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Analyzing PV system safety and the promise of optimizers

21 June 2022

9:00 am – 10:00 am | CEST, Berlin, Madrid
5:00 pm – 6:00 pm | AEST, Sydney
3:00 pm – 4:00 pm | CST, Beijing

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Senior scientist
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Welcome!

pv magazine webinars

Do you have any questions? ? 

Send them in via the Q&A tab.  We aim to answer as many as we can today!

You can also let us know of any tech problems there.

We are recording this webinar today. 

We‘ll let you know by email where to find it and the slide deck, so you can re-watch it at your convenience.  

Analyzing PV system safety and the promise of optimizers

Presented by Hannes Knopf and Dr. Heribert Schmidt

Niestetal – June 21, 2022

Fraunhofer Institute for Solar Energy Systems ISE

The Institute

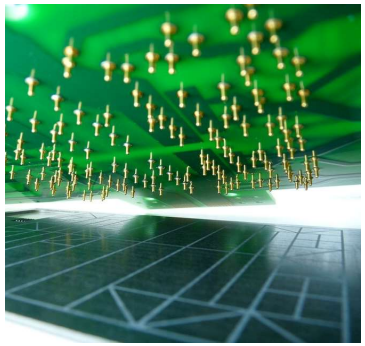
- Location: Freiburg
- Institute Directors:
  - Prof. Dr. Hans-Martin Henning
  - Prof. Dr. Andreas Bett
- Employees: ca. 1400
- Budget 2021:
  - Operation: €104.4 million
  - Investment: €12.3 million
  - Total: €116.7 million
- Founded in 1981

Fraunhofer Institute: Business Areas

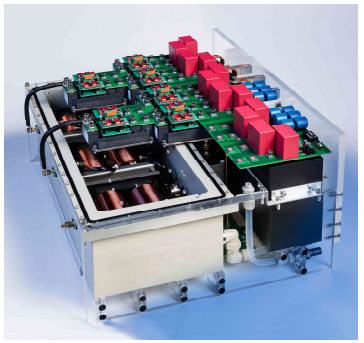
Photovoltaics

Energy Efficient Buildings

Solar Thermal Power Plants and Industrial Processes



Hydrogen Technologies and Electrical Energy Storage



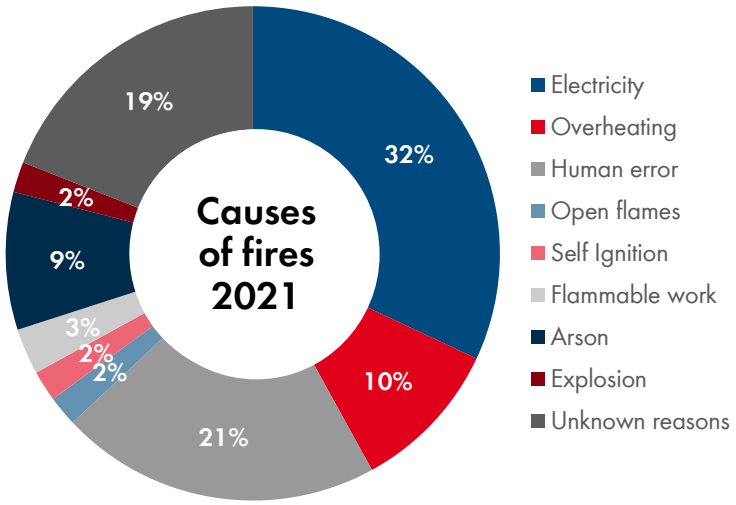
Power Electronics, Grids and Smart Systems

The SMA SafeSolar approach

How you benefit from our holistic SMA SafeSolar approach:

- **40 years** of global experience PV technology development
- **Lean PV systems** with high-quality devices
- **Intelligent and innovative** software features
- **Extensive testing** and quality inspections
- **Hands-on training** for first-time PV owners and professionals

