PV SYSTEMS - A FIRE HAZARD?

Myths and Facts from German Experience

Hermann Laukamp,
Robin Grab, Heribert Schmidt

Fraunhofer-Institut für
Solare Energiesysteme ISE

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www.ise.fraunhofer.de

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recently broad media coverage on hazards from PV systems to fire fighters

„PV systems constitute a life-threatening hazard to fire fighters – therefore they might not fight the fires.“ ! -- ?

Solardächer gefährden die Feuerwehr

laranlagen weiter Strom. Wenn die Feuerwehrleute den Wasserstrahl auf die Module richten, droht deshalb ein tödlicher Stromschlag. Im Zweifelsfall ziehen sie es daher vor, ein derartiges Haus kontrolliert abbrennen zu lassen, wie es im Februar im ostfriesischen Schwerinsdorf geschehen ist. Schaden: über eine halbe Million Euro. U

DER SPIEGEL, 12.7.20

Ostfriesenzeitung, 18.2.2010

Schwerinsdorf

Haus in Schwerinsdorf abgebrannt

18. Febru

Der Brand war in einem Zimmer ausgebrochen und breitete sich auf das gesamte Gebäude aus. Die Feuerwehr konnte erst spät eingreifen - wegen einer Fotovoltaikanlage auf dem Dach.

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fire risks in PV systems

research project

„Assessment of fire risks in PV systems and development of safety concepts for risk mitigation“

subjects adressed

- risk analysis of potential weak spots in systems and components
- fire incident analysis
- investigation of electric arcs, arc detection, arc prevention
- measures and procedures to ensure a safe system state
- fire fighting: information, hazard analysis, hazard mitigation, adapted fire fighting procedures

PV fire safety project
results – risk analysis

media statements

- „Fire fighting missions on PV buildings are dangerous.
  One fire fighter has been seriously injured by electric shock, already.“
- “Fire fighter do not extinguish fires in buildings with PV, because it is too dangerous. They only guard adjacent buildings.”
- „PV systems are especially dangerous, because they cannot be switched off.“

-> approach: investigation of incidents
(from media reports, fire brigade reports, insurance companies´ reports, damage investigators)

Results - incident analysis
statement 1

- „Fire fighting missions on PV buildings are dangerous. One fire fighter had already been seriously injured by electric shock from PV.“

incident: fire fighter seriously hurt from PV electric shock at Rösrath

from a TV report by „Kabel 1“ station

fire fighter seriously injured by electric shock from PV at Rösrath

Results - case analysis

statement 1 – fire fighter seriously hurt from PV electric shock at Rösrath

- **not PV**, but **solar thermal** (DHWS)
- fire fighters´ Accident Prevention & Insurance Association said:
  no (other) PV accident noted (out of ca. 10.000 incidents/year)

-> Myth

Results - incident analysis

statement 2 – fire fighter do not extinguish fires in buildings with PV

- fire at Schwerinsdorf, February 2010

photo: Wolters

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Results - incident analysis

statement 2 – fire fighter do not extinguish fires in buildings with PV

what happened at Schwerinsdorf ?

from the main officer´s mission report

- After “interior attack” pockets of ember remained behind large wooden panelling
- “Flashover” occured -> pull-out from building interior
- Outside attack after PV modules had been destroyed
- „PV system was not cause of building loss […], but hindered fire fighting“

(source: Einsatzbericht Gebäudebrand Schwerinsdorf / http://www.feuerwehr-forum.de/f.php?m=614570)

-> Myth

source: Wolters

Results

statement 3 - „PV systems are especially dangerous, because they cannot be switched off.”

„PV systems cannot be switched off.“

-> (currently) fact !

- fire fighting possible as defined in standard VDE 0132 (“fire fighting and technical assistance for electrical systems”, 2012): by observing minimum distances 1 m / 5 m
- hazard exists during “interior attack” and dense smoke:
  wires with burnt away insulation are “invisible” (like at Rösrath)
- hazard mitigation by measures according to recently developed draft guideline E VDE-AR-E 2100-712

  organisational, constructional, technical measures

PV fire safety

statement 3 - „PV systems are especially dangerous, because they cannot be switched off.”

