PHOTOVOLTAIC ready
Guidelines

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I. INTRODUCTION & KEY BENEFITS

The Photovoltaic (PV) Ready Guidelines specify a number of design considerations and modifications builders can make to new attached and detached homes in preparation for the installation of a future solar photovoltaic (solar PV) system. The design considerations and modifications include the following elements: roof space, solar PV conduit and wall space next to the electrical panel. Structural loading considerations are discussed in the Guidelines.

These Guidelines are intended to be simple and inexpensive to implement, while enabling significant savings in installation costs should a homeowner choose to install a complete solar PV system in the future. The Photovoltaic Ready Guidelines are specifically targeted towards the installation of solar PV systems as tested and/or certified according to Canadian Standards Association (CSA) relevant test standards; and as installed by qualified installers. For more information on relevant CSA test standards, see Section III, Part 7.

See Section IV for an explanation of the anticipated performance of solar PV systems for homes built Photovoltaic Ready.

This Guideline is intended to help increase builder and consumer awareness of the opportunity that roof-mounted photovoltaic systems provide.

PHOTOVOLTAIC READY HOMES BENEFIT:

- Homeowners, by enabling them to save money on the installation of a future photovoltaic system while increasing the value of their home;
- Builders, by offering them the tools to provide an environmentally-conscious, low-cost upgrade to new homes; and
- Manufacturers and installers, by encouraging market uptake of photovoltaic systems.

The Photovoltaic Ready Guidelines can be found on NRCan's website *nrcan-rncan.gc.ca*. Builders should ensure they are working with the most recent version.

PHOTOVOLTAIC READY BACKGROUND:

Natural Resources Canada partnered with the Canadian Home Builders Association and the Canadian Solar Industries Association to develop the technical specifications of these Photovoltaic Ready Guidelines.

II. TECHNICAL SPECIFICATIONS

Each of the following requirements should be completed by the builder. See Section III for additional information.

1. On The Roof

Builders should:

1.1 identify on the house plans a large roof area to allow the installation of a photovoltaic array with a design energy output to offset a significant portion of the annual energy budget of the house.

1.2 ensure the roof area identified in 1.1 is unobstructed (clear of chimneys, roof vents, skylights, gables and other protrusions and it should not be foreseen to be significantly shaded by building elements, surrounding buildings or mature trees at any time of the year);

1.3 ensure the roof area identified in 1.1 has an orientation ranging from east to west facing corresponding to azimuth angles of 90º to 270º from true north;

1.4 ensure the roof area identified in 1.1 is located at least 91.4 cm (36") below the roof ridge (of a sloped roof), does not extend into the 91.4 cm (36") pathway allowances at the roof edges, hips and valleys, and is located above the wall line, away from overhang areas as a best practice design (see Section III Part 1);

1.5 consider designing the roof to a recommended (not required, see Section III, Part 1) roof pitch of 5/12 to 18/12, corresponding to angles of between 23º and 56º above horizontal (0º).

NOTE: *Structural loading considerations are outside the scope of the Photovoltaic Ready Guidelines. Builders may wish to ensure the roof structure as designed not only meets all applicable building code requirements, but will also support additional loads associated with common photovoltaic energy systems. Refer to Section III, Part 1, "Loading" for related commentary. Builders may wish to consult with building code authorities for guidance on issues associated with installing PV systems on roof structures.*

2. Solar PV Conduit

2.1 To prepare for photovoltaics, one solar PV conduit of at least 3.8 cm (1-1/2") nominal diameter constructed of rigid or flexible metal conduit, rigid PVC conduit, liquid tight flexible conduit or electrical metallic tubing (as per Section 12 of the Canadian Electrical Code Part 1 concerning "raceways") should be installed. The conduit should be installed entirely within the home envelope (except for the roof termination if applicable). The conduit should be continuous from an accessible attic or roof location to the designated wall space for the PV electrical hardware (bends / elbows will be fine). In installations with any bends or elbows greater than 45 degrees, a nylon pull-rope should be installed in the conduit to facilitate installation of conductors at a future date.

