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FISUEL GAM 2019
Beirut - Lebanon

Regulation Measures for Safety of Solar PV Systems in Lebanon

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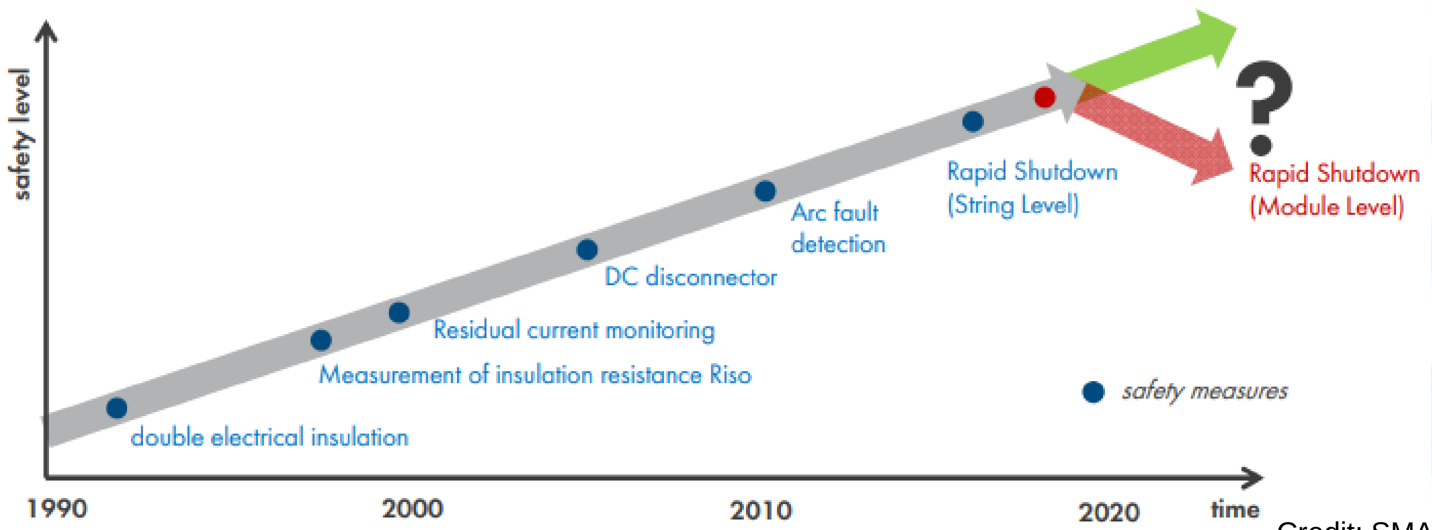
Background and Overview

- Solar PV systems have inherent safety risks that include fires, electrocution, and component damage. Internationally, regulators have introduced specific codes to cater to these risks and narrate the actions and components required to minimize them. In Lebanon, solar PV systems have been witnessing exponential growth since 2010 in terms of implementation. However, in terms of their regulatory oversight, the development has been minimal.



Credit: SMA

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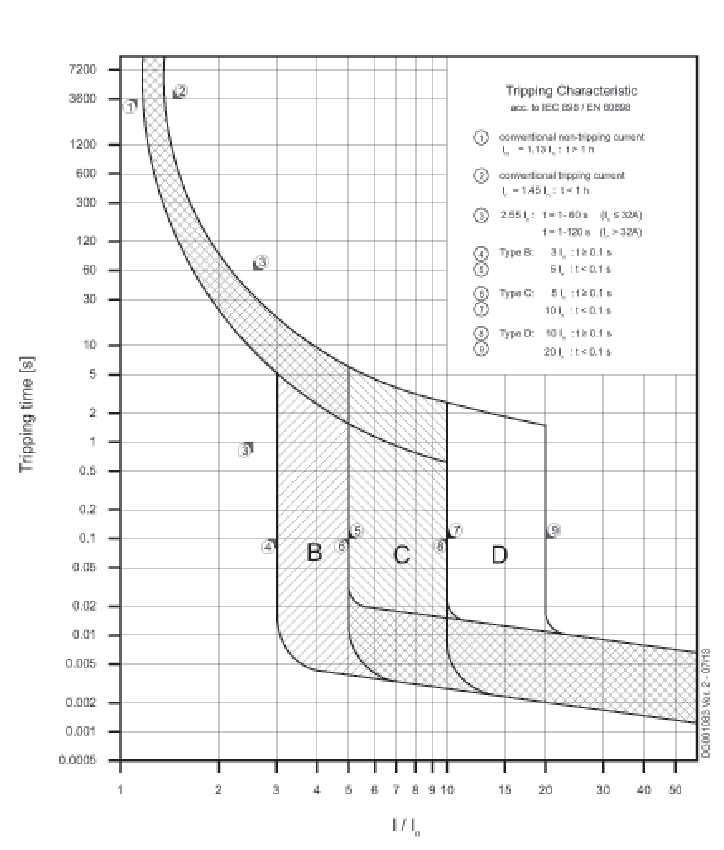
Solar PV Systems Safety Hazards - General