- hazard mitigation by measures according to draft guideline E VDE-AR-E 2100-712 (under development)
  - o **information:** sign posting on existing PV system**,** documentation, schematics, component locations**,** cable routing,
  - o fire protected installation of dc-cables (according to standards)
  - o installation of dc-cables outside building skin
  - o remote controlled dc switch disconnector or short-circuit switch array, string or module level specifications and test requirements under consideration

„PV systems are especially dangerous” **-> myth!**

PV fire safety
assessment of fire incidents

- for about 1.3 million PV systems with some 28 GW installed capacity
  - some 280 fires reported (until September 2012), where PV systems had been affected
  - some 100 fires are attributed to PV systems

PV fire safety
assessment of fire incidents

- poor components
- poor workmanship
- “some systems appear as if the installer intentionally ignored basic electrical installation requirements” (insurance investigator)
- some surprising findings
  - DC switches – several incidents
  - AC side often appears as cause of fire
    - improper handling of Al cables
    - possibly qualification tests for AC equipment not well suited for PV specific load profile:
      longtime operation near full load, daily thermal cycles
      -> ageing contacts, ageing components

PV fire safety
assessment of fire incidents

Production flaws or poor quality components - modules

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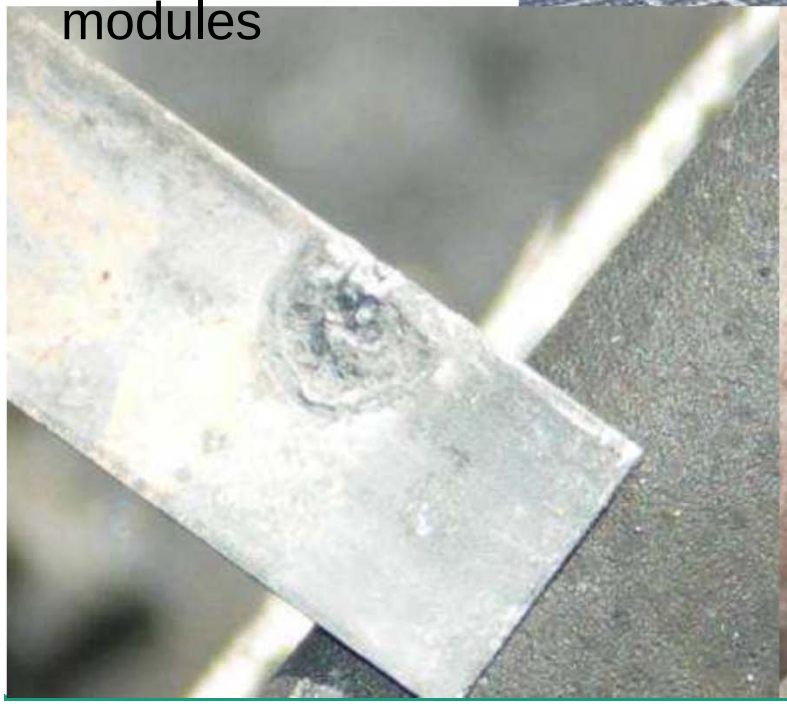
PV fire safety
assessment of fire incidents

Production flaws or poor quality components - modules

- the investigator found many poor soldering connections within modules



photos: W. Rütz

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PV fire safety
assessment of fire incidents

regular AC side components occur unexpectedly often

- fuse
- terminals/cables

photos: U. Motzer

photo: H. Godard

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assessment of fire incidents

