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Fire Safety and Photovoltaic Panels on Building Roofs

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This article is based on the report 'Fire Safety and Photovoltaic Panels on Building Roofs Workshop, Final Proceedings' by Amanda Kimball, Fire Protection Research Foundation; and the NFPA Journal Research Column 'More Power, More Problems?'

Introduction

As part of the REPowerEU plan, draft legislation to be voted on later this year requires EU Member States to ensure that suitable solar energy installations are on all new public and commercial buildings bigger than 250m2 by the end of 2026, on all existing public and commercial buildings bigger than 250 m2 by end of 2027 and on all new residential buildings by the end of 2029. This will result in unprecedented transformation of European building stock and a significant uptake in photovoltaic (PV) panel technology on rooftops. This transformation has the potential to have significant benefits from a climate and energy perspective, but it will also bring safety challenges that should be anticipated and addressed upfront.

To help ensure that EU's green transition is also a safe transition the Fire Protection Research Foundation and the National Fire Protection Association (NFPA) organized the "Fire Safety and Photovoltaic Panels on Building Roofs Workshop" on March 8, 2023 at the Danish Embassy in Brussels, Belgium. The event was hosted The Permanent Representation of Denmark to the EU. The participants included a member of the European Parliament, a representative from The European Commission, insurance companies, owners of commercial buildings, and researchers from both the EU and US. Sharing knowledge between EU and US was a key component of the workshop.

The primary objective of this workshop was to review the latest information, experiences, and research related to fire safety of photovoltaic panel installations on commercial building proofs to identify best practices for safety and installation, considerations for new policy recommendations and regulations, as well as knowledge gaps.

Perspective of the European Parliament, European Union Commission, and Member States

The representatives from the European Parliament and Commission were focused on the need for energy production. While they recognized the need for considering safety as part of the green transition of buildings, they questioned whether PV panels and other new technologies represents a greater risk than what we already have in today's buildings. The representative from Croatia expressed concern about the roll out of PV panels. Croatia has produced guidelines for analysis of existing buildings undergoing major renovations, which is a step towards addressing the concerns with PV panels. She would also like support from the Commission to estimate the scale and impact of the new risk.

It was noted that the testing in place does not consider the increased risk of PV installations. A member of the CEN 127 roofing committee noted that they are debating on PV related to building attached vs building integrated as these falls under different regulations. The committee has no mandate to work on this topic; therefore, all they can do is to write a technical report based on the experience of the member states on fire with PVs. They are lacking information and a mandate to do more. It was pointed out that fire safety is within the responsibility of the EU member states, but they rely on the tools in the form of harmonised standards. Unfortunately, without a mandate to work on new standards technical committees cannot provide the tests needed for roof mounted PV panels.

Technology today is moving much faster than regulation and standardization. With new technologies comes new risks. These might not be greater than existing risks we have successfully mitigated, but they are different risks that needs to be assessed appropriately and not through the lens of outdated technologies. We need to adjust our assessment methods for these new risks and ensure proper monitoring, checks, mitigations, and risk assessments. This is a wider issue that goes beyond buildings and Europe.

Perspective of a Building Owner

IKEA has PV panels installed on most of its commercial buildings and have had thirty fire incidents to date, which compared to fire in their core business is not a lot. Most fires were caused by poor workmanship, low quality materials, design errors, and damage during operations. The key factors to limit loss: good quality PV, OM (operation and maintenance) routines, quality roofing, working with the fire service – when they arrive on scene, tell them what to expect. Additionally, they have done some research and testing together with partners that shows the importance of the roof buildup below the installation. Big companies have resources to invest in testing, smaller companies need more help.

They would like to have EU guidelines for installations. Specifically, they need more guidance on fires starting from the roof where there is no fire protection installed (fire detection, sprinklers), material standards, and certification of installers. There needs to be a central place for guidance – some countries have extensive experience, but others are just starting, and they could learn from others. Even within countries and different cities they get different requests from authorities. A final point was the lack of qualified installers to be able to comply with the aggressive timeline proposed in REPOwerEU.