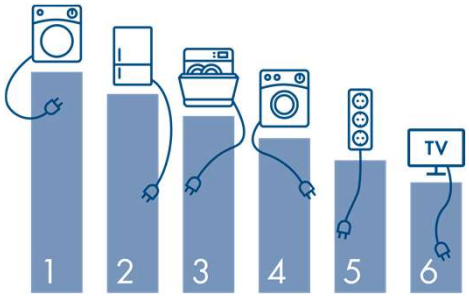
Leading Causes of Fires



1/3 of all fires were caused by "electricity"
i.e., by electrical devices

PV Systems are safe!

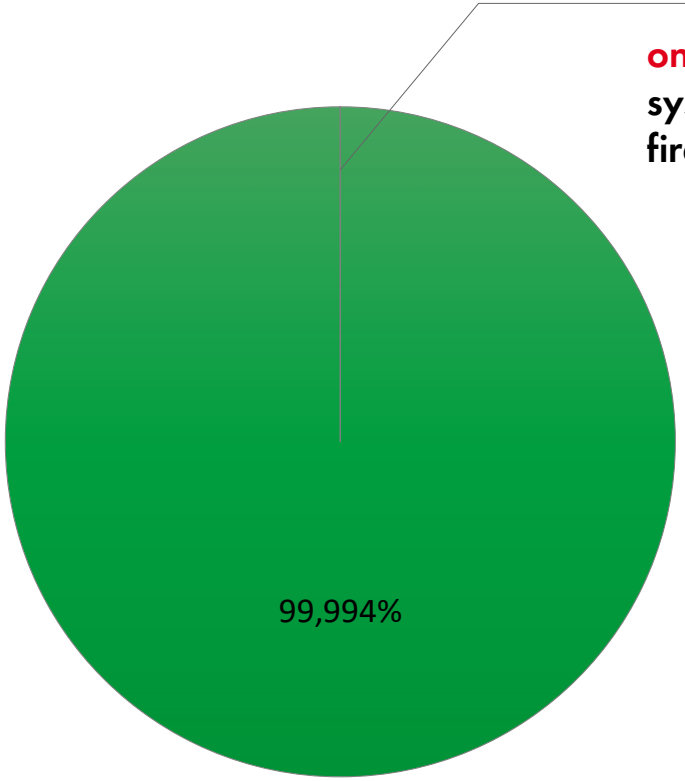
Which electrical devices were the most common cause for fires?



→ Dryers, fridges, dishwashers, washing machines, electrical extension cords, …

→ Note: PV can not be found – why?

PV Safety



only 0.006% of all PV systems have ever caused a fire

PV systems are very safe!

The German „PV-Brandsicherheit-Projekt“

- Numerous reports in media dealing with great danger caused by PV systems
- Firefighters supposed to be hindered when extinguishing fires
- A young firefighter supposed to be injured by electric shock in the case of “Rösrath”

Feuerwehr unter Strom

Im Brandfall bringen Photovoltaikanlagen die Einsatzkräfte in Gefahr

Süddeutsche Zeitung, 29.10.2010

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. Um vorzubeugen,

DER SPIEGEL, 12.7.2010

Gefahr durch Stromschläge

Feuerwehr kann Häuser mit Solaranlagen nicht schützen

halb durch Stromschläge gefährdet. Eigenheimbesitzer mit Solaranlagen auf dem Dach müssen damit rechnen, dass die Brandschützer ihr Haus bei einem Feuer nicht schützen können. Das ist bereits in mehreren Fällen geschehen. Im ostfriesischen Schwerinsdorf ließ die freiwillige Feuerwehr dieses Jahr nach einem kleinen Zimmerbrand ein mit einer Solarstromanlage ausgestattetes Einfamilienhaus niederbrennen. "Das Risiko, einen elektrischen Schlag zu

