Mainstreaming PV related training in national training institutions frameworks, led by Australia
- Subtask 4:** PV development as prosumers: the role and challenges associated to producing and self-consuming electricity from grid-tied small PV-plants in developing countries, led by France
- Subtask 5:** Outreach and Dissemination; including: a) Contribution to other groups (standardization bodies etc.) led by Germany and b) networking and dissemination led by Switzerland (OA)

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### 3.3. Participation

The OA from the very beginning made strong efforts to further re-activate Task 9 by addressing ExCo members, contacting development and other international organisations and networks in the PV sector (e.g. GIZ, ADA, ARE, IRENA, SE4ALL, and ECREEE).

The (official) members of the IEA PVPS Task 9 during the period of consideration were: **Australia, Denmark, Finland, France, Germany, Norway, Japan, Spain, Sweden, Switzerland and Turkey.** However, the members from Denmark and Finland had very limited resources which only allowed them to participate in meetings and give some feedback on reports. **The Task members who received significant resources were Germany and France.** The Task 9 member from Australia participated in all meetings and even implemented Subtask 3 without any support. The members from Spain participated in all meetings and provided input to report contents also without any financial resources. Representatives from all other member countries (Norway, Japan, Sweden and Turkey) did not provide any significant input (maximum participation in one meeting) during this working period.

Very valuable input was provided by the organisations GIZ and IRENA who had officially a kind of observer status but participated in a number of meetings and contributed with case studies, contacts and other relevant information. A representative of ECREEE also participated in several virtual meetings and provided relevant input to Subtask 4.

In the last months, the new PVPS member countries **South Africa and Morocco** expressed strong interest in the work of Task 9 but so far did not yet succeed to mobilise funding to really participate in the Task.

This resource situation among the task members set certain limits to the operation and management of the Task. The Subtasks and the resulting publications were mainly implemented by individuals while the other Task 9 members only provided some feedback on the drafts of reports. While the respective subtask leader benefited to some extent from the country experience and case studies of their colleagues, the work was **not implemented as a real group work** as this is often the case in other Tasks where several Task members significantly contribute to one common topic. For more mutual benefit a critical mass of active members is required. Furthermore, several Task Meetings were held as virtual meetings or in countries where travel cost could be limited for the participants (mainly from Europe).

Considering this situation, the output during the working phase is definitely noteworthy and the continuous cooperation with GIZ, ECREEE, IRENA and SDC as well as the networking with new initiatives and wider dissemination of publications (see also 4.5.1) have significantly contributed to increased visibility of Task 9.



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## 4. Activities and Results of Task 9

The following subchapters describe the five subtasks. Relevant results have mainly been achieved under the Subtasks 3, 4 and 5.

### 4.1. Subtask 1: PV in mini-grids (including hybrid systems)

Subtask 1 consists of two different work packages: a first one focusing on the evaluation of existing PV hybrid systems and the second one called “PV as fuel saver.

#### 4.1.1 Evaluation of existing PV hybrid systems

Under this work package **existing PV hybrid systems** should be evaluated with regard to their **operation experience, technical, institutional, organisational and financial challenges**. Such systems are typically in the range of < 100 kW consisting of a PV- and a battery-component, with a small diesel generator only used as a back-up in case the battery capacity is not sufficient. For the identified systems, their topology, operation, maintenance and financial data as well as non-technical information should be collected and analysed to evaluate: performance, grid stability, fuel consumption and cost, load profile, maintenance effort and cost, levelised cost of energy LCOE, logistical problems (material flow, fuel, replacement goods etc.), organisational issues and available infrastructure (transportation, communication), as well as options for later grid-connection.

The progress achieved is described in the following:

##### a) Definition of data format completed

An input-data format which can be processed by the data evaluation software has been developed. Most probably, each data set from various case studies (sites) will have other formats. Additional adaption will be necessary to transform the site specific data into the IEA PVPS Task9 format. This work can only be done once the data are available. To analyse the battery performance, the most important battery parameters must be available. In cooperation with Fraunhofer ISE, a minimum set of data was defined:

- Date / Time stamp
- Battery voltage
- All-over battery current (can be positive for charging or negative for discharging)
- Battery temperature
- State of Charge (SOC) of battery

As data format the following CSV<sup>1</sup> similar format was proposed:

```
DD.MM.YYYY,HH:MM:SS U_Batt[V] I_Batt[A] T_Batt[°C] SOC[%] NN
```

```
Example: 01.01.2014,07:09:22 48.2314 -12.876 18.299 0.354 0
```

##### b) Dissemination of data format to potential partners

A presentation - describing among others the data format and the objective of data collection - has been distributed among 30 potentially interested operators and contact persons. Up to now, there was no positive response. A request has also been published in the ARE weekly alert to members and in the ISES Newsletter to identify possible partners with access to systems and information.

##### c) Battery data analyses

Within the reporting period the data analyses tool was created which provides a one page standardised graphical analyses illustrating the system and especially the battery usage: overview on the pro-



