

ROOFTOP PHOTOVOLTAICS

What's Going On Up There?

Solar photovoltaic (PV) installations are becoming increasingly common for on-site electricity generation and reduction of greenhouse gas (GHG) emissions. The Government of Alberta (GoA) has PV systems on many of its facilities, including schools and offices. In addition to reducing the carbon footprint of a facility, PV integration offers educational opportunities for occupants and provides a publicly visible example of an owner's commitment to environmental stewardship. PV systems are relatively simple to design and install, however, a successful outcome requires careful planning to ensure the system is safe, durable, maintainable, and does not adversely impact the building it serves. *Design and Technology Series 12* explains the two main options for roof-mounted PV - ballasted and structurally fastened - and compares the pros and cons of each.

Rooftop PV systems typically fall into one of two categories:



Ballasted PV
Photo credit: www.solarpowerworldonline.com



Structurally Fastened PV
Photo credit: www.solarprofessional.com

Ballasted: PV arrays are secured to racks held in place by heavy concrete blocks or pavers; they require no direct mechanical connection to the supporting building structure.

Structurally Fastened: PV arrays are secured to racks that are physically connected to the roof structure or decking via structural curbs, sleepers, pedestals, etc.

The decision to install ballasted vs. structurally secured PVs requires a detailed analysis of the advantages and disadvantages of each. For existing buildings with sufficient structure, a ballasted system may be faster and initially cheaper to install, since roof penetrations and structural tie-ins are not usually required. Structurally-tied systems require careful design and construction of roof penetrations to ensure watertightness, in addition to structural considerations (e.g. snow drifting). Installations must also resist movement under wind loads, especially for ballasted systems that rely on gravity to remain in place. Skirting systems are available that reduce wind uplift forces on PV assemblies.

As ballasted arrays rest directly on the roof, effects on the roof's waterproofing membrane must be understood and accounted for. Thermally-induced expansion and contraction of the PV rack components may result in scouring of the roof membrane. Common strategies for preventing damage to the roof include the provision of an additional (sacrificial) cap sheet layer at anchor points, or the placement of PV racks on concrete pavers that are separated from the roof surface by a layer of type 4 insulation. Roof contact points must not interfere with roof drainage or promote ponding of water.



Ballasted PV Installation, J. G. O'Donoghue Building
Photo credit: Technical Services Branch

Maintenance and Safety

Regular roof inspections and maintenance extend a roof's life and are mandatory for warranties. Safety is also a priority. Consider:

- Ensure PV components meet or exceed CSA standards (or equivalent)
- Coordinate fall arrest and anchoring fixtures with PV placement
- Protect electrical components from the elements (snow, rain, etc.), extreme temperatures, and physical damage
- Allow sufficient clearances between arrays for maintenance, inspections, etc.
- Avoid PVs above sensitive operational areas. Emergency roof repairs may require extra time for PV relocation.
- Ensure redundant roof drainage to prevent water ponding
- Consult local authorities for fire and first responder safety requirements
- Installation of video cameras for security and remote monitoring
- Secure roof access and warning signage for maintenance workers and fire fighters
- Plans for bird and vermin deterrence, (e.g. fire risk from nesting birds and barring of wires by rodents)
- Alberta Roofing Contractors Association (ARCA) Advisory Bulletin AB-2017-06 offers safety guidance for working around roof mounted PV equipment¹.

Fenlands Banff Recreation Centre
Photo Credit: www.skyfireenergy.com



For structurally fastened PV systems, roof scouring is less of a concern, however, rack components and roof connections must accommodate thermally-induced movement without causing stress or damage to the roof assembly or structure.

Large expanses of flat roof space offer a tempting opportunity to maximize PV integration. Optimal PV system sizing requires the analysis of multiple factors, including roof access, penetrations and equipment clearances, maintenance, safety and roof warranty options.

While an Alberta Roofing Contractors Association warranty is not always required, much of the ARCA standard should be considered best practice. ARCA's Technical Bulletin TB-2017-05 for Roof Mounted Photovoltaic Equipment² explains the criteria a PV system must meet for warranty eligibility:

1. Enclosed roof sections with PV equipment must be independently drained, with minimum 2% slope to drain.
2. ARCA recommends that only rack-mounted PV systems be installed on low slope roofs. Installation must meet ARCA Roofing Application Standards, with racks and supports designed by a structural engineer in compliance with the Alberta Building Code. Penetrations must be executed by an ARCA contractor.
3. Minimum required clearances: 3m around the roof perimeter, 1.2m to/around roof penetrations and between PV arrays, 0.3m (vertical) underneath PV systems for roofing access and installation.
4. Roof damage caused by PV systems, or costs for moving/replacing PVs for warranty inspections or repairs are not covered by the ARCA warranty (owner's responsibility).
5. No more than 50% of the roof area should be covered by PV.

2019 update: ARCA is considering warranty coverage for roofs with ballasted PVs if the array is installed after the 2nd year warranty inspection. Systems installed before this time can prevent a thorough roof inspection and may exclude the roof from the ARCA Warranty Certificate.

The pros and cons of ballasted vs. structurally fastened PV systems must be evaluated when determining which option best suits the unique functional, financial, and environmental priorities of the project. Alberta Infrastructure's PV Guide offers further information for Project Teams evaluating solar PV options⁴.

	Ballasted	Structurally Fastened
PROS	<ul style="list-style-type: none"> • Lower first cost • Simpler installation (if structural capacity permits) • Manufacturer's warranties may permit greater PV coverage • May qualify for ARCA warranty if installed after 2nd year inspection 	<ul style="list-style-type: none"> • Lower lifecycle cost • Lighter loads on roof and structure • Greater ease of maintenance • May qualify for ARCA warranty
CONS	<ul style="list-style-type: none"> • Higher maintenance costs • More drainage interference • Higher structural capacity required • Manufacturer's warranties may be insufficient to cover losses 	<ul style="list-style-type: none"> • Higher first cost for structural details • ARCA advises no more than 50% of roof area should be covered by PV

Information Sourced From:

1. <https://www.arcaonline.ca/sites/default/files/AB-2017-06%20Roof%20Mounted%20Photovoltaic%20Safety.pdf>
2. <https://www.arcaonline.ca/sites/default/files/TB-2017-05%20New%20Photovoltaic%20Standards%20FINAL.pdf>
3. <http://www.infrastructure.alberta.ca/content/docType486/production/techdesignrequirements.pdf>
4. <http://www.infrastructure.alberta.ca/Content/docType486/Production/SolarPVGuide.pdf>

Not all Warranties are the Same

Whether ballasted or structurally-tied, a PV system may affect the warranty of the roof it is installed on; manufacturer's warranties vary significantly from ARCA coverage.

Alberta Roofing Contractors Association requires tested and vetted systems and materials, as well as inspections at project start-up, during installation, at completion, and at specific points afterwards. Inspectors are certified and must undergo continuous training to maintain their credentials. Manufacturer's inspections may vary in frequency and scope, and warranties generally cover their material costs only. For projects that specify ARCA-accepted roofing systems and materials, ARCA provides a workmanship warranty in collaboration with an ARCA contractor.

ARCA recommends a maximum of 50% roof coverage by PV. This area may be even less when clearances around roof penetrations, circulation, etc. are considered. Where an ARCA warranty and high PV density is required, explore opportunities elsewhere on the building or site (e.g. building integrated PV, PV-covered car parking, etc.).

Alberta Infrastructure does not require an ARCA warranty, but does specify required warranty and quality assurance items³.