Die Welt, 07.08.2010

The German „PV-Brandsicherheit-Projekt“

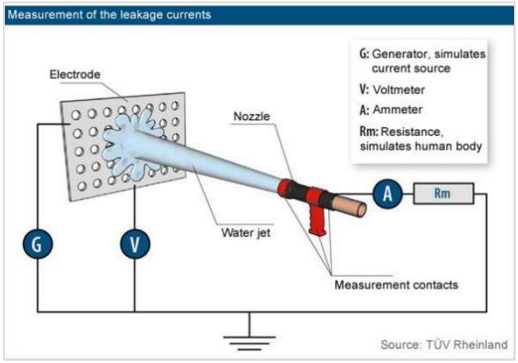
- From 2011 to 2014, a research project was performed to find out the causes of fires in PV systems, how to avoid them and how to deal with burning PV-systems
- **Beside** Fraunhofer ISE and TÜV Rheinland, firefighters and different companies were involved in this project
- In several workshops, presentations at conferences and publications the results have been disseminated
- Numerous handouts and information brochures have been prepared for firefighters
- The final report is a **“PV-safety-handbook”** and has been translated into English (funded by the US DOE) and into Spanish (funded by Ministerio de Energia, Chile)
- All documents are available under: http://www.pv-brandsicherheit.de/

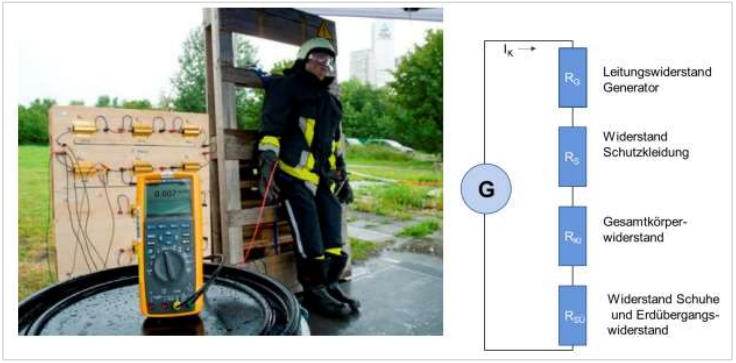
The German „PV-Brandsicherheit-Projekt“

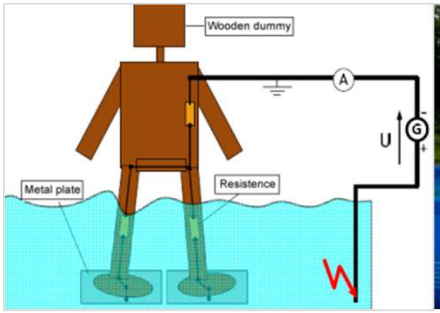
- One of the first outcomes was, that most of the cases reported in the media, - even in the trade press – were fake news
- “Bad news are good news!“
- **E. g. in the “Rösrath” case, we found, that there has never been a PV-system on the roof – but a solar thermal collector!**
- Although at this times in German more than 1.5 Million PV-systems were in operation, according to our investigations **not one firefighter has been injured by electric stroke from a PV-System!**
- These results have been **confirmed by insurances and the trade associations**

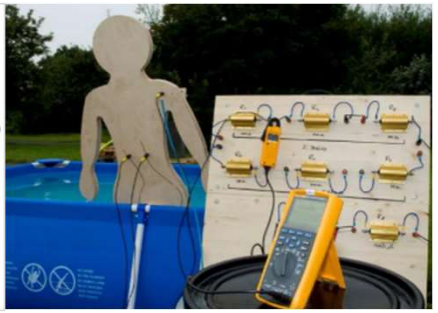
The German „PV-Brandsicherheit-Projekt“

Numerous investigations have been made regarding the safety of firefighters in case of “live” PV-systems









Source: Final report “PV-Brandsicherheit” / TÜV Rheinland

The German „PV-Brandsicherheit-Projekt“

- Active systems to shut down PV-generators or even PV modules (RSD, Rapid Shutdown Systems) have also been taken into account
- **Firefighter’s comments and conclusions:**

“We know how to deal with energized electrical systems!”