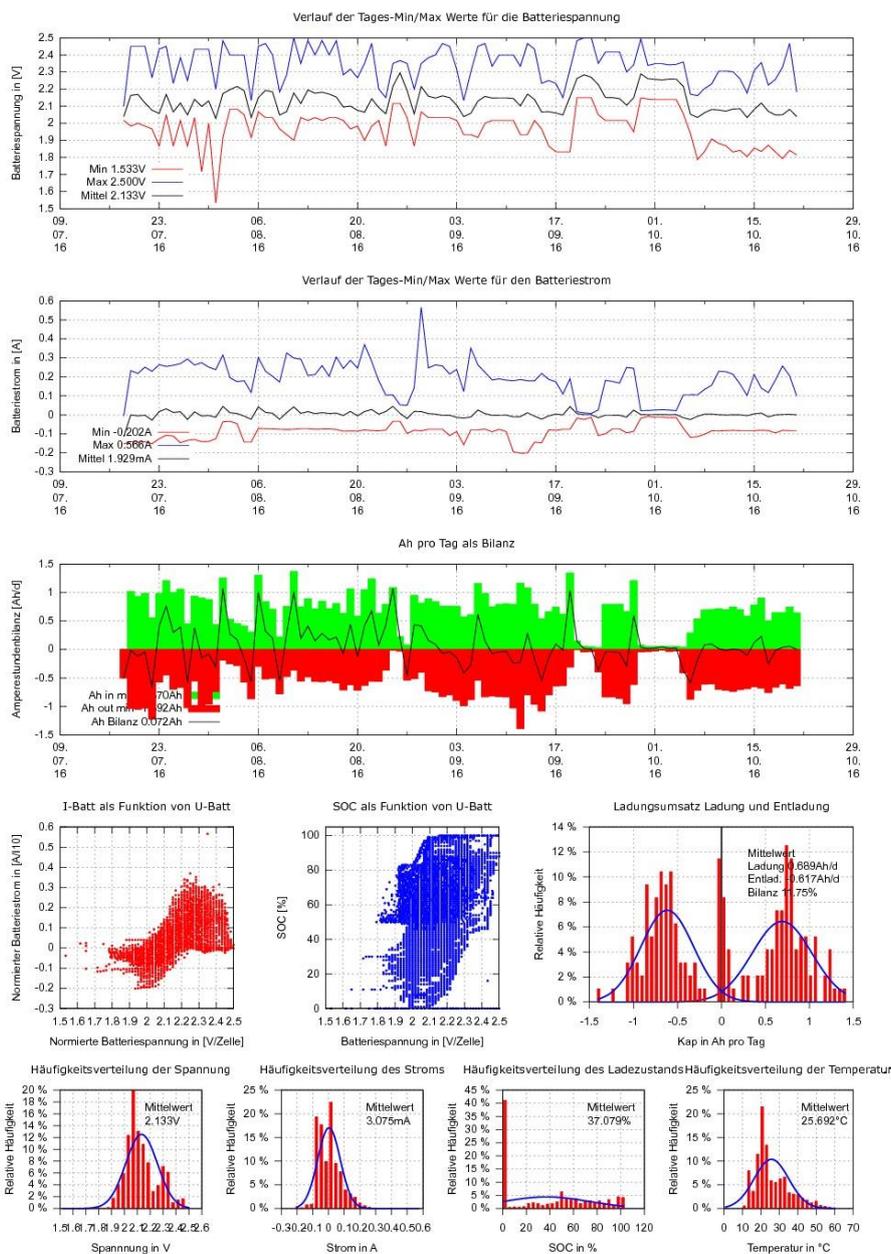
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<sup>1</sup> Comma separated values

file of the daily maximum, minimum and average values of the voltage, current and daily energy balance of the system; battery analysis based on statistical methods such as histogram functions with Gauss curve fittings. A sample of the analyses is presented on the next page, based on sample data which are collected during the reporting period.

Based on the detailed analyses of as many systems as possible, it was planned to establish a catalogue of recommendations with a focus on topics relevant for decision makers and tendering institutions. All information should be compiled and analysed in a comprehensive evaluation report. In addition, also presentations at special off-grid conferences are planned.

For this work package under Subtask 1 an interim report is planned for end 2018.



## 4.1.2 Potential of PV to support electricity generation based on diesel generators - “PV as fuel saver”

In the second work package under Subtask 1, the research focus is on **bigger systems in the range of > 100 kW which typically consist of a diesel generator supplemented by a small PV-component** (often not exceeding 20-25% of the overall installed capacity, higher percentages require a so called fuel save controller) but without any battery component. The latter is not necessary since with a diesel generator being the “dominant part” no storage is required. For such types of systems, the potential of PV to support electricity generation should be analysed (“**PV as fuel saver**”). The work started with a literature research to analyse the state of the art and countries relevant for the study. In cooperation with the operator of the systems the most suitable sites shall be selected for further investigation. Special focus will be put on the mode of operation and the motivation of the investor to install such systems. Based on the installed system technology and monitoring infrastructure, (already available) operation data shall be collected, but also non-technical data and information.

**Data analysis:** Detailed data analysis shall include: Performance of the system, stability of the grid (voltage and frequency), fuel consumption and cost, load profile compared to traditional grid users, maintenance effort and cost, calculation of LCOE. Non-technical information shall be analysed to draw conclusions on user satisfaction.

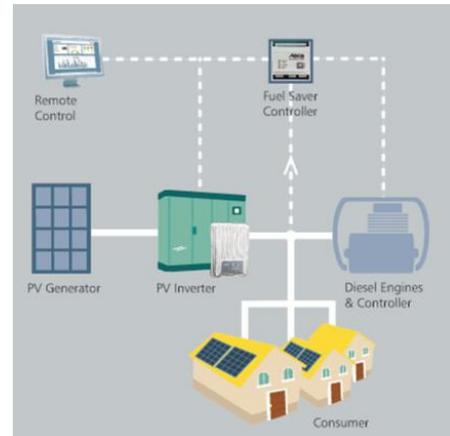
Due to serious difficulties to get access to data of existing systems, it has been decided to rather focus on **a case study based simulation of a specific system as it is and as it could be if the PV generation part is increased**. The analysis will include parameters like performance, grid stability, fuel consumption, load profile, maintenance effort and LCOE. A final evaluation report for policy makers and utilities will include recommendations, critical preconditions for system improvement, an overview on existing tools, e.g. HOMER and others and a flowchart for decision making.

Also for this work package, an interim report is expected to be prepared by the end of 2018.