NOTE: *Most PVC conduits meeting ASTM D1785, Schedule 40, 80 or 120 have a maximum service temperature of 60ºC (140ºF) and a melting point of 93ºC (200ºF). These temperature ratings could be exceeded in cases involving the eventual installation of current carrying wiring in PVC conduit that runs through attic insulation. The scope of this concern is beyond that of the Photovoltaic Ready Guidelines. However, should this case be encountered or foreseen, it is recommended that installers insert a conduit sleeve of a minimum of 2.5 cm (1") additional diameter over the existing conduit with a suitable spacer in such a way that an air space is maintained between the conduit containing the wiring and the attic insulation.*

II. TECHNICAL SPECIFICATIONS (cont'd)

3. Termination of Conduits

Attic (applicable where attics are present)

3.1A. Workspace should be allowed for around the termination of the conduit in the attic; 15.2 cm (6") above the attic insulation while allowing about 45.7 cm (18") of vertical distance between the conduit and the underside of the roof decking.

3.2A. As with all attic protrusions, the solar PV conduit terminating in the attic must be properly sealed around the attic penetration and capped to maintain home air tightness and fire ratings.

Roof (applicable to homes with no attic, e.g., cathedral ceilings)

3.1R. As with all roof protruding elements, the solar PV conduit terminating on the roof must be sealed and flashed around the roof penetration using a rubber or corrosion-resistant metal flange/boot with a gasket around the conduit, and capped to maintain air and water tightness. If the solar PV conduit also passes through an attic, but terminates on the roof, the attic penetration must be properly sealed to maintain home air tightness.

Electrical Room

3.1E. The solar PV conduit must be properly sealed at the electrical room penetration point and capped to maintain home fire ratings.

3.2E. As was the case in the attic, there should be workspace allotted around the termination point of conduit in the electrical room. For the solar PV conduit, 5 cm (2") of vertical space between the termination point and any impeding element (e.g., basement I-beam); and 15.2 cm (6") of horizontal space in one direction to allow future installers to access the conduit and snake wires through as required, will be sufficient.

4. Space / Electrical

Wall Space for Photovoltaic Hardware

4.1 Wall space should be allocated in the electrical room, adjacent to the main electrical panel for the house, for the future installation of a photovoltaic system inverter and connection hardware: 91.4 cm (36") x 91.4 cm (36") will be suitable.

5. Code Compliance

5.1. Building and electrical work must be completed in compliance with the most current versions of the National Building Code of Canada, and the Canadian Electrical Code, Part 1 including provincial/municipal amendments where applicable. Refer to Section III, Part 7 of the Photovoltaic Ready Guidelines for a list of useful documents and links.

III. SUPPORTING INFORMATION

1. ON THE ROOF

Roof Space, Roof Access and Pathways, Orientation and Mounting Angle

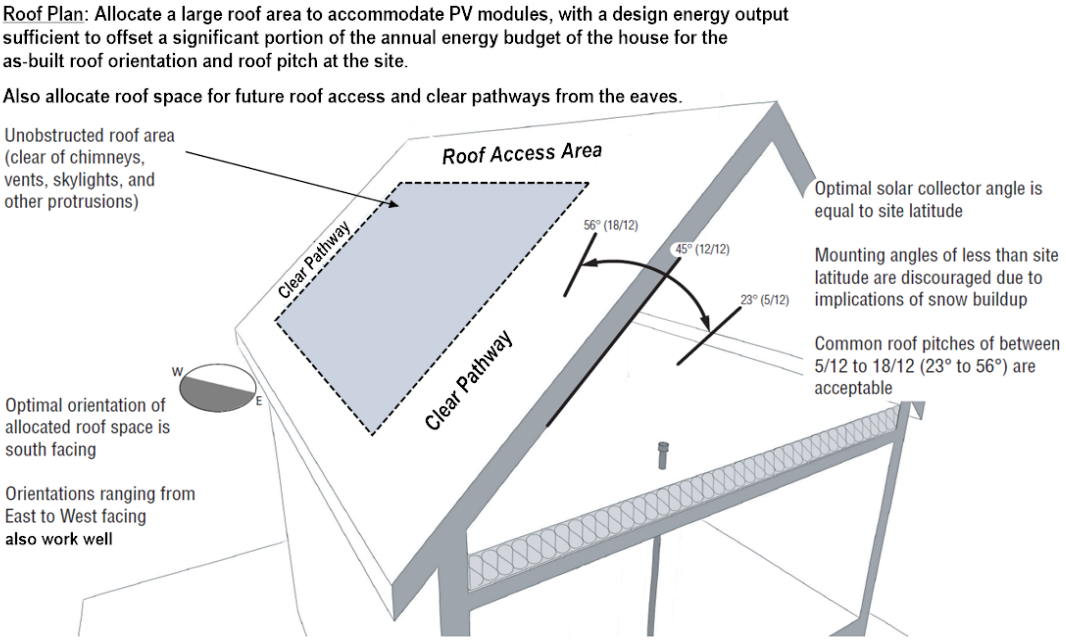

Figure 1: Roof space, orientation and mounting angle of solar PV modules

ROOF SPACE

In most residential applications, roof-mounted equipment is the most cost effective way to install a solar PV system. Figure 1 describes the recommended roof space, orientation and mounting angle of the solar PV modules. A site inspection of surrounding building structures and consultation with landscaping plans will ensure the allocated area will not be significantly shaded by surrounding buildings / mature trees at any time of the year. Photovoltaic Ready shading considerations are described in Figure 2.