“As long as Rapid Shutdown Systems (RSD) are not 100 % reliable, we have to handle PV-systems with and without RSD as being energized!”

“Therefore, Rapid Shutdown System are not beneficial for firefighters!”

The German „PV-Brandsicherheit-Projekt“

One major conclusion:

Quote:

“Often safety components like fuses and switches are integrated in the DC part of PV systems. In the individual case it must then always be checked whether this measure is really necessary. ***Each additional component poses the risk of additional contact points and other sources of faults.***

A “sleek” system with as few components as possible has the advantage of having fewer points where damage could occur to the system.”

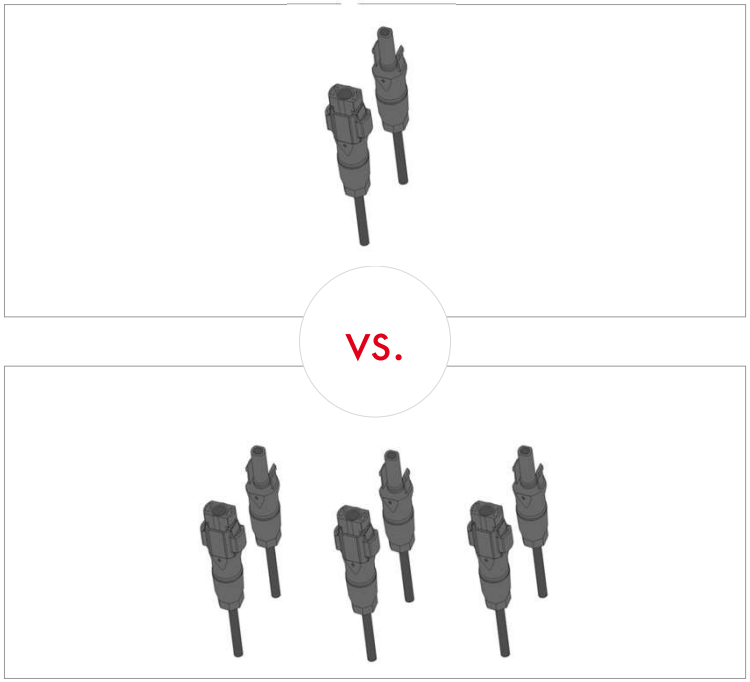
SMA SafeSolar: lean plant design

Module Level Power Electronics (MLPE) = "Optimizers" = Rapid Shutdown Devices

Impact of MLPE on Safety

3x the number of pairs of DC-connectors

→ drastically increasing the risk of electric arcs due to bad contacts, aging, corrosion – worst if connector mismatch / cross-mating between different models & brands



IEC TR 63225, Technical Report, 2019

Incompatibility of connectors for DC-application in photovoltaic systems

*"Several countries report that **problems with DC connectors are a major cause for failure such as fire hazards** in PV systems"*

Keep MLPE out to keep your PV system safe!

Summary of what we have learned so far

PV Systems are very safe

Fewer devices, means less components, less connectors, less points for failure

LESS = MORE!

= MORE Safety and MORE Lifetime!

But: If you add MLPE, thus complexity to your PV system,

you add **3x the number of DC connector**s to your PV system, you add **risk** to your PV system – risk of **failure**, and in worst case, risk of **fire**!

Keep MLPE out to keep your PV system safe!

Poll

Impact of MLPE on Lifetime

300.000 additional electronic components on the roof, in a hostile environment with heat, cold, temperature cycles, moisture.

→Potting necessary!

