Quality assurance for large power plants

Deutsche Gesellschaft für Sonnenenergie e.V.
International Solar Energy Society, German Section

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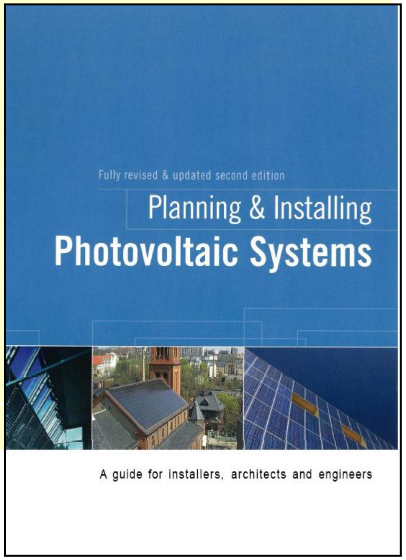
Introduction

- Oldest Solar NGO in Germany, founded 1975;
  3.000 members, 340 companies
- German section of the International Solar Energy Society (ISES)

- Consultancy for ministeries, several working groups...
- Solar School: training courses
- Technical work: standardization, quality assurance, optimization, analysis of systems, simulation of systems, final inspections, identification of system errors
- DGS is member of the German technical-scientific society (DVT).

- DGS Manual PV – Systems
  German, English, Spanish
- Solar Magazin SONNENENERGIE



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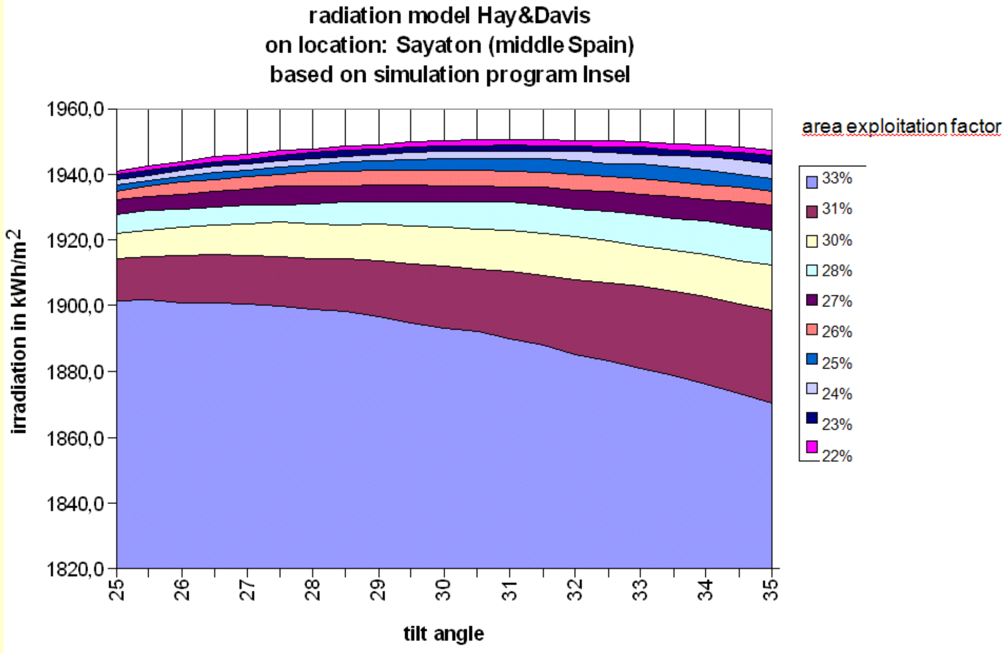
Checking Services

Inspection on calculations Insolation calculation, energy yield calculation, estimation on power degradation, pollution, spacing of modules, verification on performance parameters etc..
Location (shading, infrastructure)
Risk evaluation (theft, lightning, component problems, vegetation)
Definition of minimum quality properties for specific system and components (relevant standards, minimum performance agreement)

Result: general parameters for financing decisions

Check of suitability of components selection
Adherence to relevant standards and requirements
Adherence to agreed properties

Result: confirmation of suitability



Example: Optimization of distances between the rows on a free standing system

Field / Commissioning Inspection

- Safety
  - IEC 60364-7-712 Ed.1.0 -> safety class II,
  - cabling (type, cross section, data, laying)
  - Inherent earth-fault-protecting / short-circuit-protection
  - general construction and orientation of the PV-generator (tilt angle, distances, shading)
  - Lightning protection, grounding, best practise
- Components and systems
  - Module: IEC 61215, 61646, 61730, UL 1703 etc.
  - Inverter: EN 50 178, EMV EN 61000-6-3 EN 61000-6-1, UL1741
  - Anti-islanding certificate, „Unbedenklichkeitsbescheinigung“ BG,
  - Field inspection report
- Function Test
  - Verification of basic functions, electrical parameter measurement
- Grid connection/
  - Grid utility connection regulations (e.g. VAR, cos φ, f, “Smart Grid issues”)