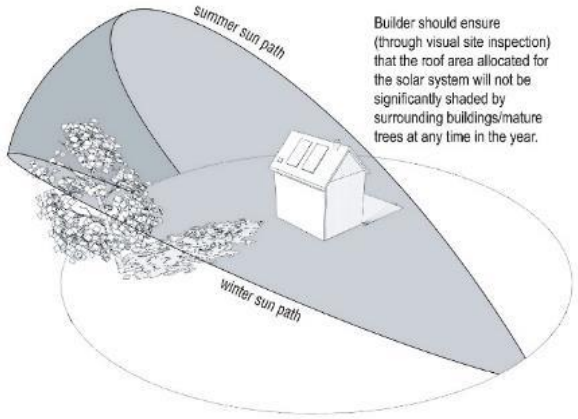

Figure 2: Shading considerations for solar PV systems

III. SUPPORTING INFORMATION (cont'd)

ROOF ACCESS AND PATHWAYS

As a best-practice design, roof access for smoke ventilation during a fire should be provided, and is applicable to all rooftop installations, regardless of roof type. To meet this best-practice design, PV modules should be installed at least 91.4 cm (36") below the roof ridgeline. Since this area is not a pathway, the ridge space doesn't have to be clear of obstructions (e.g. roof vents).

The PV array should not block access to the roof for firefighters attempting to gain access from the ground. Available roof access points must be able to support a firefighter's load and not be located directly in front of windows and doors. Rules for pathway requirements have been established for three specific roof layouts: gable, hip, and hip-and-valley. These rules apply to roof slopes greater than 2:12 pitch and require the pathways to be located over structurally supported areas that can support the live load of a firefighter.

GABLE ROOF LAYOUTS require two 91.4 cm (36") wide, clear pathways from ridge to eave on each slope where modules are installed. The most convenient location for pathways will be on outer edges of the roof as long as they are structurally supported. Refer to Figure 3 for additional guidance.

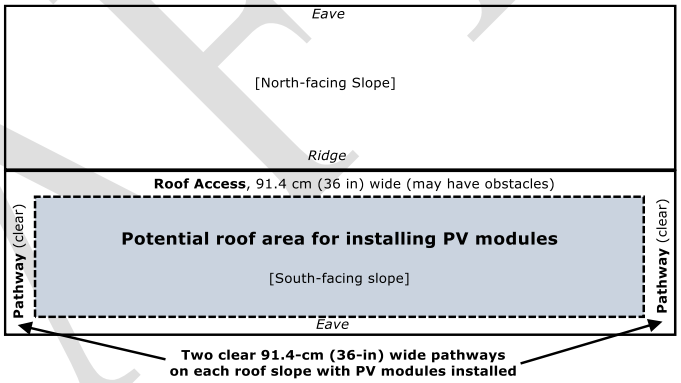

Figure 3: Gable Roof: Access and Pathway Requirements

HIP ROOF LAYOUTS require a single 91.4 cm (36") wide, clear pathway from ridge to eave on each slope where modules are located. The most convenient location for pathways will be along the hips at the outer edges of the roof-face.

If there are modules on both sides of the hip then a minimum 45.7 cm (18") pathway needs to be provided on both sides of the hip to create a 91.4 cm (36") wide pathway. If the other side of the hip is without modules, the PV array can go all the way to the hip. Refer to Figure 4 for additional guidance