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assessment of fire incidents

one example incident - combination of stress influences

- mounting of inverters and dc switches

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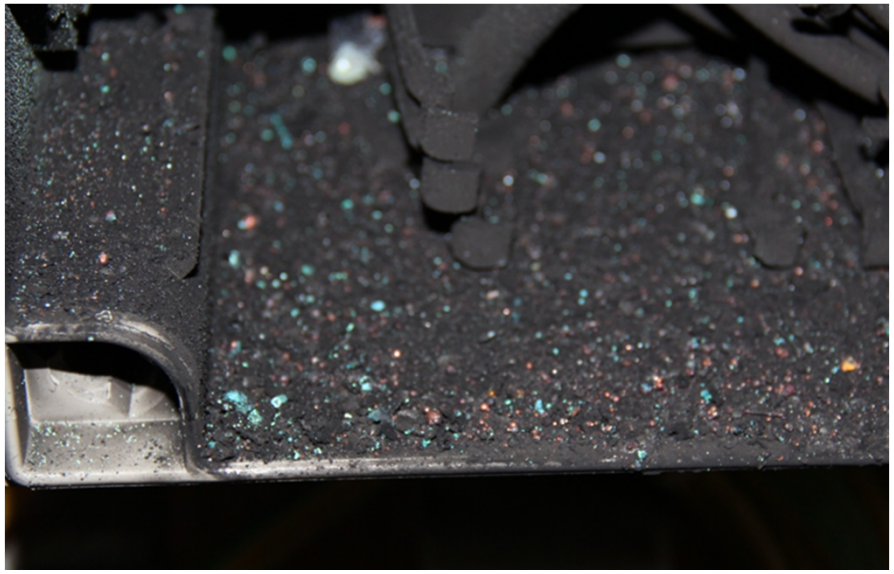
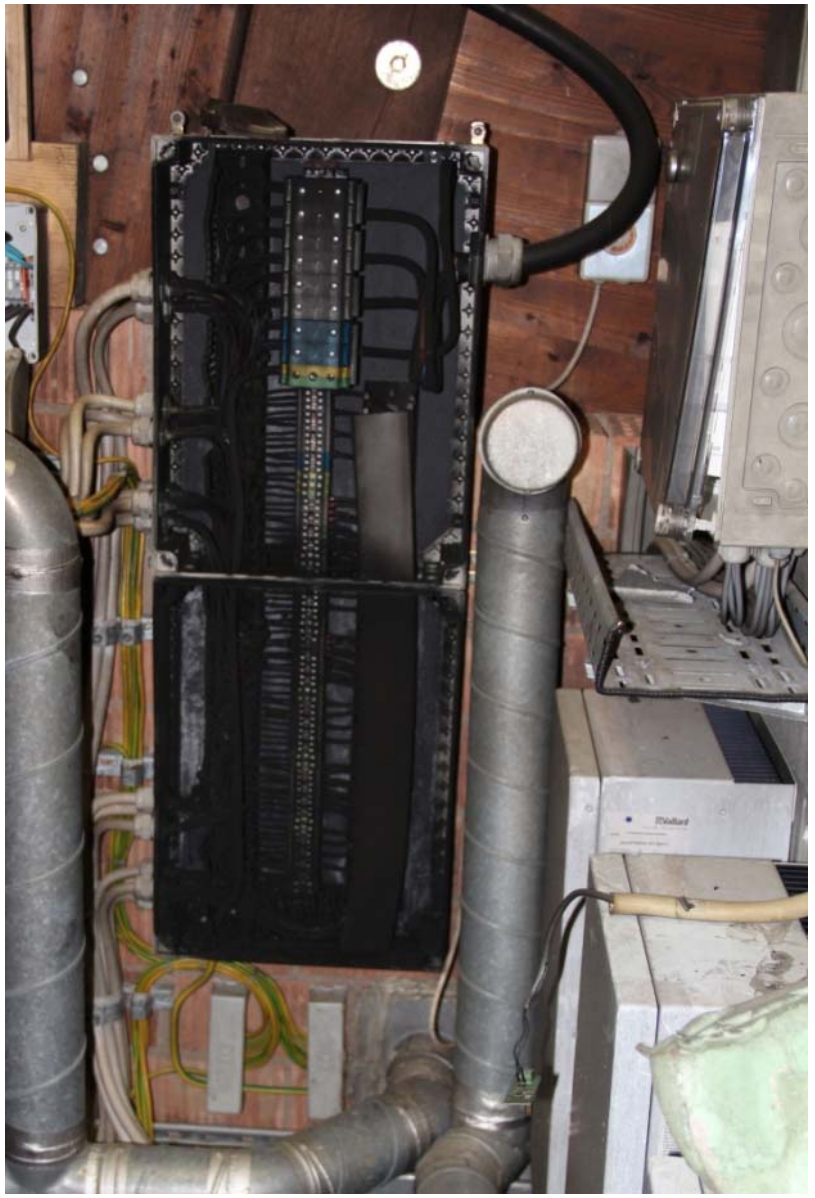
PV fire safety
assessment of fire incidents

