

# ADDRESSING WSH RISKS FOR SAFE INSTALLATION OF SOLAR PHOTOVOLTAIC SYSTEMS

Under the [Singapore Green Plan 2030](#), Singapore aims to have cleaner and better use of energy and become more energy efficient. One of the targets is to quadruple solar energy deployment by 2025, including covering HDB roof tops with solar panels, so that by 2030, solar energy deployed will be five times that of today. At its peak, the solar energy generated can power about 350,000 households a year.

This means that large-scale deployment of solar photovoltaic (PV) systems across the island is expected in the years ahead.

The best place for solar PV systems to be installed in land-scarce Singapore is on the roofs of commercial and residential buildings. Hence, rooftops will become a typical workplace setting and demand for competent contractors to complete these installation works will rise accordingly.

In view of the upcoming demand, companies should take the following into consideration to ensure companies and workers can work safely.



Worker installing panels on mounting rails

### **Pre-installation of the Solar PV system**

The first step is to select the right solar installer and roof work contractor (if engaged). Ensure that both have the sufficient knowledge, qualifications, equipment, skills, and safe systems of work that comply with the WSH legislations.

The solar installer and roof work contractor must perform the following checks before starting onsite installation of the solar PV system:

- Survey the actual worksite, i.e. the roof and surroundings;
- Conduct worksite-specific risk assessment, such as inspecting the roof for structural integrity issues such as sharp edges, rot, or a sagging roof;
- Assess the slope and pitch of the roof to evaluate the risk controls needed to ensure the safety of workers and the stability of the equipment used; and
- Implement appropriate risk controls, such as temporary edge protection, scaffolding, mobile elevating work platforms, exclusion zones, and access to the roof or mechanical lifting aids.

### **Installation of the Solar PV System**

The solar installer must survey the actual worksite to determine that the roof is suitable and safe for the installation. Critical checks for suitability include:

- Confirming that the roof can support the additional loading imposed by the solar PV system, as well as the workers and their equipment;
- Checking that there are no open sides or whether it is possible to install edge protection at all open sides and openings;
- Inspecting the roof condition and making the necessary repairs before allowing installation works to begin;
- Ensuring there is sufficient space to be allocated as designated accessways between solar panel groups;
- Verifying that designated accessways are free of hazards e.g. fragile surfaces.
- Installing systems at a safe distance from fall and electrical hazards, and allowing for a safe means of access, where reasonably practicable.

### **Maintenance of the Solar PV System**

To eliminate or minimise the risks during the maintenance phase of an installed solar PV system, solar installers are recommended to consider the following:

- Select a solar PV system that requires low or no maintenance alternatives where available, for example plastic wire ties would require replacement whereas coated metal ones may not;
- Select a modular system with removable panels and components for easy replacement;
- Install a remote monitoring and control system to reduce the need for rooftop visits;
- Deploy drones for site inspection;
- Ensure that sufficient space has been allocated for maintenance equipment and onsite activities;
- Label and mark all electrical components properly; and

- Design a system to facilitate the isolation of individual panels.



Sufficient space allocated for maintenance



Example of a walkway

### Hazards Arising from Installation and Maintenance of Solar PV Systems

Installing and maintaining solar PV systems expose workers to risks of serious injury or death. The following are the hazards that workers may face:

#### Access risks

Getting to the roof may be a challenge depending on the building type and site conditions. Ideally, the building should be equipped with proper staircases or an elevator to provide direct access to the roof. Some buildings offer a fixed ladder with access via a roof hatch. If these are not available, an erection of a tower scaffold is necessary for safe access to the roof.

#### Fall from height

Working on roofs and other works at height carry the risk of falling from height. Solar installers and contractors must put in place measures to ensure workers always remain safe while at work. A site-specific fall prevention plan (FPP) must be established and implemented to eliminate or mitigate the risk of falling from height. Workers have a responsibility to comply with the safety requirements and report unsafe situations to their employers. Where there is a risk of objects falling from the roof, protective barriers must be installed to prevent objects from injuring anyone below.