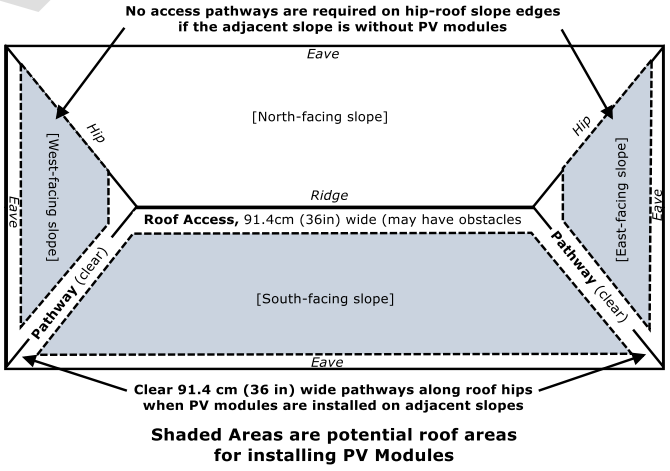

Figure 4: Hip Roof: Access and Pathway Requirements

III. SUPPORTING INFORMATION (cont'd)

HIP-AND-VALLEY ROOF LAYOUTS require at least one 91.4 cm (36") wide, clear pathway from ridge to eave on the slope that has modules. The most convenient location will be along the hips and valleys at the outer edges of the roof-faces. If there are modules on both sides of the hip or valley, then a minimum 45.7 cm (18") pathway needs to be provided on both sides of the hip or valley to create a 91.4 cm (36") wide pathway. If the other side of the hip or valley is without modules, the PV array can go all the way to the hip or valley. Refer to Figure 5 for additional guidance.

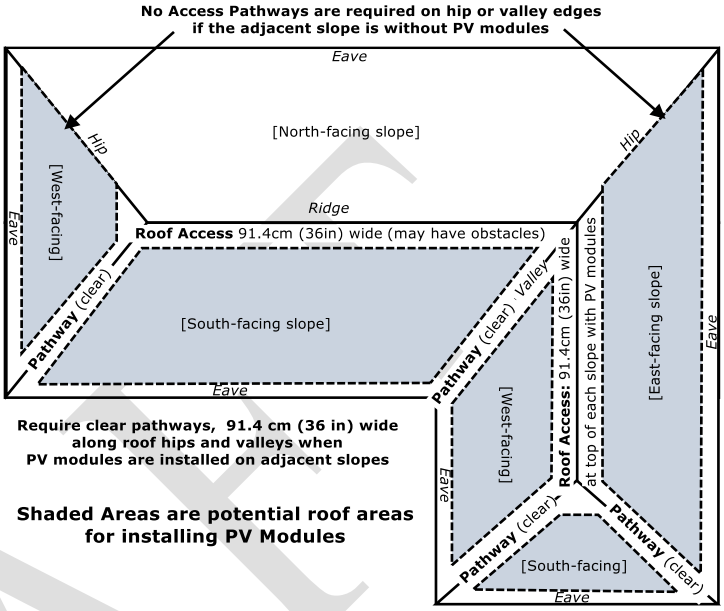

Figure 5: Hip and Valley Roof: Access and Pathway Requirements

NOTE TO BUILDERS – DESIGN CONSIDERATIONS

ROOF DESIGN

Roof designs with fewer hips and valleys and larger rectangular surfaces will maximize the usable roof area and facilitate the future installation of PV modules on the allocated roof space of the PV-Ready home. Gable roof surfaces (see Figure 3) will allow the installation of the same number of PV modules in each row and result in a rectangular PV array that has straight-line edges running parallel to the edges of the roof. This may result in a PV array that looks integrated into the roof design.

Roof designs with hips and valleys will require stair-casing of the rows of PV modules to follow the diagonal of the hip or valley (see Figures 4 and 5). These stair-cased edges of the PV array may have a greater visual impact and make the PV array stand out more on this type of roof design.

AESTHETICS MATTER

From CHBA's consumer market research:

"CHBA has confirmed that aesthetics matter. Net Zero Energy Homes with PV systems that are visually integrated with roof lines are definitely favoured by consumers. By designing the roof for PV from the initial design stage, builders are able to ensure the system will look good and is adequately sized to meet Net Zero."

Sonja Winkelmann, Director, Net Zero Energy Housing, Canadian Home Builders Association

III. SUPPORTING INFORMATION (cont'd)

NOTE TO BUILDERS – LOADING AND ATTACHMENT

To ensure roof structures can support additional loads associated with common solar photovoltaic systems, builders can consult with their local building code authorities.

DEAD LOAD

Builders can design their roof structures so that they have additional structural capacity to carry typical solar photovoltaic systems.

When designing the roof structure to accommodate a photovoltaic system, an additional design dead load of 0.17 kPa (3.5 psf) accommodates the weight of solar PV modules as well as all mounting hardware for the majority of CSA certified systems when they are mounted in parallel to the roof surface. Systems mounted at an angle to the roof surface (i.e., rack mounted systems) and ballasted systems may incur additional loads beyond the 0.17 kPa (3.5 psf) dead load.