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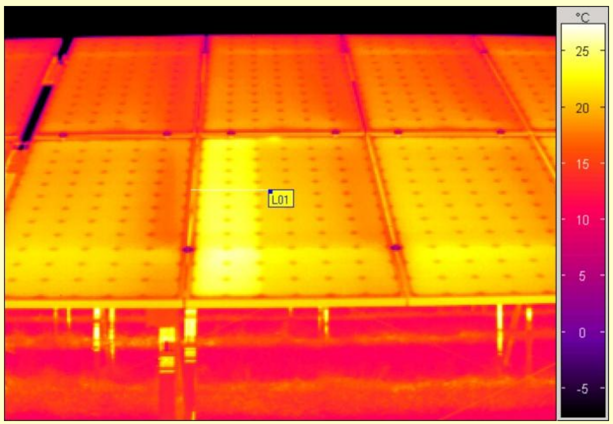
Field Inspection

- **Survey during construction**

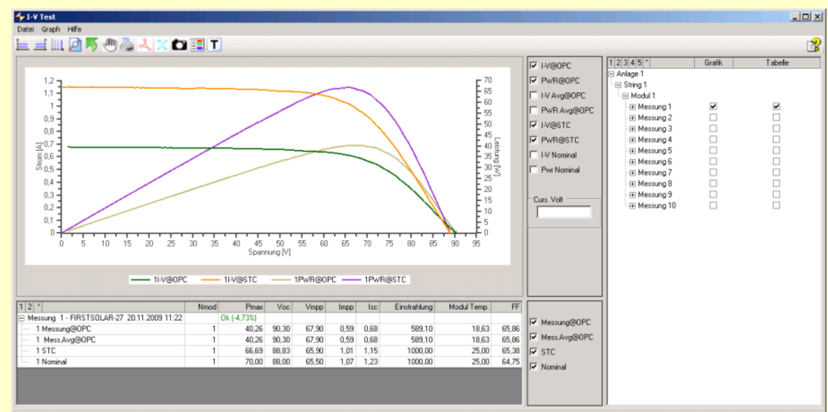
  Surveillance of the workmanship

  Detection of failures before commissioning



- **Survey during commissioning**

  Confirmation of suitability



- **Operation analysis**

  Confirmation of efficiency

The good, the bad…

A PV-system has to operate 20 – 30 years

Quality is essential in general and in detail

An independent surveyor can give certainty

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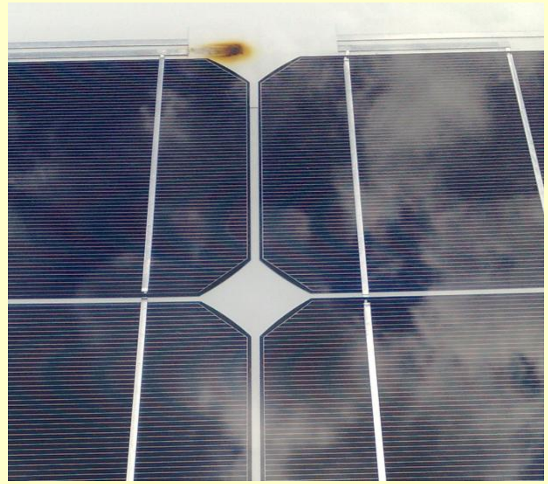
Errors may happen after years



- **Follow up inspections, ongoing monitoring**

  Yearly:
  Short inspection (visual inspection, function tests,…)

  Every 3 years
  Detailed inspection (insulation resistance measurements, string measurements,…)

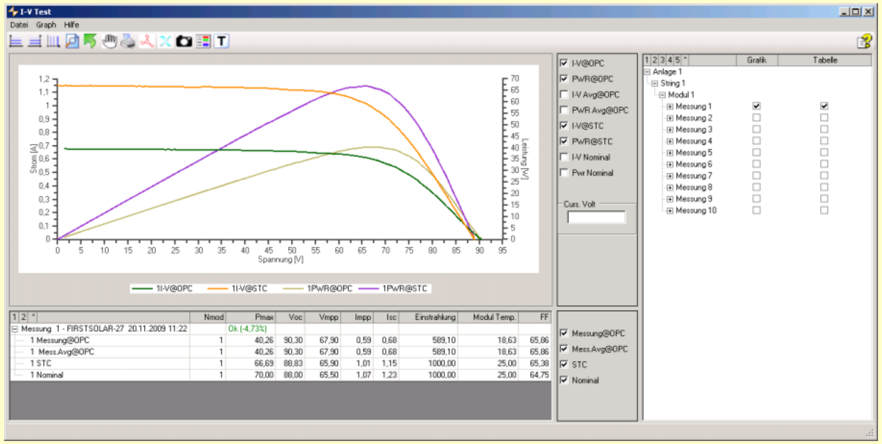
  Monitoring of yield

  If errors suspected
  Inspection and re-measurement of modules (warranty related)

