Overview of Roof Mounted Solar PV System Fire Safety

by Mr. Tan Yiing Yee

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The Government has been promoting clean energy in one form or another for quite some time. Renewable Energy (RE) related policies in the 8th Malaysia Plan were formulated to fulfill the country's obligations to international climate change initiatives and as a form of energy security. Through the years, these initiatives have facilitated sustainable long-term growth of renewable energy sources in Malaysia. Early programmes such as the Sustainable Renewable Energy Programme (SREP), introduced in 2001, paved the way for more ambitious programmes such as the introduction of the Feed-in Tariff (FiT) Scheme in Malaysia at the end of 2011.

Domestic Roof Mounted Solar PV System (Source: pv-magazine)

Although Malaysia has a multitude of renewable energy sources, solar photovoltaic (PV) systems are, by far, the most numerous due to the relative ease of installation, scalability and relatively low cost. As we are blessed with abundant sunshine with an average daily solar irradiance of 5.5 kW/m2, solar PV systems installed under the FiT scheme means comparatively short Return on Investment periods for their purchasers.

Attracted by the promise of quick returns, home and commercial property owners jumped on the RE bandwagon, resulting in consistent growth of the roof-mounted solar PV systems market segment. A rare sight not so long ago, solar PV systems are now common place and can be seen on the roofs of many residential homes and commercial complexes.

A typical grid-connected solar PV system is conceptually simple and comprises only a few main parts as shown in the diagram below:

1. Solar PV Modules arranged in an array and supported by a frame or integrated into the roof itself
2. DC Wiring, including DC Combiner Boxes
3. Inverters
4. AC Wiring and Distribution Boards

Solar PV modules are basically a matrix of PV cells connected together in series-parallel to achieve the specified output power. This matrix of cells is sandwiched between a layer of glass (the top of the module) and one or more plastic sheets including the backing sheet at the back of the model, and encased in an aluminum frame. The electrical connections from the PV cells are brought out to a small junction box glued to the back of the module. For the purposes of this discussion, the actual type of PV cell is immaterial.

DC wiring connecting one or more solar PV modules is brought to DC Combiner Boxes and from there into inverters. Of particular note is that DC wiring carries very high DC voltages and a significant amount of power. Additionally, these cables and associated accessories like connectors, are typically exposed to weather since their function is to bring power from roof mounted PV modules to the nearby inverters.

From the fire safety point of view, however, it is a fact that solar PV systems are still quite new in Malaysia. Although large-scale fires caused by solar PV systems here have not been reported so far, there have been anecdotal reports of numerous failures causing small fires that resulted in equipment and minor property damage. However if the experience of countries with higher solar PV system penetration is anything to go by, large fires caused by solar PV systems are almost a certainty in time to come. Awareness of the issues related to solar PV system fires is then required so that adequate preparations may be made.

Roof Mounted Solar PV Fire (Source: solarexpert.wordpress.com)

Fire can start from any of the parts listed above, as all of them have components that are flammable. Apart from the usual fire hazards presented by live electrical equipment, solar PV components present additional fire hazards due to a unique combination of materials, operating characteristics, installation methods and locations.

For those considering the installation of solar PV systems, the tendency is to maximise profit. This, coupled with an imperfect understanding of the deeper issues related to system reliability and safety, can create many situations where actual installations do not strictly follow industry best practice recommendations. This of course eventually leads to reliability and safety issues with system and increases maintenance costs while decreasing system availability.

Nevertheless, following the adage that prevention is always better than cure, solar PV systems can be made more reliable and safer by the following:

1. Selecting a certified designer for solar PV systems. This is more difficult than it seems due to the proliferation of installers that are only nominally trained.
2. Selection of properly rated components and equipment. A prime example is cabling that is rated for exposure to sunlight and weather. Insulation on incorrectly specified cables deteriorates quickly when exposed to the tropical sun and this can lead to fires caused by short circuits. There are many similar examples such as using the correct connectors, switching components, etc.
3. Installation of solar PV systems by certified installers to internationally recognised standards.

4. Comprehensive inspection and testing of the completed solar PV system during the commissioning stage.
5. Regular maintenance of the solar PV system during its life time.

The challenges of fighting solar PV system fires are also novel. Although roof-mounted systems are on the outside of a building, fire on the roof with solar PV installation, can quickly spread into the building and cause widespread damage. In case of such fires, fire fighters face many unique challenges such as:

- Recognising buildings with solar PV system installations.
- Isolating or "blacking out" solar PV systems. This is a particular hazard posed by solar PV systems since PV modules continue generating power so long as there is light! It must be assumed that parts of a solar PV system will always remain live even though AC power may have been isolated.
- High DC voltages of up to 1,000VDC in a large commercial system present a greater than usual risk compared to the low-voltage AC power supplies normally found in domestic or commercial environments.
- DC currents affect the human body differently from AC current; volt-for-volt DC electricity is considered more dangerous than AC electricity.
- Solar PV systems place a higher-than-usual mechanical load on roofs, particularly for retrofitted systems. This means that roofs may collapse more easily than normal under fire conditions.
- Tightly spaced solar PV modules and other related obstructions (cable trays, supports, etc.) may restrict the fire fighters' access to parts of the roof.
- Solar PV system installations that are placed off the supporting roof may worsen fire conditions by making the fire harder to get at as well as providing a flame spread path under the solar PV array.

From the above, it is clear that adequate awareness, training and equipment are mandatory for fire fighters responding to a solar PV fire.

This article has briefly introduced the types of fire hazards present in a roof-mounted solar PV system and discussed the unique challenges in dealing with fires involving such systems. As more and more systems become available, what is certain is that the challenges will multiply, and advance knowledge and preparation could minimise loss of life and property to fires in solar PV systems. ■

IEM DIARY OF EVENTS

Title: 29th Annual General Meeting Building Services Technical Division, IEM

15 August 2015

Organised by : Building Services Technical Division
Time : 11.01 a.m. – 1.00 p.m.
CPD/PDP : 2

Title: 1-Day Course on 'Introduction To Building Information Modelling (BIM) For Professionals'

20 August 2015

Organised by : IEM Women Engineer Section
Time : 9.00 a.m. – 5.30 p.m.
CPD/PDP : 7

Kindly note that the scheduled events below are subject to change. Please visit the IEM website at www.myiem.org.my for more information on the upcoming events.