- Risk of overcurrent
  - Direct causes: overloading the circuit, short-circuits, ground fault, or an arc fault
  - Direct impacts: Damage to system components
- Risk of ground faults and arcs
  - Direct causes: Damage to conductor insulation, current flow in grounded conductors, or poor grounding strategy
  - Direct impacts: Electrocution and harm to people in contact with grounded conductors or fires
- Risk of lightning and surge overvoltage
  - Direct causes: Direct or nearby lightning strikes or surges origination from the utility network
  - Direct impacts: Damage to system components

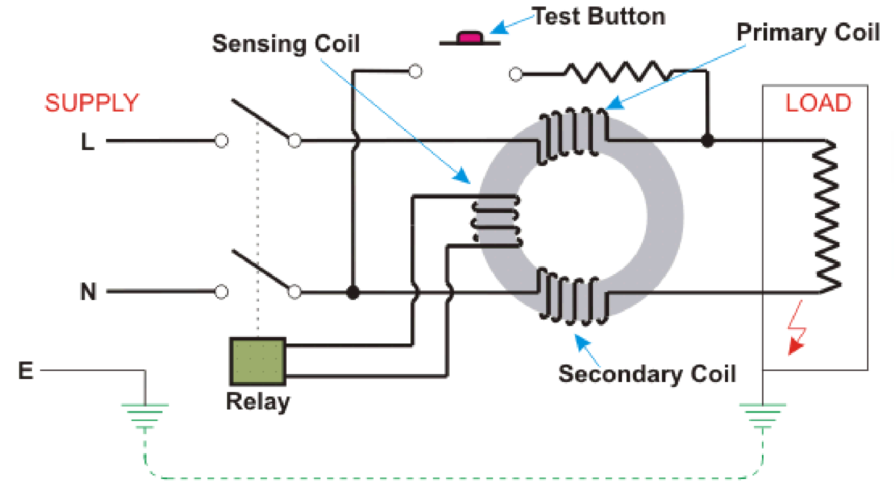
Risk mitigation – local applications: overcurrent

- Overcurrent protection by installing certified and tested overcurrent protection components in the required areas and according to best practice and international installation standards. Components can include:
  - Magnetic circuit breakers
  - Fuses
  - Overcurrent relays



