



Honorary
patronage



Media
patronage

PRZEGLĄD POŻARNICZY

Report on the 1st International Scientific Conference

Fire Safety of Photovoltaic Installations, Energy Storage, Electric Vehicles, their Points and Charging Stations, Smart Home Solutions

CONCLUSIONS AND RECOMMENDATIONS



Abridged version in English

CENTRUM NAUKOWO-BADAWCZE
OCHRONY PRZECIWPOŻAROWEJ
im. Józefa Tuliszковского
PAŃSTWOWY INSTYTUT BADAWCZY
ul. Nadwiślańska 213, 05-420 Józefów

YOUR PARTNER IN



Prepared by:

Michał Pietrzak, M.Sc. Eng.
Marta Iwańska, M.A.
Damian Bąk, M.Sc. Eng.
Marcin Twardowski, M.Sc.
Ilona Majka, M.Sc. Eng.
Michał Chmiel, PhD Eng.
st. bryg. Jacek Zboina, D.Sc. Eng.

© Copyright by Centrum Naukowo-Badawcze Ochrony Przeciwpożarowej
im. Józefa Tuliszkowskiego
Państwowy Instytut Badawczy

© No part of this report may be reprinted or copied by any technique without the written permission of the Director of Centrum Naukowo-Badawcze Ochrony Przeciwpożarowej – Państwowy Instytut Badawczy.

Published by:

Centrum Naukowo-Badawcze Ochrony Przeciwpożarowej
im. Józefa Tuliszkowskiego
Państwowy Instytut Badawczy
05-420 Józefów k/Otwocka, ul. Nadwiślańska 213
tel. (22) 76 93 300
www.cnbop.pl
e-mail: cnbop@cnbop.pl

October 2023, Józefów

Table of contents

1.	General information.....	4
2.	Purpose of the conference	5
3.	Past experience	6
4.	Course of the conference – main theses and formulated conclusions	7
4.1.	First session.....	7
4.2.	Second session.....	9
4.3.	Third session.....	10
5.	Conclusion and summary of the conference	11

1. General information

Organizer: Scientific and Research Centre for Fire Protection – National Research Institute (CNBOP-PIB) in Józefów.

Co-organizers:

- ❖ PZU LAB S.A.
- ❖ European Fire Safety Alliance
- ❖ Association of Manufacturers of Fire Protection and Rescue Equipment in Poland
- ❖ Polish Association of Alternative Fuels
- ❖ Professed Chamber of Fire Protection, Czech Republic
- ❖ Fire University of Warsaw (Apoż)
- ❖ WSB University in Dąbrowa Górnicza
- ❖ Military University of Technology in Warsaw
- ❖ Faculty of Automobiles and Working Machines of the Warsaw University of Technology
- ❖ Provincial Headquarters of the State Fire Service in Warsaw (KW PSP Warszawa)
- ❖ District Headquarters of the State Fire Service in Otwock (KP PSP Otwock)

Date of the conference: 12 October 2023

Members of the Scientific Committee: professor Bernard WIŚNIEWSKI, D.Sc. Eng., Maria ZIELECKA, D.Sc. professor at CNBOP-PIB, professor Anna RABAJCZYK, D.Sc., professor Robert SOCHA, D.Sc. professor at AWSB, nadbryg. Adam KONIECZNY, Ph.D. Eng., nadbryg. Mariusz FELTYNOWSKI, Ph.D. Eng. professor at Apoż, Jacek DYBAŁA, D.Sc. Eng. professor at PW, Piotr PIÓRKOWSKI, Ph.D. Eng. professor at PW, płk rez. Norbert GRZESIK, D.Sc. Eng. professor at WAT, Andrzej CZUPRYŃSKI, D.Sc. Eng. professor AWSB, Paweł LUBIEWSKI, D.Sc. professor at AWSB, st. bryg. Adam KRASUSKI, D.Sc. Eng. professor at the University (Apoż), dr hab. inż. Andrzej KRZYSZKOWSKI, professor at UTH Radom, st. bryg. Paweł JANIŁ, Ph.D. Eng., Dariusz GOŁĘBIEWSKI, Ph.D. Eng., ppłk Michał JASZTAL, Ph.D. Eng., st. bryg. Jacek ZALECH, M.Sc. Eng., st. bryg. Ernest ZIĘBACZEWSKI, M.Sc. Eng., st. bryg. Rafał SZCZYPTA, M.Sc. Eng., st. bryg. Daniel MAŁOZIĘĆ, M.Sc. Eng., st. bryg. w st. spocz. Waldemar JASKÓŁOWSKI, Ph.D. Eng., bryg. Artur ANKOWSKI, Ph.D. Eng., Michał CHMIEL, Ph.D. Eng., Tomasz POPIELARCZYK, Ph.D. Eng., Jarosław TĘPIŃSKI, Ph.D. Eng., Michał PIETRZAK, M.Sc. Eng.