Example: Field Measurements Of I/U Curves

- Stable module performance necessary
- Measurement is not under STC conditions
- Irradiation has to be > 700 W/m², constant
- Module temperature usually > 40°C
- Gradient on module usually > 5°C
- Gradient in array often > 10°C
- Temperature coefficient only given for Uoc

- Uncertainty > 4%
- Comparison with calibrated module is reasonable
- Measurement outdoor <u>and</u> at a certified laboratory gives certainty



Problems During Field Inspections

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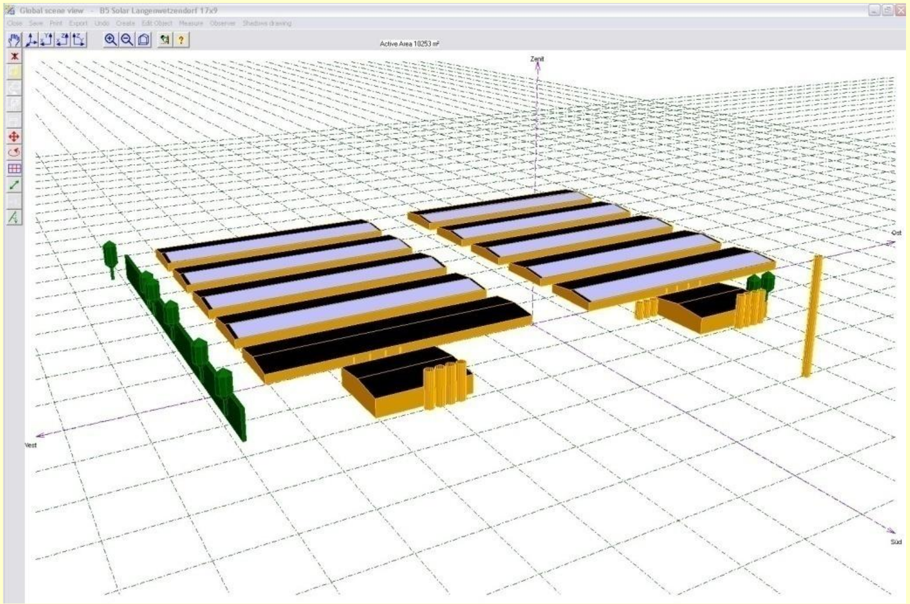
- Stable Module Performance
- Sufficient Isolation
- Accessibility of Modules
  - outdoor test
  - dismounting
- Other Conditions

Yield Prediction Methods

- Energy yield predictions are based on:
  - Meteorological data for the specific area (What comes in?)
    - *Global irradiation profile*
    - *Ambient temperature profile*
    - *Site conditions (dusk-dawn shading, altitude)*
    - *wind*
    - *Other effects (snow etc.)*
  - Specific parameters of components and installation (How is the performance?)
    - *Component parameters (type, efficiency, electrical parameter)*
    - *Inverter matching (MPP, size, capabilities)*
    - *String connection, cable cross section and cable length*
    - *Orientation (possibly tracking system)*
    - *Analysis of shadowing effects*
  - External effects (What limit factors exist?)
    - *Pollution*
    - *Degradation of power*
    - *Loss factors of periphery (e.g. transformer or grid connection)*

Energy Yield Prediction Tools

- Sources and methods:
  - Source of meteorological data
    - *Actual measurements (e.g. provided by DWD)*
    - *Simulated meteorological profiles (e.g. by Meteonorm, National Weather Service)*
  - Calculation/simulation tools for the energy yield
    - *Insel (software)*
    - *PV Scout (software)*
    - *PV Sol (software)*
    - *PV Sys(software)*
    - *Etc.*
  - Consideration of external effects
    - *Including further specific effects which have not been considered*
    - *Uncertainty estimation*



References: Large PV installations in Italia

PV-Plants (Examples)	Power	
San Donaci / Calabria	990 kW	2 axis tracking system
San Giorgio I, II and III	3 x 980 kW	open space
Colleferro / Lazio	3.5 MW	roof mounted system
San Pietro Vernotico / Calabria	2 x 990 kW	open space
Mancini / Abruzzo	4 MW	open space
Mazulli / Abruzzo	1.8 MW	open space
Ribera / Sicilia	995 kW	open space

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Conclusion

- **A quality program is most important for large power plants because yield losses cause very high financial losses**
- **A sufficient quality program has to include all steps from planning, calculation, construction, commissioning and operation**
- **In principle a quality program can be used for large power plants and for small PV-installations**
- **A comprehensive quality program is normally appropriate only for large plants due to effort and costs**
- **A proper yield prediction is inevitable for all types of plants**
- **Given the nature of the economic risk and the current quality of components and systems, impartial and independent oversight is a necessity**

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Thank you for your attention