→Lusser's law

Electronics don't like harsh environments

Lusser's Law

Lusser's Law

- The **reliability** of a series of components is equal to the **product of the individual reliabilities** of the components
- A series system is **weaker than its weakest link**
- This can be represented by the following equation:
  System Reliability = Reliability of Component1 x Reliability of Component2 ...

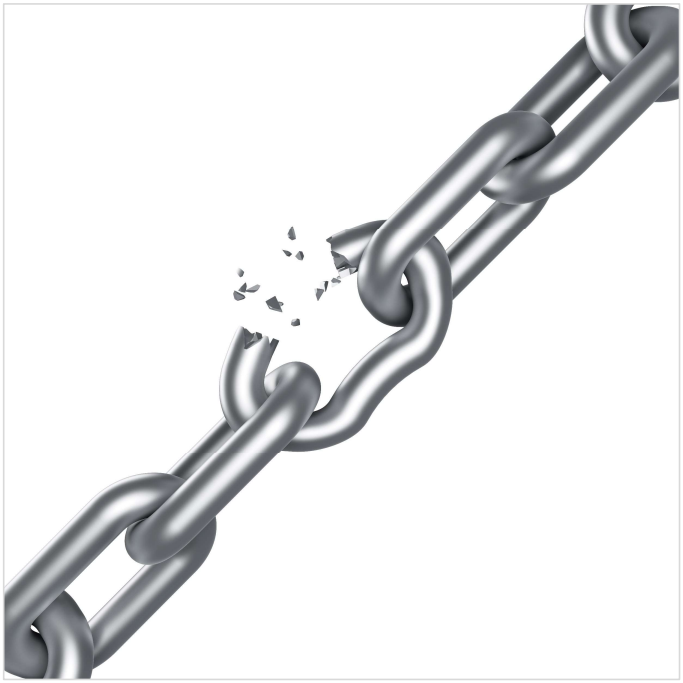
Example 1 – System with two components

Rs = 90% x 80% = 72%

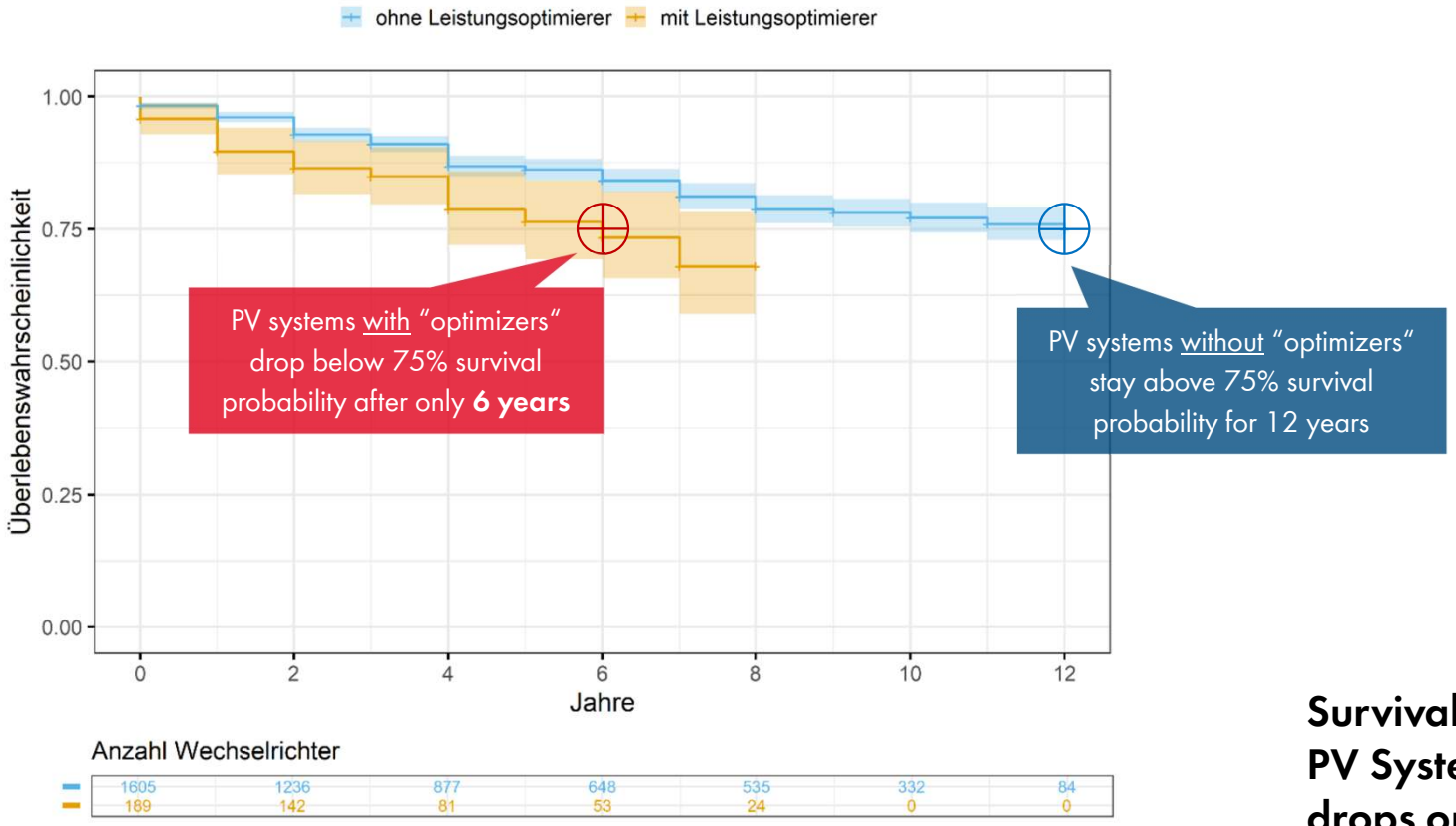
Example 2 (300 kWp PV-System with MLPE)