Chairman of the scientific committee: st. bryg. Jacek ZBOINA, D.Sc. Eng.

Members of the Organization Committee: Michał CHMIEL, Ph.D. Eng., Michał PIETRZAK, M.Sc. Eng., Ilona MAJKA, M.Sc. Eng., Piotr TRZEWIK, M.Sc. Eng., Damian BAŁ, M.Sc. Eng., Marcin TWARDOWSKI, M.Sc., Ewa SOBÓR, M.Sc. Eng., Anna BANULSKA, M.Sc. Eng., Marta IWĄŃSKA, M.A.

Chairman of the organization committee: Ilona Masna, M.A.

Partners: SITP branch at CNBOP-PIB, Neuron Sp. z o.o. Sp. k, Gras PPPH, Robert Bosch Sp. z o.o., Huawei Polska sp. z o.o., Bruk-Bet Sp. z o.o., TechSterowniki Sp. z o.o., Ambient System Sp. z o.o.

Exhibitors: AMBIENT SYSTEM Sp. z o.o.; NEURON Sp. z o.o. Sp. k.; SOLARSTOP Sp. z o.o.; ROBERT BOSCH Sp. z o.o.; HUAWEI POLSKA Sp. z o.o.; SOLAREEDGE TECHNOLOGIES (Poland) Sp. z o.o.; TECHSTEROWNIKI II Sp. z o.o.; BRUK-BET@ Sp. z o.o.; Gras PPPH.

2. Purpose of the conference

The conference is intended by its organizers and partners to be a cyclical venue for the presentation and dissemination of research results, current knowledge, review of expertise and solutions. It is intended as a tool to exchange views and experiences of various communities interested in fire safety of intensively developing technologies such as photovoltaic installations, energy storage, electric vehicles and their charging points and stations, as well as numerous others referred to as smart home solutions. The conference will also include a presentation of new testing and training stands at CNBOP-PIB built to improve fire protection of PV installations, energy storage and electric vehicle charging stations.

Circumstances prompting the subject of fire safety are past experience, research and its results, new technical solutions and technologies offered, the growing number of facilities equipped with PV installations, energy storage and charging stations, changes in the organization and resources of the State Fire Service, statistical data on incidents involving PV installations, energy storage, charging points and electric vehicles, including the challenges for fire protection associated with their mass use. Additional justification is provided by the research conducted and forecasts made, as well as the experience and solutions in this area in other countries.

3. Past experience

The issue of fire safety of photovoltaic installations in research and work of CNBOP-PIB is not a new issue. In 2021 the Institute published open access items such as *Selected Utility and Safety Issues in Photovoltaic Installations (Wybrane zagadnienia użytkowe i bezpieczeństwa w instalacjach fotowoltaicznych)*, as well as *Fire Risk Assessment in Photovoltaic Installations. Defining Safety Concepts to Minimize Risks (Ocena ryzyka pożarowego w instalacjach fotowoltaicznych. Określenie koncepcji bezpieczeństwa w celu minimalizacji ryzyka)*. Meanwhile, another publication in the CNBOP-PIB standards series – PV design documentation – is under development (scheduled for release in 2023). New test stands have also been built at CNBOP-PIB, allowing confirmation (testing) of the functionality of products (PV installation components) relevant to fire safety and the safety of rescue teams, such as:

- arc detection and arc fault interruption in the DC circuits of PV systems and alarm signalling,
- PV power disconnection and signalling of PV system operating conditions for emergency crews.

These stands allow testing and functional testing of various configurations of PV installations in terms of fire safety, compliance with fire protection conditions, safety of emergency crews. They are also used for knowledge dissemination, didactics and training, including the development of model design documentation for PV installations for buildings, the development of technical standards for fire protection, such as guidelines, requirements for products, test methods, etc. The created testing and training stations, which are also active PV installations equipped with energy storage and an electric vehicle charging point, will be the subject of presentations at the conference. In addition, the application of dedicated technical fire protection systems for the fire protection of these installations will be discussed. In addition, the purpose of the designed and constructed installations is to recommend fire protection solutions that combine utility functionality, demonstration and training, and research capabilities.