Risk mitigation – local applications: ground-fault and leakage current

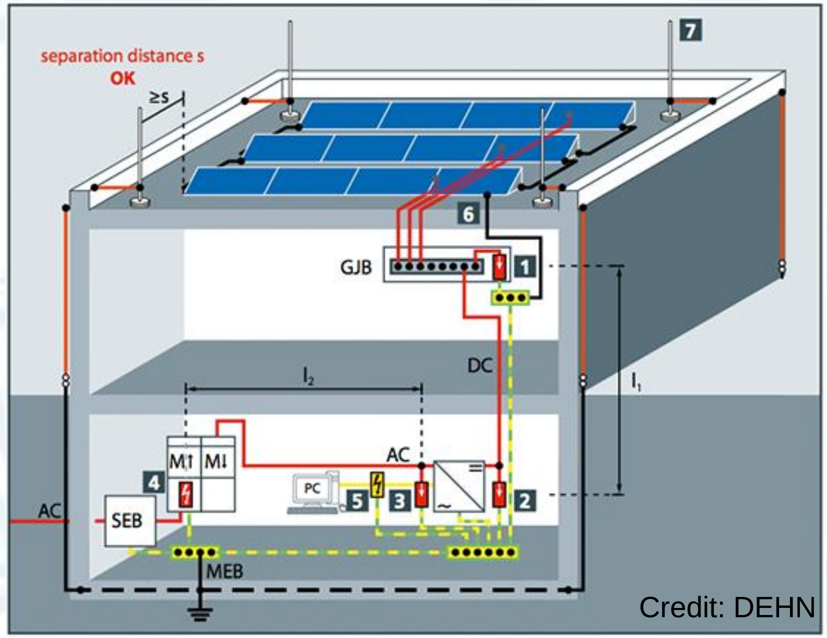
- Ground-fault and leakage current protection by installing certified and tested leakage current protection components in the required areas and according to best practice and international installation standards. The main protection component can be a ground fault circuit interrupter or a residual current device (RCD).



Working Principle of Residual Current Circuit Breaker

Risk mitigation – local applications: lightning and surge overvoltage

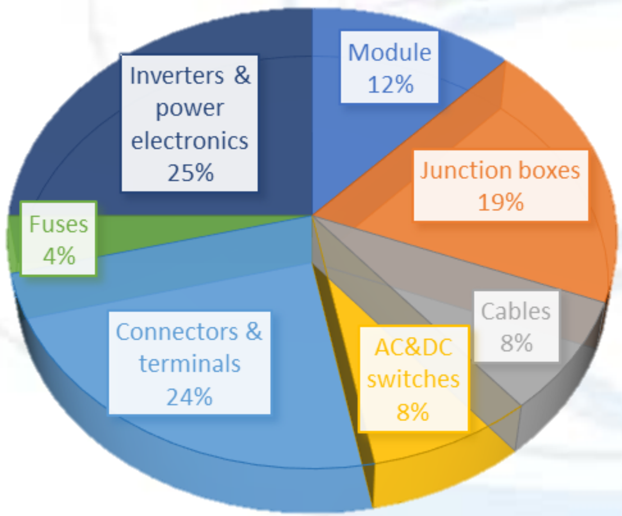
- Surge protection by installing certified and tested surge protection components in the required areas and according to best practice and international installation standards.
  - Surge protection devices or surge arresters.



Credit: DEHN

Risk mitigation – local applications: rapid shutdown and de-energizing conductors

- Due to their nature, solar PV systems remain energized (under sunlight) even when the mains network is disconnected. The rapid shutdown switch makes it possible to disconnect circuits remotely for use in fire emergencies and maintenance.