### **Remaining challenges for Subtask 1**

Beside the reported interim results there are still significant challenges to implement Subtask 1:

- Up to now, the contact management was not successful. With the help of all IEA PVPS Task 9 participants it was planned to access systems and data. Due to the limited contribution to Task 9 the foreseen “channels” to get access to data could not be used. Consequently, higher effort of the Subtask leaders was required. To finalize WP1&2 a **strong support from other IEA member states** would be necessary to adhere to the planned schedule.
- Once key persons are identified it is still difficult to get access to the systems data as it is expensive to travel to remote sites; the concerned managing institutions would need external financial support to cooperate with Task 9. The majority of such countries in Africa are not IEA members.
- During the reporting period a strong focus was put on Indonesia where the situation regarding data access seems to be more promising. Since 2012, the Indonesia Directorate General for New and Renewable Energy and Energy Conservation EBTKE through contractors has installed about 400 units of 15 kW to 150 kW solar mini-grid systems for rural village supply. In some of them, systems for continuous monitoring had been installed. Fraunhofer ISE continued talks with GIZ and EBTKE to get some of this data for analysis and evaluation and thus to integrate lessons learnt from the Indonesian electrification program. Despite GIZ’s general agreement, a response from EBTKE is still outstanding. Since the project in Indonesia is part of the so-called Energising Development Programme EnDev, supported among others by



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Germany and Netherlands, the Operating Agent contacted the managing director of EnDev at GIZ and the Dutch counterpart at RVO to explain about the possible mutual benefit. Given the uncertainty of the continuation of Task 9 beyond April 2018, it had been decided to focus the work in 2017/2018 mainly on the second work package.

#### **4.2. Subtask 2: Deployment strategy for 100% RE on small islands**

Being a hotly debated topic, this Subtask is attracting increasing interest in the research community. The Subtask was thought to collect documentary evidence of the technical and non-technical (social, economic and regulatory) issues that have been identified and addressed in small island countries that are working towards 100% RE targets. These targets have often been set by politicians and then it is the role of the relevant Government departments such as Department of Energy and in-country electricity utilities to identify and address all the technical and non-technical requirements to meet the target. A series of **5 case studies** should be compiled. Gathering case study data and collating the information in a suitable format would provide guidance for other small island countries. The plan was to finally produce a guideline which should include (but not be limited to) the following aspects:

- The penetration level of different renewable energy technologies
- The size of systems and the required land areas
- Energy storage
- Grid stability and control requirements
- Ownership of RE systems
- Power Purchase Agreements
- Tariff Structure
- Regulatory requirements
- Capacity building requirements
- Community and social issues



After presenting this Subtask at the ExCo Meeting in Belgium (April 2016), broad interest in the topic came up from a number of countries. Following this, the OA organised a **virtual meeting** (June 16, 2016) at which 15 persons participated and exchanged on their ideas and expectations with regard to the topic. Main target was to find out whether the topic should remain a Task 9 activity or if it should be treated in a broader context. Interested countries were Netherlands, France, USA, Portugal, Sweden, Canada, Italy and ECREEE (representing ECOWAS countries). Several participants indicated that they could contribute specific case studies. To further follow up, participants agreed on the following two activities:

- **All participants** to provide more detailed information on their proposed case studies to the Subtask leader so that he can use this also as input to a concept paper AND check for possible funding of activities
- **Subtask leader (with support from OA)** to develop a **concept paper** based on inputs from participants (see above) and on already existing studies; check for funding from Australia

In addition, the OA had a discussion with the ExCo of France (Paul Kaaijk) and Stéphane Biscaglia (ADEME's expert on smart grids, storage and islands) mainly on ADEME's consultancy based study (on the French Caribbean) islands that shows how to technically implement 100% RE (with hourly simulation steps to assure network stability). Since the study has a very technical focus it could be complementary to the content as described under Subtask 2. Furthermore, various links to related publications were received from the French and American ExCo and from the IRENA and from the ECREEE representative.

Given the fact that **no financing at all** was provided by Australia, the above mentioned idea of a first literature review and developing a concept paper had to be given up despite the high interest. Therefore, **Subtask 2 was completely put on hold due to lack of commitment and funds.**

### 4.3. Subtask 3: Mainstreaming PV related training in national training institutions frameworks

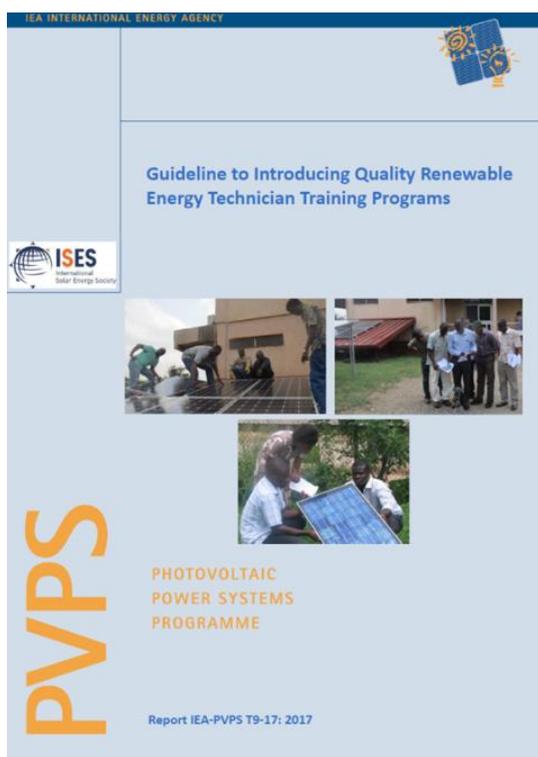
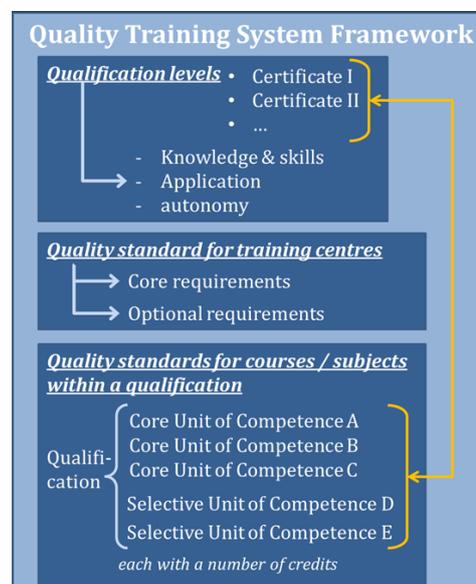
High quality technical training for Renewable Energies (RE) technicians - in training institutes, technical colleges or polytechnics - is a crucial precondition for successful sector development. Incorrect installations are not only dangerous but can also discredit a technology in a country. Though RE has increased dramatically over the last 10-15 years, training of technicians within accredited training centres has not kept pace with the industry requirements. Only in a few countries specific RE training is already included in the training framework.