Regardless, CNBOP-PIB conducts – independently, as well as with technological partners – numerous other activities, research and work, the results and experience of which authorize the formulation of conclusions, the definition of threats, the assessment of their risks, the definition of needs and requirements for fire protection, as well as their dissemination. Research on electric vehicle batteries, which has been conducted at the Institute for several years, has provided specific experience, knowledge and test results for various products. This research has recently been expanded to include technical security systems dedicated to the detection and control of fires at electric vehicle charging points, as well as equipment and supplies dedicated to rescue operations involving electric vehicles.

The research and experience gained, combined with cooperation with the State Fire Service and technology partners, additionally resulted in the development this year of a guide for rescuers entitled *Conducting rescue and firefighting operations during incidents involving electric vehicles (Prowadzenie działań ratowniczo-gaśniczych podczas zdarzeń z udziałem pojazdów z napędem elektrycznym)*, as well as the preparation and implementation of a dedicated training course on conducting rescue and firefighting operations involving electric vehicles.

4. Course of the conference – main theses and formulated conclusions

The CNBOP-PIB scientific conference was divided into three thematic sessions dealing with the following topics:

1. New technologies – Photovoltaic Installations, Energy Storage, Electric Vehicles, their Points and Charging Stations – today and tomorrow, perspectives and threats,
2. Presentation of CNBOP-PIB research, teaching and training stands,
3. Modern technical fire protection systems, fire brigade equipment and supplies dedicated to fire protection and rescue operations.

At the end of the first and third sessions and after listening to all the lectures within the dedicated thematic blocks, panel discussions were organised with the participation of invited guests, experts, as well as conference participants, which allowed the exchange of knowledge and answer questions that arose.

4.1. First session

- The energy transition, if it is to proceed without undue disruption, must be safe, and should therefore take fire safety aspects into account;
- Analysis of the current state of knowledge, competence and awareness of fire safety in the context of energy transition mandates the conclusion that it is insufficient and needs to be addressed in the future;
- The main cause of fires in EU countries is electrical equipment and installations;
- The percentage of fires that are generated by photovoltaic installations, energy storage, electric vehicles or charging points and stations is small in relation to the fires generated by current electrical installations and equipment;
- At the moment, there are no regulations for fire protection of new technologies, photovoltaic installations or charging points. Nevertheless, fire safety engineering tools are in place and, among them, methods are available to assess this risk.
- Prompt detection of the hazard and control of the fire until firefighting units arrive is vital.
- It is important that the development, modernisation and optimisation of renewable energy sources involve financial institutions, such as banks or insurers;
- Energy storage facilities used in underground garages present both a high risk due to the low level of security, which, combined with the accumulation of a large amount of energy in a small space, results in an increased risk and problem for the work of the fire brigade;
- When it comes to new technologies, one should be guided by facts and collected data, not by fear of their implementation and effects. This is all the more important given the limited resources at our disposal. Therefore, it is incredibly important to allocate them appropriately, taking into account the most important areas to be covered;

- The selection of fire protection measures and methods should seek the optimum approach in order to balance the need to achieve the stated objectives (i.e. ensuring protection of life first and protection of buildings and property second) with economic considerations;
- The solutions in question are not yet fully validated technologies and therefore all the risks involved are not yet known;
- Fire protection will not completely change with regard to the issues raised, but it must nevertheless adapt to new technologies and solutions;
- The firefighting tools and equipment used are extremely important, however, it is equally important that they are used, installed and designed correctly so that they can fully perform the tasks assigned to them;
- In terms of further development, interprofessional cooperation and the provision of conscious education will be very important.

Conclusions:

- It is extremely important at both European and national level to raise awareness of the risks involved in the energy transition. Consequently, efforts should be made to continuously improve the knowledge of those involved in this topic and, in particular, to target efforts to raise the awareness of decision-makers on whom future regulations and requirements may depend;
- In order to ensure the involvement and cooperation of financial institutions, including banks and insurers, it is necessary to improve knowledge and develop appropriate risk assessment methodologies to identify risks and determine how to assess and manage them;
- In view of the problems encountered in securing energy storage facilities used in underground garages, relevant requirements, recommendations and guidelines should be developed for securing these solutions both for normal use and for fire-fighting operations;
- Knowledge must continue to be improved through appropriate research and analysis as well as the acquisition of fact-based knowledge regarding both the positive aspects of newly implemented technologies and the identification of burdens on available resources and the environment. Obtaining this information will make it possible to identify what environmental consequences and burdens may occur for each of the safeguards in place and what benefits and costs can be expected from their implementation;
- For the purposes of the activities to be carried out, it is worthwhile to make use of the gained knowledge and documents developed by countries and circles which have been dealing with the subject longer than Poland. Therefore it is recommended to make use of knowledge available in other countries of the European Union and beyond.