The site-specific FPP must cover the following:

- Permit-to-Work (PTW) system: Put in place a PTW system for work activities where a person could fall more than three metres. Ensure on-site checks are carried out by a competent person and risk controls are confirmed effective before authorising the work at height. Details on PTW system, including a sample PTW template can be found in the [Code of Practice for Working Safely at Heights](#).
- Safe Work Procedures (SWP): Develop a SWP for carrying out the task on the roof, taking into account the roof's characteristics, e.g. material of construction, profile and angle of slope, and the duration and frequency of work. Provide supervision to ensure the SWP is strictly followed. A comprehensive SWP for work on roofs can be found in the [WSH Guidelines on Working safely on roofs](#).

- **Open side guarding:** Install temporary guardrails or erect a scaffold platform with guardrails, if feasible, to prevent workers from falling off the roof edge. If this is not feasible, install a properly anchored lifeline for workers to attach themselves to, using fall-arrest or travel-restraint equipment.



- **Worker training:** Deploy only workers who have successfully completed the Workforce Skills Qualifications (WSQ) Perform Work at Height course to work on roofs. Train workers to always anchor their safety harnesses when working at height.
- **Personal Protective Equipment (PPE):** Equip roof workers with anti-slip safety footwear and, if necessary, fall-arrest or travel-restraint equipment along with secure anchor point(s) or lifeline. Read more in the [WSH Guidelines on PPE for Work at Heights](#).

If there is a risk of falling through a fragile surface while on the roof, e.g. skylights, additional risk controls may include:

- Identify, mark, barricade and communicate the presence of fragile surfaces;
- Cover the fragile surface with a secure cover or provide all-round barricades;
- Provide workers with a way to work under, e.g. using a tower scaffold, or above the fragile surface, e.g. using a mobile elevated work platform;
- Install roof ladders, gangways, crawl boards and roof brackets to facilitate movement on sloping roofs; and
- Deploy safety nets below fragile surfaces.

Read more in the [WSH Guidelines on Anchorage, Lifelines and Temporary Edge Protection Systems](#).

### Electrical risks

Solar panel installers and maintenance personnel may be exposed to electrical risks while at work. To prevent electrical injuries, companies are advised to carry out the following:

- Deploy only workers trained for electrical work;
- Implement a PTW system for electrical works and allow work to start only when electrical systems are de-energised or isolated;

- Implement lockout-tagout procedures to ensure de-energised or isolated systems cannot be turned on by accident;
- Test if the electrical equipment is dead, e.g. by using a voltage detector, before working with it;
- Provide workers with insulated tools, rubber-soled shoes, and electrically resistant gloves;
- Stop electrical work during unfavourable weather, e.g. when there is a lightning risk, or when the work area is wet; and
- Ground all electrical circuits before turning on electrical systems.



Distribution box

### **Other risks**

Monitor weather conditions and stop any roof works during unfavourable weather conditions such as strong winds, lightning, and heavy rain. For strong winds, ensure all equipment used are secured to prevent them from being blown off the roof.

Check for slippery surfaces, e.g. wet or mossy conditions, as they may pose a risk to slips and falls; use anti-slip footwear if necessary. Work zone(s) need to be kept clear of tripping hazards such as loose tools, cables, or debris.

Take care of workers by providing rest breaks, access to cool water, and mechanical aids, e.g. trolleys and power tools, to manage fatigue and heat stress.

### **Further information**

1. [WSH \(Work at Heights\) Regulations 2013](#)
2. [Guide to Solar PV by Energy Market Authority](#)
3. [Handbook for Solar Photovoltaic \(PV\) Systems by Energy Market Authority and Building Construction Authority's Handbook for Solar Photovoltaic \(PV\) Systems](#)
4. [Best Practices for Installing Solar Panels on Building Rooftops by Building Construction Authority, Energy Market Authority and Urban Redevelopment Authority.](#)

## Annex 1: WSH Checklist for safe installation of solar PV systems on the roofs

This checklist highlights the key WSH considerations for installation of solar PV systems on roofs to help solar installers and contractors better manage WSH and implement effective control measures. The checklist is by no means exhaustive and is not a replacement for proper planning including a fall prevention plan and risk assessment.