secondary fault - the AC distribution box had seen an internal fire

no fuse for any inverter

-> gross design flaw





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PV fire safety

assessment of fire incidents

critical issues – what was the cause of this fire?

- inverters located in attic – high ambient temperature from non-insulated roof
- inverters densely packed – beyond manufacturers instructions
- small room with poor ventilation– where does dissipated heat go?
- do you know that the standardised maximum ambient temperature of switch gear is 40 °C? (IEC 60947)
- origin of fire was identified in a dc switch
  - planning error? - wrong location and mounting for the heat load
  - product failure? – similar components have failed from poor connections
  - planning error? – lack of derating of switch
  - lack of maintenance? – occasional operation of switch may be required by manufacturer to remove oxidation layers

PV fire safety
Conclusions

PV SYSTEMS - A FIRE HAZARD?

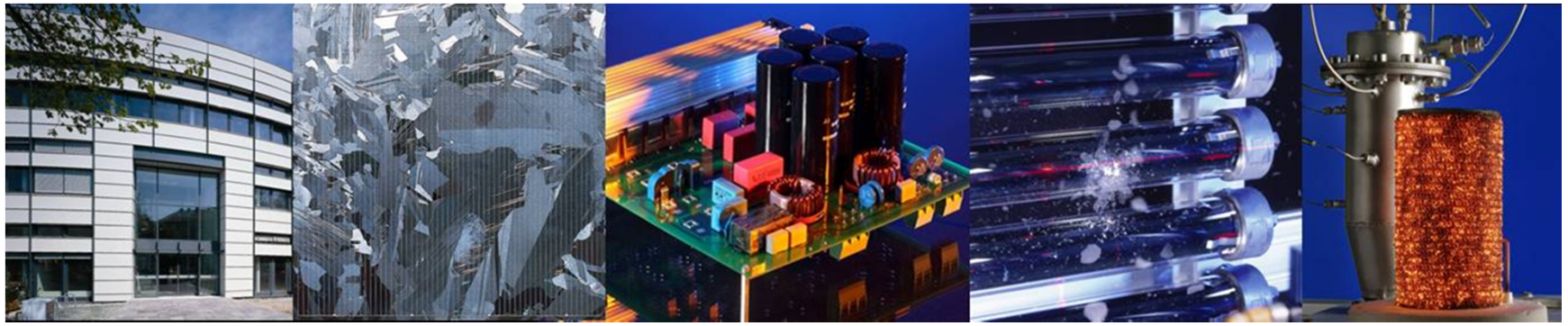
- much less so than publicly alleged in Germany
- there is a small risk that fires can be started by PV components
- this risk can be reduced by
  - careful installation
  - initial verification i.e. inspection and testing
  - periodic verifications
  - (yield) monitoring to detect degradation problems
  - verification of test procedures and maintenance requirements for conventional AC- components
- PV systems are not maintenance free

Thanks!

to You, for Your attention

the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) for financial support

all fire(wo)men for their tough efforts



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Reserve

Informationen, Quellen, links

- Film Kabel 1: http://www.youtube.com/watch?v=lrox-kWgLFo

http://dfv.org/fileadmin/dfv/Dateien/Fachwissen/BSW_Feuerwehrbroschuere_2010.pdf

http://www.dgs.de/fileadmin/bilder/Dokumente/PV-Brandschutz_DRUCK_24_02_2011.pdf

www.vds.de/fileadmin/vds_publikationen/vds_3145_web.pdf

http://vds.de/fileadmin/vds_publikationen/vds_2033_web.pdf

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