Under this Subtask, Task 9 and the International Solar Energy Society (ISES) jointly published a “Guideline to Introducing Quality Renewable Energy (RE) Technician Training Programs”. It addresses the RE industry, multi-lateral and bi-lateral donors and government ministries/departments that want to introduce quality training programs for technicians.

The guide helps to introduce RE courses into an existing quality training framework or, if one does not exist, to establish a process whereby the training being provided is following quality procedures.

#### Components of a Quality Training Framework

A “**National Quality Training Frameworks**” is achieved through established **committees** comprising stakeholders from industry, training institutes and at times government who identify and document the required knowledge and



skills. Training institutes become accredited via an **auditing process** undertaken by a recognised body, often a (semi-) government entity based on a set of **quality management standards**. The publication explains about **quality training frameworks**, presents key elements included in a **quality management standard** which an approved training centre should be audited against.

#### Introduction of quality RE training and what if there is no country Quality Training Framework?

The document describes required steps like a needs and gap analysis, introduction of training courses while considering e.g. training formats and material as well as training of trainers. It discusses the need for an **international body for accreditation and approval of RE training centres** and summarises work undertaken by a body established in 1996, the Institute for Sustainable Power.

#### Existing Quality training and technician’s certification/accreditation schemes

The publication provides illustrative **examples** of the

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introduction of quality RE training programs including West Africa (ECREEE), France, India, Kenya, Malaysia, the Pacific region, South Africa, Singapore, and UK.

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

The [Guideline](#) can be downloaded on the PVPS-Task 9 webpage. The [October 2017 issue of the Newsletter of the Alliance for Rural Electrification ARE](#) highlights the publication. It was presented and thus disseminated to a broader public in a [Leonardo Energy webinar](#) on Nov 30, 2017.

#### 4.4. **Subtask 4: PV development as prosumers**



A study on this topic had been implemented for 20 (industrialised) countries in 2013 (under Task 1). The objective of the Subtask 4 in Task 9 was to broaden this study scope by including emerging and developing countries. The content focuses on **opportunities and challenges associated with producing and self-consuming electricity from grid-tied small PV-plants**.

The study focuses mainly on political/regulatory and financial/fiscal issues applying for urban residential, administrative and commercial “prosumers” (producer-consumer); it does not cover industrial and rural prosumers. Even though technical aspects like grid stability, data transmission and storage are important aspects, they could not be studied extensively. The idea to develop a prospective view on the topic arose from rapid urbanization in developing countries and the related opportunities in terms of energy production and consumption schemes. Opposing the results of this new study with those from the study on industrialised countries (2013) allows for an interesting N-S-S comparison and exchange.

During the conceptual phase, it had been important to well identify partners (e.g. ECREEE, GIZ, IRENA, ARE, CLUB ER, ASEF, etc.), to understand the needs of developing countries, interested in prosumer development, in terms of knowledge transfer and capacity building, and to define the target group/s and appropriate dissemination strategy for the deliverables.

Based on the analyses and comparison of different countries, a comprehensive evaluation was elaborated to summarise main hindrances, best practices, importance of self-consumption compared to net-metering, but also different “implementation models” (who invested under which conditions, access to finance).

The publication provides

- an excellent overview on the different “non-tax incentives” for self-consumption and partial injection which comprise: Feed-in-Tariff, Green Certificates and net metering / net billing
- an general overview on the development and today’s net metering situation (in countries worldwide) and the particular importance if the topic for emerging countries
- specific details on the net-metering situation in 1) three countries where net-metering already applies (India, The Philippines, South Africa), 2) three countries where a regulatory framework exists but no net-metering is applied for now (Kenya, Cape Verde, Ghana) and 3) two countries where net-metering is not allowed (Benin, Burkina Faso)

Besides the **electricity sector status**, the **net metering situation** (value of excess energy, impacts on end consumer, impact on distribution entities / utilities) and - where relevant - the **lessons learned** are summarised for each country. Furthermore, information on further reading and links are provided for more detailed information.

The comparative analysis focuses on: value of excess energy injected into the network, impacts on the final consumer and the PV sector and impacts on distribution companies. The latter are obviously often thwarting net-metering due to (mostly unjustified) reservations and fears.

A **SWOT analysis** provides an overview on strengths, weaknesses, opportunities and threats as presented in the figure on the next page.

Based on lessons learned, the study provides “**best practices**” which is a very useful list or “recipe” of dos and don’ts for the successful introduction of net-metering. In this context, a strong recommendation is given to use experience from other countries to optimize the regulatory framework, and to take into consideration expertise of international organisations like GIZ (German International Cooperation) which already provided technical assistance in several developing and emerging countries<sup>2</sup>.

<b><u>Strengths</u></b>	<b><u>Weaknesses</u></b>
<ul style="list-style-type: none"> <li>• Increased installed capacity</li> <li>• Improved access to energy (clean and modern source)</li> <li>• Diversification of the energy mix; on the long term: more decentralized generation with less dependence on a few big power plants (increase of network stability), requires less transmission capacity</li> <li>• Promotion of small scale private investment</li> <li>• Increase in building value</li> <li>• Strengthening the solar sector / job creation</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced profit for the distribution company (but: depends on their own generation cost and tariff level)</li> <li>• Lack of money for the government</li> <li>• Associated administrative costs (adaptation of customer management)</li> <li>• Possible technical constraints</li> </ul>
<b><u>Opportunities</u></b>	<b><u>Threats</u></b>
<ul style="list-style-type: none"> <li>• Urban growth</li> <li>• Strong sunshine</li> <li>• Dependency on imports / Supply instability</li> <li>• Inability to invest in new power plants</li> <li>• Service improvement objectives (e.g. ↑ electricity access / ↓ electrical losses / ↓ load shedding)</li> <li>• Political objectives (Renewable energy development and Sustainable City)</li> <li>• Decrease of PV equipment cost</li> <li>• More and more experience feedback</li> </ul>	<ul style="list-style-type: none"> <li>• Political instability</li> <li>• Inappropriate regulation</li> <li>• Lobbying of distribution companies</li> <li>• inefficient data management system</li> <li>• Poor coordination / lack of skills of actors</li> <li>• Availability of new low-cost energy sources</li> <li>• Inability of clients to invest (limited access to investment funds)</li> </ul>

Finally, the study presents specific case studies with technical and financial data from The Philippines and India and points out **commercial opportunities** resulting from net-metering including new business models (cash payment, “lease to own”, sale/purchase agreement).