It is the installer's responsibility to both select and install a solar photovoltaic system so that it meets the building code load requirements.

METHOD OF ATTACHMENT

There are a variety of methods for attaching solar systems to the roof structure. When installing solar systems on Photovoltaic Ready homes, solar installers should identify the appropriate attachment method given the requirements of the system to be installed and the design capacity of the roof structure.

It should be noted that to use a desired attachment mechanism on a roof that is designed to withstand the additional load of a solar system, an installer may need to provide additional reinforcement to transfer loads appropriately to structural elements of the roof system. Particular consideration to future attachment mechanisms may be needed where attic space is difficult to access, such as is the case for roofs above cathedral ceilings.

TRUSS DESIGN PROCEDURE

In 2011, the Truss Plate Institute of Canada (TPIC) developed a "Solar Ready Truss Design Procedure" for solar systems installed on truss-based roofs. This procedure focuses on truss systems designed to carry the additional dead load and support typical methods of attachment currently being used by solar installers. This is one design option builders may wish to use to address dead load and methods of attachment (refer to *www.tpic.ca*, Technical Bulletin #7 for details).

SNOW MANAGEMENT DEVICES

Photovoltaic arrays can represent an avalanche hazard when large sections of accumulated snow slide off the glazing. Snow management devices such as snow clips and fences are available for attaching to PV arrays to slow and breakup the release of snow. These attachments are typically limited to regions with snow loads up to 2.39 kPa (50 psf).

In regions with higher snow loads, builders are advised to allocate roof space and plan access to structural elements of the roof system for mounting snow management devices such as snow fences directly to the roof surface below the PV array.

III. SUPPORTING INFORMATION (cont'd)

SOLAR PV MODULE ORIENTATION

From the standpoint of maximizing solar energy collected, the ideal PV module orientation is south facing. However, based on a design target of not less than 70% of maximum performance, and taking into consideration that some lots will not allow for optimal orientation, the Photovoltaic Ready Guidelines recommend roof space orientations varying between east and west facing.

SOLAR PV MODULE MOUNTING ANGLE

From the standpoint of maximizing the annual solar energy collected, the ideal PV module mounting angle is generally equal to site latitude. Builders can consult the Solar Resource Maps of Canada (see Section III, Part 7) for details. Vertical mounting of solar PV modules is also possible, but should generally be limited to extreme northerly locations (see comments regarding seasonal optimisation below).

It should also be noted that systems mounted at low angles (generally 45º (12/12) pitch or less) will not shed snow as well as systems mounted at slightly steeper angles and will thus not perform as well in winter months.

For Photovoltaic Ready, the recommended roof pitch is 5/12 to 18/12, corresponding to angles of between 23º and 56º above horizontal (0º). Roof mounting kits are available for low slope or flat roofs to achieve the desired mounting angle. Builders/installers should be aware of load implications associated with using such kits if chosen.

SEASONAL OPTIMISATION

Solar systems can be designed to perform best in summer or winter, depending on the intended use and site location. As most solar installations tend to "over-produce" in summer and "under-produce" in winter, some builders, particularly in extreme northerly locations, may wish to design for improved winter performance by allocating a steeper sloping area of roof space (or wall space) and/or allocating roof space with a modified orientation. As a general rule of thumb, solar systems optimized for winter performance will perform best at mounting angles 10 degrees greater than site latitude and oriented slightly west of due south. The effects become more pronounced the further north the site is located.

However, since grid connected solar PV systems are typically designed to maximize summer output, steeper mounting angles may be less desirable for Photovoltaic Ready installations.

III. SUPPORTING INFORMATION (cont'd)

2. SOLAR PV CONDUIT

Note: The solar PV conduit should be installed entirely within the house envelope (except for conduits terminating on the roof).

Photovoltaic Ready suggests installation of one dedicated solar PV conduit of at least 3.8 cm (1-1/2") diameter for use by a potential future PV system. This conduit need not be straight, as wiring can be "snaked" around elbows. If the solar PV conduit is installed with any bends or elbows that are greater than 45 degrees, a nylon pull-rope should be installed in the conduit to facilitate installation of conductors at a future date. The solar PV conduit details are described in Figure 6.

