

Interactive PV Training tool – Concept based on Case Studies

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Abstract: arsenal research is participating as national expert the International Energy Agency (IEA) Photovoltaic Power Systems Programme (PVPS) Task2 dealing with operational performance, reliability and analysis of monitored PV data. The company TBB plans and installs various PV and Hybrid systems. Consulting activities of both authors at universities, vocational and polytechnic schools have shown, that the most written tutorials don't follow the technology progress and the fact level is often poor. An interactive PV Training tool (IATT) is the easiest way to disseminate current technologies and to update continuously the content synchronised with the technology progress. The concept of IATT relies on selected monitored and analysed case studies. The tool is linked to some new means of communication dealing with generic and multimedia entities. The aim of IATT is to make the target groups understand about PV and Hybrid technologies and "to think as well as to feel like a sun".

KEYWORDS: Training -1: Simulation -2: Multimedia -3

1. Introduction

Training and Educating will come automatically with the increasing number of PV/Hybrid applications (see also Fig.1). As the people see that there is a new technology and they know nothing about it they will get the feeling that there is something which they have to learn. Onsite Analysis results are facts we learn from. Especially in daily installation projects are many different unpredictable influences affecting the expected results. The supply of PV systems mainly on rural countryside must put the people into concern that they need to deal with technology. So on one side there is the set up of a new system with probably new components and on other side the person who isn't trained on using the equipment. Training and Educating provide valuable information to one who manufactures the products, to one who plans the system and

to the one who uses PV/Hybrid technologies. Very often it is the customer that leads to new or improved components, systems or procedures so that the Monitoring and evaluating of the data is important [1].

2. State of the Art

The following chapters 2.1 to 2.4 may give you a rough general overview about several today used programs, tools and standards.

2.1 Simulation programs

A Simulation program predicts the expected yield of a real system based usually on statistical data. Components will be simulated in mathematical models within different configurations. The essential basis data of PV systems works with monthly average values of

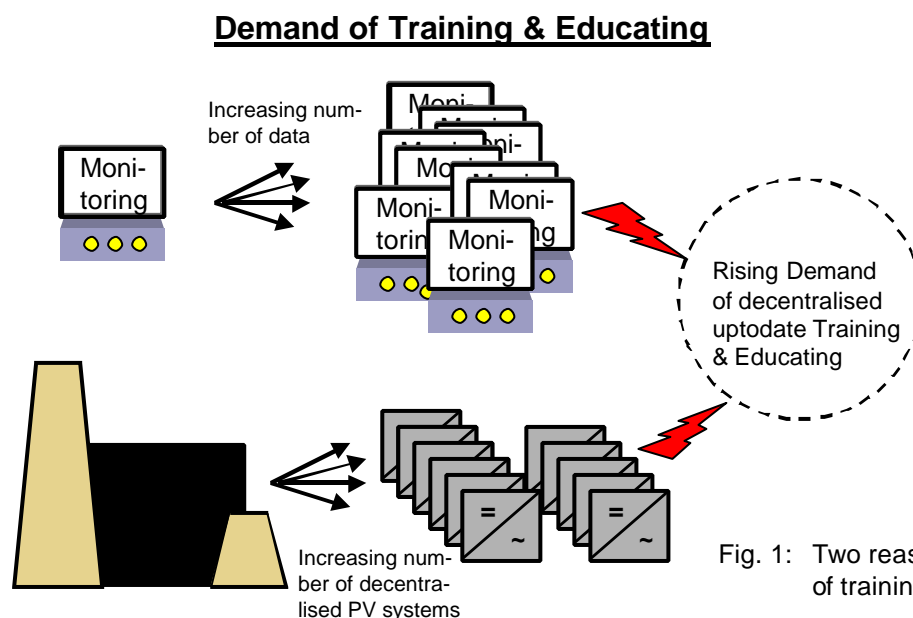


Fig. 1: Two reasons for the rising demand of training and educating

global irradiation and with the ambient temperature of the different locations. The implemented simulation software calculates the daily variations of the meteorological data for one year. This data will be converted afterwards on the module level. This converted data runs through the core models: PV generator and inverters for grid-connected systems (GCS, see also Fig. 2) and is additionally influenced by the back-up (battery as well as auxiliary generator) and end-user consumption for Stand alone systems (SAS) as well as hybrid systems. In these applications the consumption and the worst irradiation conditions are estimated to size the optimum Balance of Systems (BOS). If the system components are properly working under worst case conditions, it may do it during the entire operational period. Existing simulation programs allow to change system coefficients, which may lead step by step to the optimum configurations.