The most important results drawn from the study are:

① **In-depth analyses** are necessary prior to setting up any compensation schemes. On the one hand, the distribution companies’ fear of revenue losses has to be taken into account otherwise they might be reluctant to support and promote net metering. On the other hand, compensation schemes should be attractive enough to promote net metering amongst clients whose investment capacities are limited. Subsidies from governments can help.

② **Strong politic will** is necessary to turn the law into concrete achievements. If the cost of fossil fuels is the sole motivation of governments, then the political will fluctuates. Instead, an actual ambition to increase the share of renewable energies and the quality / resilience of the electrical service is a key to successful implementation of net- metering.

③ It seems that net metering development in emerging countries can be **split into two phases** (i) 1<sup>st</sup> phase where net metering is mainly addressed to those whose investment capacities are relatively high (e.g. industrial and commercial user rather than residential ones) and (ii) 2<sup>nd</sup> phase where net metering becomes interesting to every type of user.

In addition to the main report, for **each country one datasheet with facts & figures** has been developed.

<sup>2</sup> See also [https://energypedia.info/wiki/Net\\_Metering](https://energypedia.info/wiki/Net_Metering)

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The various target groups considered important for this study include: policy makers in developing countries at national and/or regional level, private sector e.g. producers, retailers of PV equipment, engineering companies, European companies interested in targeting these emerging markets and urban planners in developing countries. Since these groups cannot be addressed by the same product, ideas on the final product/s for the respective target group/s are being developed. The report is in its final stage and will most probably still be published on the PVPS webpage in June 2018.

## **4.5. Subtask 5: Outreach and dissemination**

### **4.5.1 Networking, outreach and dissemination**

Task Management, networking, dissemination and outreach activities were the main responsibility of the Operating Agent (supported by all Task 9 members). This included coordination, support and management of the activities in the Subtasks as well as making contacts, networking, and dissemination of existing and new outputs through different channels.

The OA during the reporting period of 2.5 years organized **7 Task Meetings** (Istanbul, Zurich, virtual meeting 2016, Bad Hersfeld, Düsseldorf, virtual meetings 2017 and 2018). The scheduled 6<sup>th</sup> meeting for Oct/Nov, 2017 in an African country had to be cancelled because of a last minute cancellation of the organizers of the ECOWAS Sustainable Energy Week.

**Other events:** The OAs prepared and implemented an “Exchange Workshop” (29.2.16) in Zurich where representatives from SDC, SFOE, REPIC, GIZ, IRENA and the private sector had the opportunity to exchange with Task 9 members on their own activities and future Task 9 activities. The discussions during the Workshop substantiated the high relevance of Task 9 activities. Especially the representatives of GIZ and IRENA expressed their strong interest in cooperation and exchange of information. The OA also prepared and implemented a side event at the “International Conference on Solar Technologies & Hybrid Mini Grids to Improve Energy Access” (20.9.2016) in Bad Hersfeld. Task 9’s ongoing activities were presented and a number of valuable feedbacks e.g. on possible case studies were given by international participants (private sector, government institutions, universities, research institutions, NGOs etc. from Mozambique, Kenya, Norway, Switzerland, Germany).

**Task 9 products have been promoted** at a number of events (e.g. “International Conference on Solar Technologies and Hybrid Mini Grids to Improve Energy Access”, PVSEC-26 in Singapore). Standard promotion material had been developed (ppt presentation, poster, flyer on publications) and a comprehensive input had been provided to Task 1 for the PVPS newsletter but also content to completely up-date the Task 9 presentation on the new webpage.

The OA wrote an article for the recent ARE Newsletter on capacity building and training to promote the most recent Task 9 Publications: Guideline to introducing Quality RE Technician Training Programs and User guide on monitoring and sustainable operation of PV-diesel hybrid systems. The aforementioned first of the two publications was presented in a webinar on Nov 30, 2017 and the second one will most probably be presented in a webinar in May or June 2018.

The OA managed to place Task 9 publications also on the **Energypedia platform to reach a broader public** in particular among practitioners in development cooperation:

- [https://energypedia.info/wiki/Deploying\\_PV\\_Systems\\_for\\_Regional\\_Development\\_-\\_Publications](https://energypedia.info/wiki/Deploying_PV_Systems_for_Regional_Development_-_Publications) and
- <https://energypedia.info/wiki/Portal:Solar>

Task 9 was represented by its member Michael Müller at the Intersolar, India on Dec 7, 2017. A presentation on Task 9 activities was held at the ARE Off-Grid Workshop which took place during the event.

Task 9 was presented at the 4<sup>th</sup> Africa Mini Grids Summit, 21-22 March, 2018 in Nairobi Kenya; Michael Müller presented Task 9’s activities as well as the specific Subtask on mini grids.