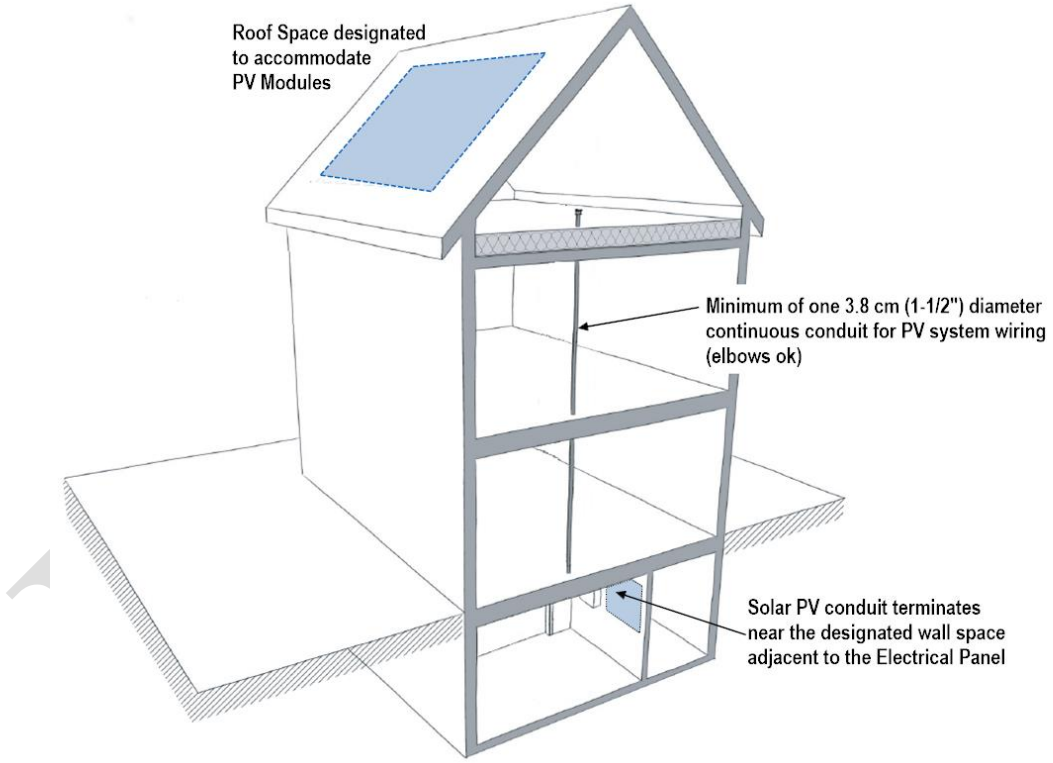

Figure 6: Solar PV conduit specifications

III. SUPPORTING INFORMATION (cont'd)

3. TERMINATION OF CONDUIT

The optimal roof location to terminate the solar PV conduit for use by a future PV system is difficult to ascertain ahead of time. It is for this reason that termination in the attic is the preferred option.

When terminating the conduit in the attic, the builder should ensure there will be adequate workspace for a future solar system installer to accomplish the work. The workspace specifications are explained in Figure 7.