4.2. Second session

- PV installations in buildings should comply with requirements for fire safety and the safety of emergency teams;
- The cause of most fires in PV installations is electrical arcs in DC (direct current) circuits;
- Correct installation of PV modules and regular maintenance are important to ensure the safety of the installation;
- The car parks are categorised as having a medium OH2 fire risk, for which the required sprinkler intensity is 5 mm/min/m²;
- Early and rapid fire detection reduces damage and fire casualties. Fire detection systems are designed to quickly detect an outbreak and alert people in the affected area.

Conclusions:

- PV installations in buildings are fire and crew-safe if they are made of tested and certified equipment and installation components, are designed and constructed by qualified, authorised and competent personnel (designer, installer), and are periodically serviced and maintained by a qualified, certified and competent PV installation technician;
- The main way to protect the DC circuits of a PV installation against arcing is through a device or functionality integrated into the PV inverter for the detection and interruption of an electrical, arc fault circuit (AFCI – Arc Fault Circuit Interrupter);
- For inverters without AFCI functionality, it is possible to use an external module to connect the DC system with an arcing detection device for PV systems. However, the disadvantage of such a solution is the higher installation and maintenance cost and the lack of compatibility with inverter suppliers;
- To address the problem of fault and short-circuit detection in a photovoltaic system with a DC voltage not exceeding a maximum PV open circuit voltage of 1500 V DC, the international standard IEC 63027:2023 *Photovoltaic power systems – DC arc detection and interruption* has been developed;
- The most common causes of fires in photovoltaic installations include: short circuit in the installation, lightning strikes, inadequate disconnection of PV installations, inappropriate selection of protection, poor quality PV modules;
- The installation of a fire location detector (DMP) at the vehicle parking space guarantees the detection of a fire in the relevant parking space, regardless of the effect of domestic ventilation, draughts or the migration of smoke to another parking space;
- For smoke and flame detection, or as a supplement to the existing fire detection system used in the building to be protected, additional systems can be used, such as video fire detection systems, which combine reliable smoke and flame detection with high speed. These systems enable fires to be detected much more quickly than conventional point detectors mounted on the ceiling.

4.3. Third session

- Firefighters have sufficient equipment to deal with the risks identified in terms of photovoltaic installations, energy storage, electric vehicles and charging points and stations, but they must nevertheless be properly prepared;
- Due to the low number of fires involving photovoltaic installations, energy storage facilities, electric vehicles and charging points and stations, the fire service has not yet reached a degree of 'routine' in the firefighting operations undertaken in this area;
- An extremely important action during a firefighting operation is correct reconnaissance through the use of available means, e.g. vehicle rescue cards. Incorrect recognition can lead to an incorrect selection of extinguishing tactics;
- No specific ways of securing energy storage, users choose according to their individual approach and preferences;
- While sprinklers do an excellent job of suppressing and controlling an electric car fire, most garages in Poland are not equipped with them;
- A major problem after the firefighting operation for an electric car fire is water disposal;
- In the near future, bus and electric truck fires could be a challenge for the fire brigade.

Conclusions:

- Carbon dioxide fire extinguishers are not designed for battery fires;
- Due to the sporadic occurrence of incidents related to the installations in question, the only way to prepare firefighters for operations is through constant drills and refreshing theoretical knowledge;
- The use of communication between the charging station and the electric car was considered to transmit additional information to the fire alarm system, e.g. data on the type and model of car, so that firefighters heading to an event receive comprehensive information about the incident;
- Fire extinguishing tarps are an effective method of suppressing a vehicle fire, allow for the reduction of post-fire water and provide an additional protective barrier against radiant heat, escaping gases and high temperatures;

5. Conclusion and summary of the conference

The given presentations, the discussed theses and the formulated conclusions entitle us to conclude, that the aim of the conference has been achieved.

The new research, teaching and training stands presented in the 2nd session, dedicated to testing and protection of PV, vehicle charging and energy storage solutions, were created as a result of CNBOP-PIB's cooperation with partners. This project, carried out at CNBOP-PIB, is open and continued (ongoing), with a view to identifying threats and indicating optimal protection measures in relation to new technologies and solutions. These activities will continue at CNBOP-PIB with partners.

The initiated series of CNBOP-PIB and partners' conferences on current problems and challenges in the area of fire safety of new solutions and technologies will continue, and the topic that has been identified as requiring immediate attention at the next conference is fire protection of energy storage facilities. We are already inviting you to the next conferences on fire safety of new technologies and solutions.

Chairman of the Committee of the Scientific Conference
sen. brig. Jacek ZBOINA, D.Sc. Eng.