- Photovoltaic Internet Laboratory (<http://www.ntb.ch/Other/PVwwwLab>) is an online experimental system dealing with the performance of grid-connected and stand-alone PV systems. The Internet Laboratory allows the users to interact and observe already installed and monitored PV systems [3].

2.3 Existing Internet Database

The Performance Database of IEA PVPS Task 2 is designed to provide experts, industry, utilities, manufactures, system designers, installers and schools with suitable information on the operational performance, reliability and design of Photovoltaic (PV) systems and components. The benefit of the Performance Database lies in sharing technical information focusing on long-term performance and reliability of PV systems and providing tools for practical and educational purposes. [4], [5]

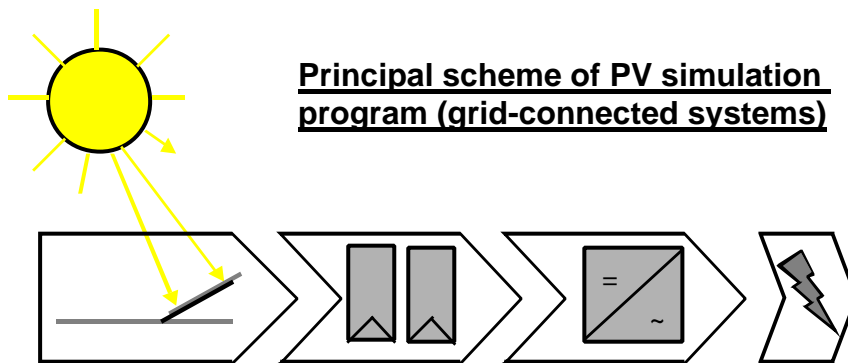


Fig. 2: Principal scheme of a simulation model of grid-connected PV systems

2.2 Online training programs

Learning via on-line courses are fashionable with growing followers. Some interesting examples of interactive learning systems about Renewables based on different simulation tools were presented on the last PVSEC in Glasgow:

- ILSE - Interactive Learning System For Renewable Energy (<http://emsolar.ee.tu-berlin.de/~ilse>) offers lessons about solar and wind energy as well as cost predictions. The users are able to test their technology knowledge with interactive multiple choice tests. Besides the lessons and tests the ILSE Toolbox provides online calculations and simulations [2].

Database contents:

- Information of over 260 PV plants in IEA countries world-wide
- Grid-connected, off-grid and hybrid PV systems of 1 kWp up to 3 MWp
- General plant information (size, system type, mounting, location, cost, photo)
- System configuration and component data
- Monitoring data (values of monthly energies, irradiation and temperature)
- Calculated data (monthly and annual values of performance indicators)

2.4 MPEG7 - New means of communication

Audio-visual information plays an important role in our society. More and more audio-visual information is available, from many sources around the world. The information may be represented in various forms of media, such as pictures, graphics, 3D models, audio, speech, video etc..

MPEG-7 is an ISO/IEC standard being developed by MPEG (Moving Picture Experts Group). MPEG-7 aims to provide standardised core technologies allowing description of audio-visual data content in multimedia environments. A description generated using MPEG-7 description tools will be associated with the content itself, to allow fast and efficient searching for, and filtering of material that is of interest to the user. [6]

3. IATT - Interactive PV Training tool

The more the industry and research organisation contribute to the application of PV the more will be automatically supported the aspect of vocational schools and universities.

3.1 IATT Concept

The concept of this tool is based on the evaluation of existing simulation and training programs as well as experiences on existing Internet Database administrations. The presentation of the data is linked with the new standard MPEG7 for facilitating the access to information, which satisfies the user's preferences and the general understanding about how to use solar technologies most effectively. One goal of the IATT concept is to gain the attraction of innovative PV and Hybrid

technologies towards a rising public. The approach of the IATT concept is shown in the flow diagram below (see Fig. 3).

The simulation programs are effective tools for system designers and installation companies. The monitoring program validates these data regarding expected results and reflects THE onsite performance of installed PV systems. The reliability of the PV system is evaluated and analysed with real measured data. A lot of knowledge and experience are required to plan with simulation programs and to analyse measured data. For addressing the increasing number of interested people simulation and monitoring programs constitute as second and third stages after the training course. Convenient case studies are selected, constitute as the basis for training as well as educating and close finally the loop of the learning process.