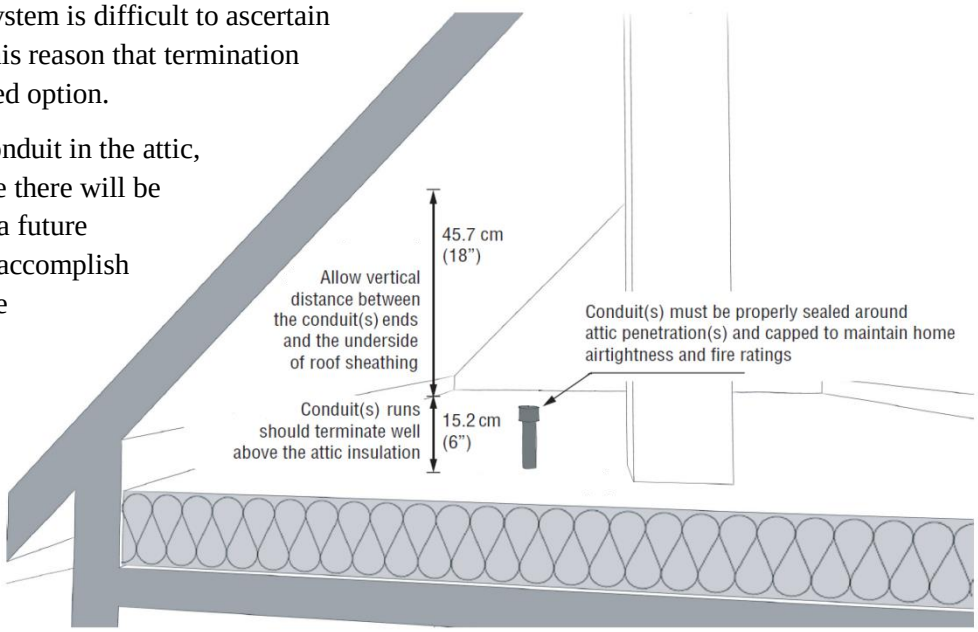

Figure 7: Workspace specifications for attic termination of Solar PV conduit

However, for situations where attic termination is not feasible (e.g., cathedral ceilings), roof termination is also possible. For roof terminations, the builder should make every effort to locate the conduit protrusion as close as possible to the perimeter of the allocated roof space, while respecting the roof pathway areas.

As with any roof protruding element, the builder should ensure the protruding conduit is sealed and flashed to maintain envelope water tightness. The roof termination option is not shown graphically.

The conduit termination in the electrical room should end near the wall space reserved next to the main electrical service panel. The end of the conduit should be easily accessible with sufficient surrounding workspace such that future solar PV system installers will be able to readily snake wires through the conduit to connect to the PV system on the roof. See Figure 8 for guidance.

III. SUPPORTING INFORMATION (cont'd)

4. SPACE / ELECTRICAL

WALL SPACE FOR PHOTOVOLTAIC HARDWARE

Wall space should be allocated for the photovoltaic system inverter and connection hardware. Refer to Figure 8 for guidance.

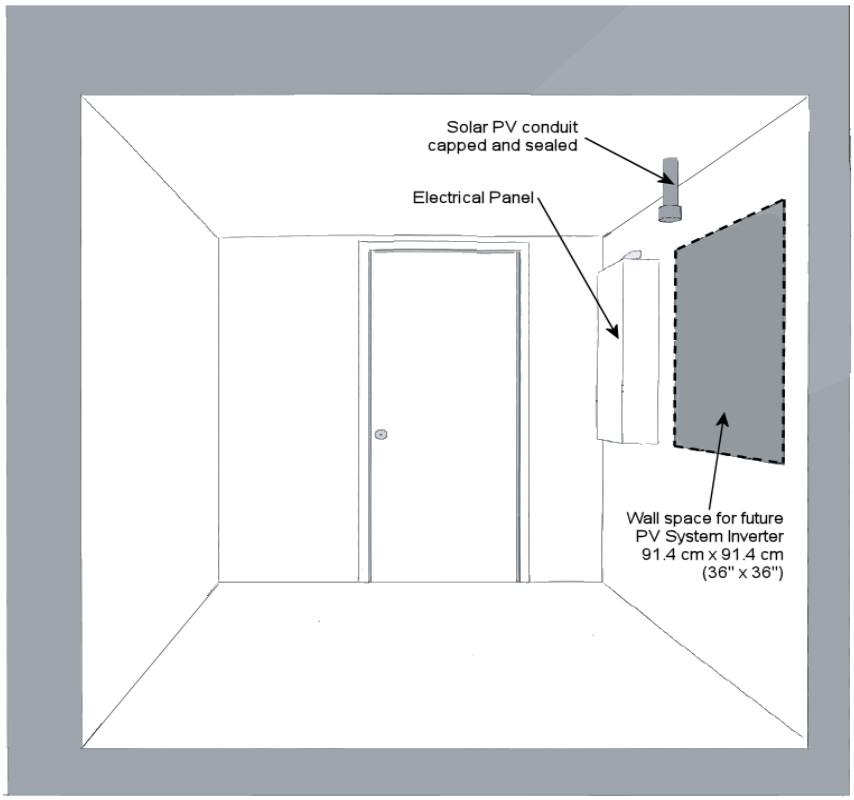

Figure 8: Allocation of Wall Space and termination of the Solar PV conduit adjacent to the Main Electrical Panel

5. CODE COMPLIANCE

Builders must ensure that all elements related to the Photovoltaic Ready Guidelines are completed in accordance with the National Building Code of Canada, the Canadian Electrical Code, Part 1 including provincial/municipal amendments thereto.

III. SUPPORTING INFORMATION (cont'd)

6. IDENTIFICATION OF SOLAR READY COMPONENTS

PROVIDED BY THE BUILDER TO THE HOMEOWNER:

A completed copy of the Photovoltaic Ready Checklist & Builder's Declaration should be provided to homeowners for their records.