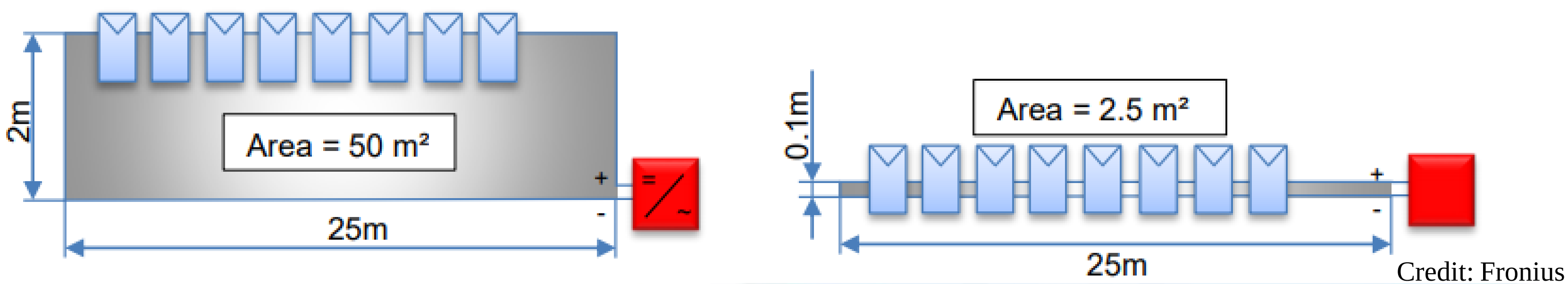


Components where fire started in 180 fires in Germany between 1995 and 2012

Credit: Laukamp et al., 2013

Risk mitigation – local applications: general best practices

- Electromagnetic loop reduction during stringing and cabling
- Equipotential bonding of exposed metal parts and the grounding conductor
- Proper material use for cable heads and interconnections
- Proper crimping and power cable connection
- Operational maintenance and regular checks



Credit: Fronius

Regulatory needs

- The absence of a permitting process resulting in ad-hoc connections and uncontrolled back-feeding of excess renewable energy into the grid
- The absence of a technical and administrative regulatory authority to establish and enforce rules and regulations that include:
  - Interconnection requirements and procedures
  - National codes, component certification requirements and quality assurance
  - Listing of approved components and standards
  - Reactive power compensation procedures and requirements
  - Installation and safety guidelines for stakeholders (firefighters, EPCs, O&M providers, etc.)

International codes, standards and guidelines

- **IEC** stands for the International Electrotechnical Commission headquartered in Geneva, Switzerland, is the organization that prepares and publishes international standards for all electrical, electronic and related technologies.
- **DIN** stands for Deutsches Institut für Normung. It is a registered non profit organization which has been based in Berlin since 1917.
- **NFPA** 70, National Electrical Code (**NEC**), sets the foundation for electrical safety in residential, commercial, and industrial occupancies in the US.

E.g. **DIN VDE 4105** defines the requirements to the low-voltage grid connection of PV-systems; **IEC 62446-1:2016+A1:2018** defines the information and documentation required to be handed over to a customer following the installation of a grid connected PV system; **NEC 2014 690.12**, defines the rapid Shutdown requirements of PV systems on buildings.

Local adoption and enactment

- The EDL net metering committee has set a list of required compliance standards (safety and other) and acceptable components for renewable energy plant owners when applying to get enrolled into a net-metering scheme.

INVERTER (1) COMPLIANCE STANDARD / معايير العاكس (1)

VOLTAGE FLUCTUATIONS (SELECT AT LEAST (ONE

- (IEC 61000-3-11 (I<=75A
- (IEC 61000-3-5 (I>75A
- (OTHERS (SPECIFY

(HARMONICS (SELECT AT LEAST ONE

- (IEC 61000-3-2 (I<=16A
- (IEC 61000-3-4 (I>16A
- (OTHERS (SPECIFY

PV MODULES COMPLIANCE STANDARDS / المعايير الملتزمة بها اللوائح الكهروضوئية

SAFETY QUALIFICATION (SELECT AT LEAST ONE)

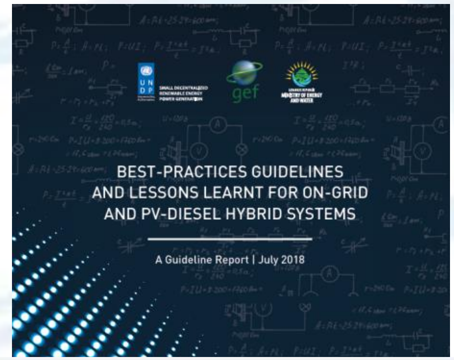
- IEC 61730
- OTHERS (SPECIFY)

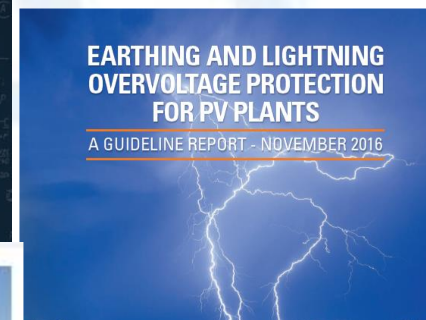
SALT MIST CORROSION TESTING OF PHOTOVOLTAIC (SELECT AT LEAST ONE)

- IEC 61701
- OTHERS (SPECIFY)