All components are assumed to be of the same, very high reliability of 99.999%, resulting in a **total system reliability** of

1 component:	Rs = 99.999%
2 components:	Rs = 99.999% x 99.999% = 99.998%
300.000 components:	**Rs = 99.999% ^300.000 = 5% reliability only!**



PV Reliability and Survival Probability



- Preliminary results – BFH Forschungsprojekt Lebenserwartung Photovoltaik-Wechselrichter

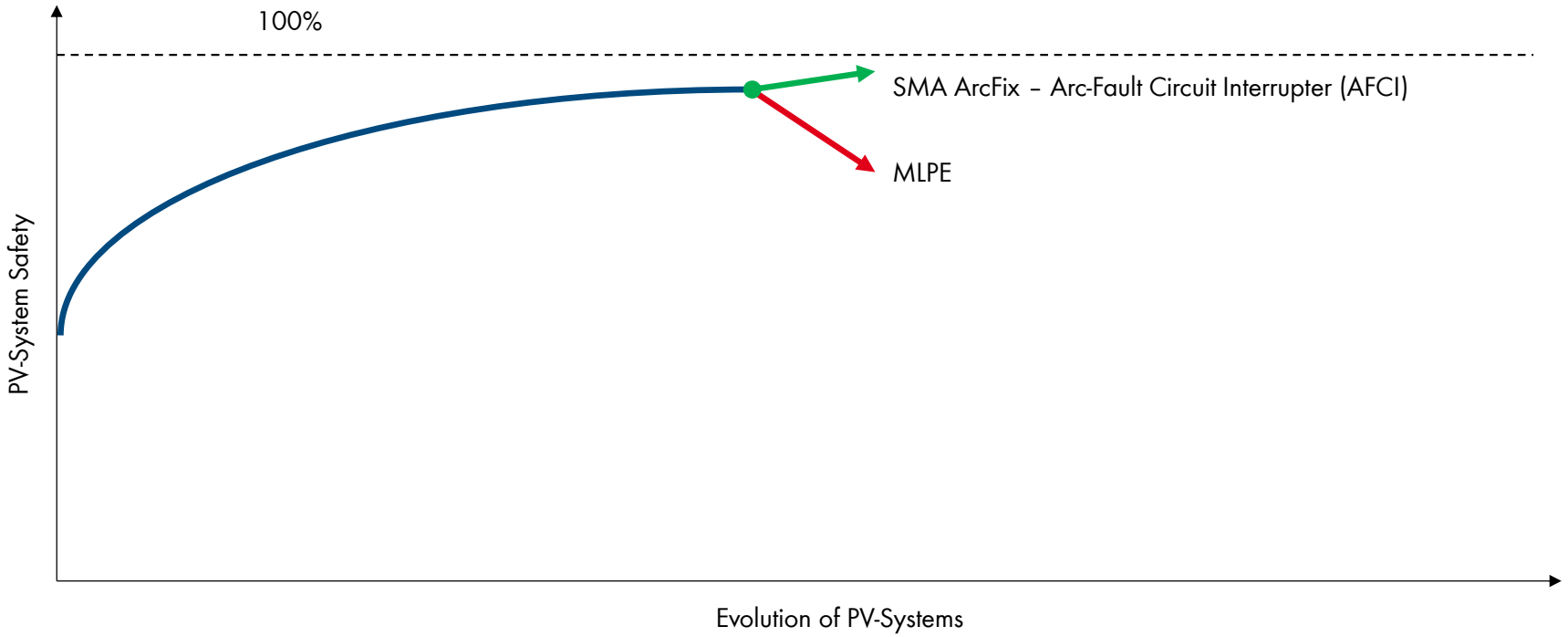
Survival probability of PV Systems without MLPE drops only half as fast as for systems with MLPE!

What does SMA do to Improve Safety

- **SMA advantage:** we will be integrating our Arc Fault Circuit Interrupter (AFCI) solution SMA ArcFix into all our string inverters
- **SMA ArcFix:** effectively stops electrical arcs
- No additional devices in your PV plant necessary

SMA ArcFix: newly integrated safety function for even greater safety in your PV plant

The Evolution of PV Safety



SMA ArcFix is taking a step into the safer direction!

Impact of MLPE on the Environment

- For a **300kW** system we counted **300.000 additional electronic components** on one roof
- **84M "optimizers"** shipped by one of the main suppliers of MLPE **by the end of 2021**!
- This equals **> 89.000.000 kg** and **> 103.000 m³** of electronics, which equals the payload of **> 720 fully loaded Boeing 747-400F** all-cargo aircraft, eventually most likely going to the landfill with questionable "benefits".

Is this the concept of a "renewable" energy supply?

With lean and smart SMA systems we keep our energy and our environment clean!

Poll

The majority of PV plants are built in unshaded or minimally shaded areas, where SMA ShadeFix generates higher yield!

Final Conclusions

- **PV systems are safe**
- **SMA ArcFix** (AFCI) integrated into SMA inverters **makes PV systems even safer**
- **Less is more** – less complexity is more safety
- Focus on a **lean system design** (less devices, less connectors, less components)
- Additional devices such as **MLPE** ("Optimizers" or Rapid Shutdown devices) **increase the risk and reduce the lifetime of a PV system**
- All **SMA string inverters** come with **integrated** functionality
  - to **maximize safety (ArcFix)**,
  - to **maximize performance and yield (ShadeFix)**
  - and **maximize lifetime by design**.

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11:00 am – 12:00 pm EDT, New York

Thursday, 23 June 2022
3:00 pm – 4:00 pm CEST, Berlin, Madrid
9:00 am – 10:00 am EDT, New York

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Algorithms for solar tracker optimization under adverse conditions

Chasing the sun – advanced analysis for innovative PV materials

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Thank you for joining today!