Energy storage, energy production and SMART technology in buildings

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Abstract

Modern buildings are being built with increasingly complex technical installations and energy systems. The introduction of renewable energy production, like photovoltaic (PV) panels on building roofs and facades and an increasing number of connected electric appliances, changes the way the electric power is distributed from production to end-user. The difference in production and demand for energy over time also gives incentives for installing energy storage systems. Electric energy can be stored in batteries, transferred into hydrogen gas via electrolysis or stored as thermal energy for use later. The current work presents an overview of an ongoing study in the Fire Research and Innovation Centre (FRIC) [1], on fire safety implications related to implementing new technology for energy storage and production. The focus is on the built environment such as dwellings and office buildings situated in the Nordic countries. This study builds on previous studies of related topics [2-4].

The effect of performance-based building regulations on fire safety of photovoltaic installations

The use of PV systems on buildings introduces new challenges for fire safety. Electric connections in PVs can be ignition sources [2] and cavities between the PV module and the building may trap heat, potentially giving higher fire temperatures and faster fire spread [5]. PV systems represent a physical barrier between the fire service and the buildings, which may be a challenge for firefighting efforts. Solutions for improved fire safety may include sectioning, reaction to fire properties of underlying materials, and studies to further understand the fire dynamics.

In Norway, no specific regulation governs all aspects of PV installations in buildings. Depending on the application and type of PV system, different building- and electrotechnical regulations apply. Currently, FRIC is studying the effect of performance-based building regulations on fire safety of PV installations, which will lead to more in-depth knowledge on how fire safety aspects should be implemented in the building and PV design. The results from this work will be presented.

New challenges for fire safety in buildings

A mapping of existing energy storage and energy production technologies that can be applied in buildings and fire risks associated with them and safety measures have been studied.

Different types of energy storage and energy production technologies can be implemented in buildings. Possible sources of energy for buildings can be solar radiation, wind, biomass, liquid fuel from fossil or renewable sources, or a combination of these. Their implementation in buildings introduce risks related to ignition sources, combustibility and toxicity of the materials, and contributions to flame and fire propagation. Also, they may present challenges for firefighters' ability to gain access to the building and their extinguishing efforts.

Energy storage systems conserve energy excess from production, to assure the continuity of the energy supply and to improve the reliability of the systems. The forms of stored energy that are best suited to small scale solutions are chemical and thermal energy. For example, the use of batteries, compressed hydrogen, and the storage of thermal energy in hot water or phase-changing materials. When used as energy storage solutions for dwellings, these systems are often integrated into the energy system of the building and should be located safely, as they may come into contact with sources of ignition. An electric fire or an external fire directly affecting the systems are examples of ignition sources. Hazards associated with batteries are associated with thermal runaway, including venting and fire- and explosion hazard. For pressurized hydrogen storage, hazards include a potential release of flammable- or explosive gases. Meanwhile, for phase change materials, fire safety and human health hazards are mainly linked to the introduction of flammable or toxic materials, as these may consist of organic materials such as paraffin.

The role of SMART technology

Smart technology in this study is defined as units that can receive input from sensors or other sources of information, make some type of analysis, and can give output based on this analysis. In this study, we have focsed on how smart technology is integrated into building, and on how the introduction of this technology may give new options for improving fire safety. An example is that it may allow early detection of electrical faults, as well as reduction and control of system malfunctions. Smart technology is also closely related to "Internet of things" (IoT) solutions, which may also give new options for fire protection of buildings and people.

However, integration between different systems increases complication of the overall system, which in turn leads to more potential for failure. It may also increase the difficulty in operation and maintenance and increases the dependency on reliable internet, network and power connections.

Methodology for evaluating impact on fire safety.

Currently, work is ongoing to survey in detail how selected energy systems and smart technology in combination may affect fire safety in buildings. These detailed analyses will be utilized to provide a methodology for evaluating how different smart technologies, energy storage and production systems can impact fire safety in the built environment. The aim is a unified framework that will enable fire safety engineers, building owners, architects, authorities, and product suppliers to evaluate and compare not only the costs but also positive and negative fire safety related aspects of systems. The methodology will be pilot tested with the partners in FRIC.

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