Name:	Date:	Time:
Site Address:		

<b>Pre-work Planning and Preparation</b>			
	<b>YES</b>	<b>NO</b>	<b>NA</b>
Has an onsite survey of the worksite been conducted, i.e. the roof and its surroundings to determine that the roof is suitable and safe, with appropriate control measures, for solar PV installation works?			
Has a site-specific RA and safe work procedures been prepared for the high-risk work to address falls and electrical risks?			
Have all workers been informed of the identified risks, and control measures and safe work procedures implemented, prior to commencing work?			
Do all workers have the required qualifications and competencies for their tasks? Including work-at-height safety training?			
Are appropriate personal protective equipment provided to the workers and are they being used correctly?			
Has a site-specific emergency plan been prepared for roof works?			
<b>Accessing the Roof</b>			
	<b>YES</b>	<b>NO</b>	<b>NA</b>
Are the safe means of access and egress to the roof inspected and verified safe prior to starting daily work? E.g. ladder, access scaffolds, stairways, walkways.			
If scaffolds are used as access; have they been checked to ensure that they comply with the Workplace Safety and Health (Scaffolds) Regulations?			
If mobile elevating work platforms are used to access the roof, have pre-operational checks been conducted and statutory examinations completed?			
<b>Transfer and Placement of Work Materials on the roof</b>			
	<b>YES</b>	<b>NO</b>	<b>NA</b>
Has the location on the roof been checked to ensure it can hold the weight of the materials transferred?			
If storing heavy items or equipment on a roof, have they been checked to ensure that the weight is evenly distributed?			
If lifting operations are to be performed by cranes, has a lifting plan been prepared in accordance with the Code of Practice for Safe Lifting Operations?			
<b>Working on Roofs</b>			
	<b>YES</b>	<b>NO</b>	<b>NA</b>
Have all sides, fragile surfaces, or openings into and through which a person may fall been covered or guarded by barriers?			
Are covers that protect openings securely fastened to prevent accidental displacement?			
Has a safe route of access across the roof been designated to minimise unnecessary movement?			

Have roof surfaces that are subjected to heavy foot traffic been provided with walkways or similar protective devices to prevent slips, trips and falls?			
Has a fall prevention plan been prepared and implemented for roof works?			
Is a permit-to-work system in place and have onsite checks been carried out before starting works at height?			
Have workers been trained and briefed in works at height, how to apply the SWP, and what are the emergency responses procedures?			
Is there adequate supervision to ensure that workers follow safe work procedures while working at heights?			
Are workers trained in the proper use of safety harnesses, restraint belts and anchorage points?			
Are all fall-arrest equipment within service date and inspected prior to use?			
Are sufficient and secured anchorage points provided?			
<b>Protecting against electrical risks</b>			
	<b>YES</b>	<b>NO</b>	<b>NA</b>
Are all electrical works being undertaken by a licenced electrical worker?			
Are all workers aware of the permit-to-work system for electrical works?			
Are lockout-tagout procedures implemented to ensure de-energised or isolated systems cannot be turned on by accident?			
Have damaged wiring and equipment in the affected area have been identified, isolated where possible, and reported to the owner?			
Are all equipment and tools in good working condition and rated for the voltage of the system?			
Is a voltage tester or multimeter being used to ensure that the system is de-energised before beginning any work?			
Are all wiring and components properly grounded and bonded?			
Are all wiring properly labelled and organised?			
Have all workers wearing rubber-soled shoes, electrically resistant gloves and using insulated tools when working with electrical systems?			
If workers are required to modify, repair, or install electrical equipment, have they been checked if they are qualified to do so?			
<b>Other risks</b>			
	<b>YES</b>	<b>NO</b>	<b>NA</b>
Has checks been done on the weather conditions? Work activities should stop in the event of unfavourable weather conditions such as strong winds, lightning, and heavy rain.			
Have all equipment been secure to prevent them from being blown off the roof during strong winds?			
Has the work zone been cleared of tripping hazards such as loose tools, cables, or debris?			
Are regular rest breaks, cool water, and mechanical aids provided to workers to manage fatigue and heat stress?			