Dissemination of knowledge and UNDP/MoEW guideline reports

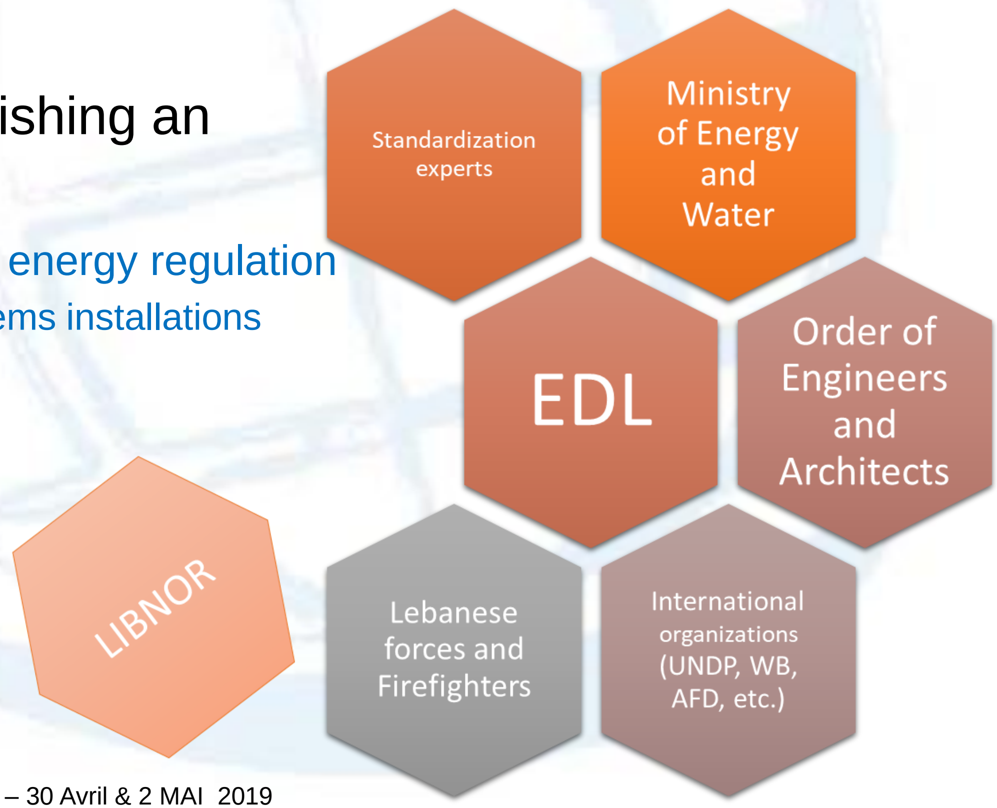
1. Best-Practices Guidelines and Lessons Learnt for On-Grid and PV-Diesel Hybrid Systems: A Guideline Report - July 2018
2. Earthing and Lightning Overvoltage Protection for PV Plants: A Guideline Report - November 2016
3. Solar Photovoltaic (PV) Hybrid Power Plants: A Guideline Report – July 2016
4. Solar PV Grid Interconnection Code for Lebanon: Recommendations and Guidelines - 2016





Concluding remarks

- National and International cooperation between standards experts, firefighters, technologists and key stake holders will be crucial to future success.
- Clustering the knowledge and establishing an autonomous authority.
- A national authority for energy and renewable energy regulation
  - Official national guideline for solar PV systems installations
  - National safety codes
  - National control center requirements
  - etc.



Thank you.

References:

- Laukamp, H. et al., 2013. PV Fire Hazard – Analysis and Assessment of Fire Incidents. 28th EU PVSEC, Paris.
- IEA-PVPS, Photovoltaics and Firefighters' Operations: Best Practices in Selected Countries, 2017.
- SMA, Safety of a PV Plant, 2018, from http://glavaenergycenter.se/images/pdf/sma.pdf
- B. (2015). SolarPro Magazine. Retrieved April 29, 2019, from https://solarprofessional.com/articles/design-installation/rapid-shutdown-for-pv-systems#.XMYRF2gzbIV