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The OA has been continuously disseminating information on Task 9 and keeping the relevant stakeholders informed on the ongoing activities. Among these stakeholders are the following:

- **ECREEE** ECOWAS Centre for Renewable Energy and Energy Efficiency (contact persons Hannes Bauer, Mahama Kappiah and Jansenio Delgado): participated in the Virtual Task 9 Meetings in May and June 2016; invitation to bi-annual Meetings but despite strong interest, ECREEE representative so far could not participate due to budget constraints; mainly interested to contribute experience to Subtasks 2 (100% RE on Islands, example Cape Verde). In fact, ECREEE contributed information to Subtask 3 and 4 (Training Frameworks in ECOWAS countries and prosumer study)
- **GIZ** (contact person Caspar Priesemann): An excellent and very fruitful cooperation had been established between Task 9 and GIZ. The GIZ representative Caspar Priesemann is continuously participating in Task 9 Meetings and providing very valuable contributions to the various activities (detailed review of documents, linking with project and program managers for information on case studies, networking etc.).
- **IRENA** (contact person Roland Roesch): The IRENA representative is also continuously participating in all T9 Meetings and cooperates with Task 9 experts by providing specific inputs e.g. to the Training Framework Guideline. Making reference to IRENA's own publications and possible case studies to be evaluated is extremely helpful for the Task's work.
- **ARE Alliance for Rural Electrification** (contact person Marcus Wiemann): Despite their limited funds, ARE is very much interested in exchanging information with Task 9; the ARE member Katarina Uherova Hasbani (Revelle Group; Renewable Energy House, Belgium) represented Task 9 at the PVSEC-26 in Singapore on Oct 26, 2016. On Dec 7, 2017 a Task 9 member participated at the ARE Off-Grid Workshop during the Intersolar India. ARE was very supportive in publishing information on Task 9 in their newsletter and weekly alert to members.
- **SE4ALL**: OA provided input to the SE4ALL Steering Committee Meeting on Nov 19, 2015; further discussion with Dean Cooper<sup>3</sup> (Energy Finance Programme Manager at UNEP) during the Conference in Bad Hersfeld.
- Task 9 information sent to **ADA** and invitation to Meeting in Zurich and personal contact at OTTI Conference in Bad Hersfeld; problem of limited funds.
- The OA also was in **contact with ExCo members** of the following countries to draw their attention to the Task 9 work: Morocco (Ahmed Benlarabi), South Africa (Stephen Koopman) China (Wang Sicheng), Finland (Jero Ahola), Japan (Masanori Ishimura), Malaysia (Catherine Ridu), Thailand (Thidarat Sawai), Spain (Ana Rosa Lagunas), Turkey (Kemal Gani Bayraktar) etc..

More recently, the following options for cooperation had been sounded by the OA:

#### **International Solar Alliance ISA**

The OA has been in contact with Cécile Martin-Phipps Strategic management & Operations Director at [International Solar Alliance ISA](#)<sup>4</sup> to exchange on planned activities and possibilities for cooperation. This was also discussed in a phone conference with the French ExCo.

The ISA is still a very new organisation and headquartered in India. In January 2016, Narendra Modi, and the French President François Hollande jointly laid the foundation stone of the ISA Headquarters and inaugurated the interim Secretariat of the ISA at the National Institute of Solar Energy (NISE) in Gwalpahari, Gurugram. ISA intends to bundle the interests of the "solar rich countries", since so far mostly OECD countries do research in this field while the solar-rich countries do not have an own strong voice in product development as well as in relevance and quality of such products. ISA is not meant to compete with organisations like IEA or IRENA but rather intends to be complementary. With so far, 23 members (mainly in Asia and Africa); France and India are the main supporters. ISA's

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<sup>3</sup> Dean Cooper is no longer with SE4ALL. A new contact was not yet established

<sup>4</sup> Also called International Agency for Solar Policy and Application (**IASPA**)

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first program launched by France and India is focusing on **affordable finance at scale** and a second on **scaling applications for agricultural use** (launched in April 2016).

As a follow-up of this communication, the OA established a kind of **juxtaposition ISA – IRENA – PVPS Task 9** presenting for all 3 organizations: type of organization, overall objectives, foundation, member countries, headquarter, general director, examples for existing collaborations and future roles. Possibilities for **future complementary work** can be roughly summarized as follows:

- Task 9 could support IRENA through systematic **analysis of implemented projects** (e.g. projects under Abu Dhabi Fund for Development ADFD); IRENA providing data and Task 9 providing (scientific) analysis. Here, Task 9 could produce **lessons learned** and **best practice recommendations** based on IRENA-financed projects.
- ISA and IRENA to define specific (technical, policy etc.) **challenges and problems** to be analysed by Task 9
- Task 9 is at the interface of OECD countries (members of IEA and PVPS) and developing / emerging markets (represented by ISA and also IRENA). Thus, Task 9 could make a technological link and facilitate **“transfer of experience”** including technical as well as non-technical aspects

### **“Mission Innovation Challenge No 2: Off Grid Access to Electricity Innovation Challenge”**

The OA has been in contact with several persons regarding the so-called [Mission Innovation Challenge No 2](#) MIC2 to better understand the overall objective and possibilities for mutual benefit of possible collaboration. Relevant information is summarized in the following bullet points.

- The **overall objective** of MIC2 is to develop systems that enable off-grid households and communities to access affordable and reliable RE electricity. For individual homes, the objective is to reduce significantly over the next 5 - 10 years the price of RE power systems for lighting and communication. For remote communities, the objective is to demonstrate, in diverse geographic and environmental conditions, the robust, reliable and autonomous operation of RE power systems up to 100 kW at a significantly lower cost than today.
- Countries participating in MIC2 have committed to **double their governments’ clean energy R&D investments over five years**. Following this commitment, theoretically: there can be an extra 15 billion dollars coming online every year.
- **India**, (recently joined the IEA as an Association Partner), is also showing real leadership in this space and is **co-leading with France the MIC2**.
- IEA on July 12, 2017 organised a [MIC2 Workshop in Paris](#). This workshop looked at priority actions, metrics to measure and stakeholders for implementation.

The OA of Task 9 had a **phone conference with Simone Landolina / IEA** (organiser of the MIC2 Workshop) who provided the following additional information.

- In the second half 2017 each **India and France launched calls for proposals in support of demonstration projects and innovative solutions for off-grid access** to RE electricity. CERT is considering to holding a joint session on energy access with the IEA Standing Group on Long-Term Co-operation (SLT) (5 June, 2018 in Paris).
- Most interested and **engaged countries** in MIC2 (also in monthly conference calls) are: France, India, Netherlands, Canada (mainly interested in SSA), Australia, European Commission and Italy and UK indirectly; **Task 9 could present** its activities in one of these monthly conference calls
- Singapore: not (yet) in PVPS and not in MIC2 either, but very interested in SE-Asian market, doing research work on mini grids (Energy Research Institute at the NTU of Singapore REIDS). REIDS mainly does research on software solutions, energy storage including battery systems, flywheel technology, hydrogen etc.