Latest Research

Based on analysis of available data there is an expected rate of 29 fires/year/GW PV installed. However, it is difficult to obtain the total number because many jurisdictions do not include details on PV in losses – and smaller incidents are not reported. Research by Jens Steeman Kristensen at University of Edinburgh shows how PV installations impact the fire dynamics and increases the extent and speed of

the fire spread. PV modules influence ignition, heating of materials, spread of fire, pyrolysis, and feedback loop.

There is a need for a high-fidelity, in-depth parametric system at different scales to understand the system. System analysis is key and testing systems as built is recommended. Membranes that prevent spread without panels burn readily with panels installed. In addition, research conducted so far has found there is a critical gap height. For retrofits, mitigation layers are often needed. Fire safety of PV modules on buildings needs further research now – a small investment could lead to substantial gain.

FM Global have found through their research that the presence of PV panel changes the shape of the flame and can preheat and promote fire spread. There is a need for a comprehensive fire test that robustly tests fire spread of roof/PV panel combination to see how it acts as a system. FM Global is currently using a modified ASTM E108 test.

There was a question about the use of polystyrene insulation used on roofs in Europe and how to avoid risks from use of this material with PV installations. The researchers noted that based on testing conducted, these types of roofs will need an intervention and mitigation layers or will need to be renovated. It was pointed out that older roofs may likely need renovation before installing PVs. We should not install PVs, which have a 30-year life span, on roofs that will need to be renovated within the next decade.

It was noted that while significant testing is needed to develop guidance, a lot could be learned by testing and analyzing common roof types, PV installations, and mitigation options. There are only a select few mitigation solutions that are feasible for use because of other hazards (e.g., wind).

Insurance and Fire Service Perspective

Roof mounted PV needs to be resilient against fire, hail, and wind. Current standards are ASTM E108/UL 790, *Standard Test Methods for Fire Tests of Roof Coverings,* and CEN/TS 1187 T1-T4, *Test methods for external fire exposure to roofs*. These standards only evaluate fire on the roof, not presence of PV. Therefore, FM Approvals have developed an alternative method FM approval Standard 4478, Approval Standard for Rigid Photovoltaic Modules and some systems are certified to this. Technology exists to meet the fire requirements but will is needed to implement these requirements.

Loss prevention engineers consider building construction and materials; panel layout, aisle spaces, skylights; type of PV; and building load calculations to determine the loss exposure. Compliance to building regulations may still result in an exposure to a facility, but there are ways to reduce risk. Based on loss experience, FM Global sees limited damage when using an FM Global approved PV panel/roof system or other risk-reduction measures such as glass backed panels, metal roof-top surface, or FM Approved or non-combustible insulation. The experience has been a total loss when plastic-backed panels and combustible multi-ply roof cover are combined with EPS insulation. Therefore, there is a need to consider assemblies that meet the current test, better configurations of systems, early notification of a fire, and emergency response planning with the fire service.

The representative from the Amsterdam-Amstelland Fire Department explained that currently, there are no formal regulation for PV installations in The Netherlands. Large installations are following insurance requirements, but the fire service does not have a role. For residential buildings, there are no insurance

requirements and for anything below 15 panels, there are no regulations at all including no certification required.

The operational concerns from the fire service in The Netherlands are that there is no reliable way to know if PV systems are installed (other than visual inspection). For retrofitted installations, there is no standard location for inverters and the fire department have even found them in escape routes. In terms of reignition, there are no guidelines on handover after event. And PV panels also create a barrier for operations on roof. There is a need for workforce education to keep firefighters up to date on technologies and there is a big need for education and training – today it is the wild west for fire fighters.

Discussion

The discussions during the workshop emphasized that adding PV panels to rooftops should not be done without clear guidance on how not to compromise fire safety. It was also clear that more research is needed to better understand the interactions between PV panels and the roof build up. This should then lead to a standardized test method that includes both PV panels as well as the entire roof buildup to show how all the different components interact during fire. A representative from the European Commission commented that the current EU project on developing a large-scale façade test could serve as a model for developing a test for roofs with PV installations.