IATT should show clearly the influence of important parameters on the system performance (technical and economic) and on selected coefficients to make the target groups understand about the optimum use of PV and Hybrid technologies. The innovative, easy to use and interactive tool might allow "to think as well as to feel like a sun"

- By demonstrating the influence of important parameters on system performance (technical and economic),
- By learning how to optimise system sizing,
- By analysing several defined malfunctions,
- By validating results of some existing simulation programs through a cross comparison with monitored case studies and
- By elaborating some new ways of

Flow diagram of the IATT Concept

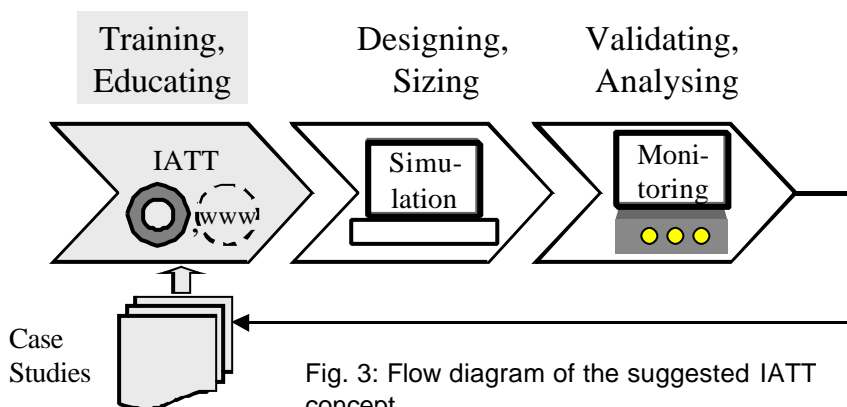


Fig. 3: Flow diagram of the suggested IATT concept

Glossary

Designing – is depending on environmental and technological conditions.

Sizing – The system is generally sized according to individual worst case conditions.

Monitoring - A monitoring program validates expected and measured onsite data of installed PV/Hybrid systems.

Analysing – of the evaluation results for providing suitable

dissemination by using new means of communication dealing with generic as well as multimedia entities.

3.2 New IATT tools

Innovative, easy to use and interactive tools are developed for reaching the above mentioned aims. The tools may lead to the further improvements on design and sizing of PV/Hybrid systems to emphasise the market penetration of renewable technologies.

▷ **Extraction tool** – the explaining content of IATT is linked with digitised data like pictures, graphics, bitmaps or audio data. For identifying these links the context and related visual and audio data are filtered through the extraction tool. Two examples may highlight the use of the extraction tool: (1) The components of the PV system can be extracted in the convenient picture. (2) In the context described performance coefficients of the PV system can be extracted in the convenient bar diagram or other graphics.

▷ **Highlighting tool** – all extracted data are marked off the environment by highlighting it.

▷ **Interaction tool** – for allowing the interactive use of the important performance coefficients the extracted and highlighted data are linked to a simulation model for changing monitored data of selected case studies. The results of changed coefficients are shown on the display. accompanied by some comments.

4. Summary and Outlook

An interactive PV Training Tool (IATT) has been introduced dealing with monitored and simulated data. The concept of IATT clarifies the influence of important parameters on the system performance (technical and economic) and on selected coefficients will contribute to make the target groups understand about the PV and Hybrid technologies. The tool can be connected to some new ways of communication and might be disseminated online to address the growing number of interested user's. Knowledge widespread disseminated to the target groups via an innovative, easy to use and interactive tool may lead to the further improvements on design and sizing of PV/Hybrid systems to emphasise the market penetration of Renewables in Europe and abroad.

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New ways of communications

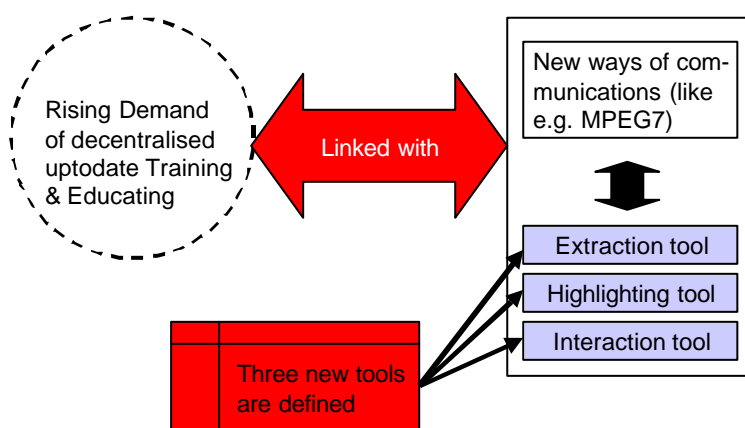


Fig. 4: Three new tools for using new ways of communication