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Furthermore, The OA had a conversation with Roch Drozdowski-Strehl, Deputy Director of the **REIDS, Energy Research Institute at the NTU of Singapore**, because REIDS is carrying out extensive work on mini-grids and is also looking at opportunities of international collaboration (including under MIC2). REIDS has more than 20 industrial partners which are partly also founding members (Schneider Electric, EDF etc.). REIDS cooperates with three different types of players: equipment suppliers, players in Singapore, SE Asia utilities. **Task 9** was invited and presented its activities on April 17, 2018 **at the REIDS Workshop on mini grids** where WB and a number of industrial partners participated.

Based on the various information received, the OA established a **list of contact details of persons responsible for MIC2 activities in the various countries**, including Australia (planned to use MIC2 funds directly for activities of Task 9), Canada, France, Netherlands (?), EC, USA and Denmark.

#### **4.5.2 Contribution to IEC 62109 (Safety of charge controllers) within IEC-TC-82 (Solar PV energy systems)**

The overall goal is to separate the requirements for inverters from those for charge controllers.

1) **Review** the existing standard related to safety and performance especially regarding its application to small PV power converters. 2) **Development of reasonable safety features for small PV devices.** Existing safety rules shall be reviewed and new rules shall be developed. In particular, they should be designed to be applicable for small devices in general. Also different rules for different classes of input voltages shall be discussed and developed. 3) The work will be summarized in a **list of recommendations** to improve the existing standard. Finally, a draft version of an update for the existing IEC62109 and 62509 standards will be developed. The work has started and Michael Mueller participated in two meetings (26.9.2016 in Frankfurt/Main – Deutschland / off-grid workshop; 29./30.9.2016 IEC62109 meeting in Frankfurt/Main).

#### **4.5.3 Contribution to CIGRE (Conseil International des Grands Réseaux) C6.28 WG**

Relevant Task 9 input is provided to the **CIGRE C6.28 WG** technical brochure: “Hybrid Systems for off-grid power supply” (Remote Grids). Georg Bopp from ISE acts as German delegate and PV expert. He attended the last meeting in Paris at 23.8.2016; the existing draft of the brochure has been reviewed and the existing table of content has been revised resulting in the following final structure:

- A. CHAPTER 1 – Background and Overview
  - B. CHAPTER 2 – Evaluation of Existing Sample Off-Grid Hybrid Systems
  - C. CHAPTER 3 – Market Offerings for High Renewable Penetration Off-Grid Systems
  - D. CHAPTER 4 – Systems Architecture and Technical Requirements
  - E. CHAPTER 5 – Development of Guidelines
- CONCLUSIONS  
BIBLIOGRAPHY/REFERENCES  
Appendix Case Study - Topologies of a few remote grids

A draft of 3 chapters out of 5 and a very detailed appendix “Case Studies” written by CIGRE experts now exist. In May 2017, Georg Bopp reviewed the existing draft and closed the gaps in CHAPTER 1 “Background and Overview” by writing the subchapter A 4. “Architecture and Technical Applicability”. The input for this subchapter is based on the IEA PVPS Report IEA-PVPS Task11, PV Hybrid Mini-Grids: Applicable Control Methods for Various Situations, L. A. C. Lopes, L. Arribas, F. Katiraei, K. Mauch, M. Vandenbergh. The status of the missing chapters 4 and 5 is unknown.

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## 5. Summary on most important achievements

**Main results** which had been fully achieved by Task 9 during the 2.5 years support from REPIC are:

- The objective to set new and **relevant priorities**, namely 1. PV in mini grids (including hybrid systems) and 2. Distributed PV in bigger grids (grid connected PV) mini-grids, has been well achieved.
- Task 9 produced **four publications** which have been promoted through webinars, by presenting them at conferences and on various platforms (including [Energypedia](#)):
  - December 2015: “[A User Guide to Simple Monitoring and Sustainable Operation of PV-diesel Hybrid Systems; Handbook for System Users and Operators.](#)”
  - September 2016: “Deploying PV Services for Regional Development, Products and Future Activities of the IEA Working Group”, published in the Conference Proceedings of the “International Conference on Solar Technologies & Hybrid Mini Grids to Improve Energy Access”, Bad Hersfeld Sept 2016.
  - April 2017: “[Guideline on Mainstreaming PV-related Training in National Training Frameworks](#)”
  - April 2018 (under preparation): “PV development as residential prosumers”
- **Dissemination** activities including presentations at conferences and workshops, webinar, and presentation of publications on external internet platforms to reach a broader audience. Presentation of Task 9 publications on “Energypedia” to reach a broader public, in particular among practitioners in development cooperation:  
[https://energypedia.info/wiki/Deploying\\_PV\\_Systems\\_for\\_Regional\\_Development\\_-\\_Publications](https://energypedia.info/wiki/Deploying_PV_Systems_for_Regional_Development_-_Publications) and <https://energypedia.info/wiki/Portal:Solar>
- Task 9 enlarged its network and outreach e.g. through exchanges with ARE, ECREEE, IRENA, ISA, GIZ etc. and thus also increased its visibility at international level. **Outreach and networking** activities included:
  - “**Exchange Workshop** on Deploying PV Services for Regional Development – Needs and Opportunities”, Zurich, Switzerland, February 29, 2016 with development partners, international organisations (SDC, GIZ, IRENA, etc.) and private sector to discuss the relevance of the Task 9 working topics
  - **Side Event of Task 9 at the OTTI Conference** “International Conference on Solar Technologies & Hybrid Mini Grids to Improve Energy Access”, Sept 21-23, 2016
  - IEA PVPS Workshop@ **PVSEC-26**, in Singapore, on October 27, 2016; presentation of Task 9 by Katarina Uherova Hasbani (member of ARE)
  - Presentation of Task 9 by its [member Michael Müller](#) at the Intersolar, India on Dec 7, 2017 at the [ARE Off-Grid Workshop](#).
  - Task 9 was represented at the **4<sup>th</sup> Africa Mini Grids Summit**, 21-22 March, 2018 in Nairobi
  - Development and structuring of the **Task 9 content on the new PVPS webpage**

## 6. Impact / Sustainability

The topics addressed by Task 9 under this Work Plan are of very high relevance and the fact that the publications are available on different platforms (PVPS, Energypedia) and promoted at different conferences, webinars, newsletters etc. ensures that they will have a significant impact.

Given the very limited number of Task members and the extremely limited funds for its work, the **output of Task 9 is quite remarkable**. The experts who worked under a specific Subtask did this more or less alone while also “non-funded” participants made a real effort to contribute to these Subtasks e.g. by providing case studies and reviewing reports.

Targets of the mandate	Achieved results
Contribute through the Task 9 work 1) to <b>improved quality of projects and programs</b> which include PV within development cooperation 2) to facilitate <b>access to the growing markets</b> in developing countries for economic sectors concerned 3) ) to improve <b>Swiss products and services export opportunities</b> in this field and to generate promising new projects	These are rather long-term objectives which can only be influenced in an indirect way. The various activities and publications of Task 9 significantly contribute to achieve these objectives. The main impact that Task 9 achieves - even beyond the term of the Task - is based on the <b>publications</b> which are the result of a synthesis of experiences and case studies brought in by experts from different countries collaborating in this working group. This is reflected by the fact that publications often have a <b>comparative element</b> . The publications elaborated during the reporting period provide excellent insight in e.g. RE training frameworks worldwide or policies governing PV self-consumption.
<b>Partnership with related organizations</b> should be intensified	This target has been fully achieved as elaborated under paragraph 4.5. Close cooperation was established with IRENA, GIZ, ECREEE, ARE and others.
Task 9's <b>visibility</b> should be strengthened within the global environment	This target was achieved through participation in numerous conferences, organisation of workshops, side events etc. but also through the publications (also presented in webinars, announced in newsletters and made available on other platforms like energypedia) and last but not least though the new contents on the PVPS Task 9 webpage.
Future <b>strategic direction</b> of Task 9's activities shall be repositioned.	The current phase has been managed based on a work plan established beginning of 2016. Now, in 2018, at the end of the Swiss support for the OA mandate, a new work plan with a more technical focus has been elaborated. The general focus on developing and emerging countries has been further strengthened.

## 7. Outlook / Further Actions

At the last ExCo Meeting (Kuching / Malaysia, Apr 2018), it was decided to try out whether a **more technically oriented (new) Task** would attract more interest among the PVPS member countries. The advantage of this approach will certainly be that a strong technical focus is more attractive for research institutions / government organisations. The risk might be that the complexity of technical AND non-technical problems related to PV deployment in emerging and developing countries is rather neglected, although in particular non-technical aspects are often crucial for success (e.g. training requirements, operational models for mini-grids, financing options).

To finally decide on the usefulness of such an initiative, a **“preparatory phase”** should help to define WHO is interested to participate in a possible future Task 18 and WHICH topics should be addressed by such a new Task. Michael Müller (Task 9 member, Germany) will coordinate the activities during this preparatory phase (based on funding from Germany).

**Ten countries** so far expressed their **interest in a new Task 18**: Malaysia, Thailand, Morocco, Australia, Canada, Germany, Denmark, France, Sweden and China. The ExCo members from these countries promised to identify interested stakeholders and funding in their respective countries to participate in a new Task 18.

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The focus of the new Task 18 should be on the **following topics**, as also specified in the new Work Plan drafted by the current German Task 9 members (Michael Müller / Steca, Georg Bopp, Johannes Wüllner, Norbert Pfanner / Fraunhofer ISE: PV off-grid systems including mini-grids up to 20 MW, Li-Ion batteries (for such off-grid systems), LED and other energy efficient appliances etc.

For the next ExCo Meeting, Michael Müller should then provide a report on the **progress of the coordinating activities** and before the next-but-one ExCo Meeting (in one year) these activities should – as the case may be - result in a **final Work Plan (for Task 18)** specifying the member countries, detailed number of available person months, names of experts etc.

## 8. Lessons Learned / Conclusions

Three main lessons learned can be drawn from the terminated working period of Task 9:

1. The multitude of exchange activities with international organisations and initiatives has shown that the **topics which Task 9 recently addressed are of prominent importance** (PV and hybrid mini-grids, prosumers and net-metering, systematic training & capacity building).
2. A stronger **R&D focus (also) on emerging and developing countries** (“solar-rich countries”) **within the PVPS Programme** is crucial to make experience available to non-OECD countries to avoid re-inventing the wheel. However, this requires due consideration of the particularities such countries.

During the reporting period, an **online survey was implemented among ExCo members on the role of Task 9** in the next PVPS term. It showed that the ExCo members see a clear added value to include non-OECD countries, their needs and points of view into the work of PVPS. In particular, Task 9 is seen by most of the survey participants as a “translator”, meaning it should play a role in analysing experience from OECD countries (e.g. distributed generation) and “transfer” or check applicability of such information for emerging and developing countries. An excellent example is the completed Sub-task 4. When being asked about topics of highest interest, ExCo members referred to integration of PV into grid, grid code, impact of high penetration levels, on-grid funding mechanism for rooftop PV, feed-in tariffs models, PV value chain and job creation. Some of these topics have been successfully addressed in the last working phase of Task 9.

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## 9. References

- December 2015: "[A User Guide to Simple Monitoring and Sustainable Operation of PV-diesel Hybrid Systems; Handbook for System Users and Operators.](#)"
- September 2016: "Deploying PV Services for Regional Development, Products and Future Activities of the IEA Working Group", published in the Conference Proceedings of the "International Conference on Solar Technologies & Hybrid Mini Grids to Improve Energy Access", Bad Hersfeld Sept 2016.
- April 2017: "[Guideline on Mainstreaming PV-related Training in National Training Frameworks](#)"
- April 2018 (under preparation): "PV development as residential prosumers"