7. USEFUL DOCUMENTS AND LINKS

Builders and others may find the following documents and links useful towards their implementation of the Photovoltaic Ready Guidelines:

CODES:

Canadian Standards Association. Canadian Electrical Code, Part 1.
http://shop.csa.ca/en/canada/landing-pages/2015-canadian-electrical-code-part-i-/page/cecode2015

National Research Council. National Building Code of Canada, 2005.
http://www.nationalcodes.ca/eng/nbc/index.shtml

CERTIFIED PRODUCTS LISTING:

Canadian Standards Association. Certified Products Listings
http://www.csagroup.org/services/testing-and-certification/certified-product-listing

SOLAR PV TEST AND INSTALLATION STANDARDS:

Canadian Standards Association. Solar photovoltaic rooftop-installation best practices guidelines SPE-900.
http://shop.csa.ca/en/canada/renewable-thermal-energy/spe-900-13/invt/27035492013

OTHER REFERENCES:

National Renewable Energy Laboratory. PV Watt Solar Energy Calculator.
http://pvwatts.nrel.gov

Natural Resources Canada. Comprehensive Energy Use Tables, Tables 39, 40, 42, and 43.
http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_ca.cfm

Natural Resources Canada. Photovoltaic Potential and Solar Resource Maps of Canada.
http://www.nrcan.gc.ca/energy/renewable-electricity/solar-photovoltaic/14390

Natural Resources Canada. National Survey Report of PV Power Applications in Canada, 2014.
http://www.cansia.ca/uploads/7/2/5/1/72513707/national_survey_report_of_pv_power_applications_in_canada_2014.pdf

International Solar Energy Society. Spatial insolation models for photovoltaic energy in Canada, Solar Energy Journal, Volume 2, Number 11, 2008.
http://www.sciencedirect.com/science/article/pii/S0038092X08000996

IV WHAT HOMEOWNERS CAN EXPECT FROM PHOTOVOLATIC (PV) READY HOME

The Photovoltaic Ready provisions will simplify and lower the cost of the future installation a photovoltaic system, within the allocated roof area.

- Homeowners can expect a roof space, clear of obstructions, which will facilitate the future installation of a PV array that is sized to offset a significant portion of the annual energy usage of their Photovoltaic-Ready home.
- Homeowners can expect to save about 50% on the installation of a photovoltaic system mounting system in a home built Photovoltaic Ready versus a standard home. (Assumes the PV-Ready house includes Solar Ready Trusses, while retrofit requires additional structural support added to standard trusses).

The following paragraphs provide an example of the anticipated performance of an installation as per the Photovoltaic Ready Guidelines. Installed system performance may vary according to, among other factors, allocated roof space, site location, system type and size and household energy usage.

SOLAR PHOTOVOLTAICS – PUT IN PERSPECTIVE

Canada has an average solar PV potential is about 1195 kWh (4.3 GJ) / kW_{peak} (Source: Solar Energy Journal, Vol. 2, No. 11, 2008). For location specific resource details, consult Section III Part 7.

Assuming a roof space allocation of 4.8m by 10.6m (i.e. ~51m^2) for a Photovoltaic Ready house, the installation of 8.4 to 9.8 kW of solar PV modules is possible (e.g., thirty 280-325 Watt PV modules of about 1.05m (3.4') x 1.6m (5.2') each).

At optimal tilt and orientation (south facing; tilt equal to site latitude), this represents an average system output from the Photovoltaic Ready roof space of 10040 to 11650 kWh (36.1 to 41.9 GJ) annually, based on average weather conditions for urban centres across Canada (Source: See Section III Part 7).

The average Canadian household in a newly constructed home annually uses about 61 to 100 GJ of energy for lighting, appliances and space conditioning depending on the energy performance rating of the new home as shown in the middle three columns of the following table (Source: See Section III Part 7). The right-hand column shows the average energy usage of thirteen recently constructed *Net-Zero Pilot Homes* located across Canada. These detached homes had additional energy upgrades resulting in an average annual energy usage of 36 GJ.

New House Energy Performance Rating >	New Basic house	New Energy Star™ house	New R2000™ house	R2000™ Net-Zero Energy Pilot house
Household Annual Energy Usage >	100 GJ	77 GJ	61 GJ	36 GJ
Energy Production from PV Array >	36.1 to 41.9 GJ	36.1 to 41.9 GJ	36.1 to 41.9 GJ	36.1 to 41.9 GJ
Annual Energy Usage provided by PV >	36% to 42%	47% to 54%	59% to 69%	100% to 116%

The energy production of the PV array installed on this example PV-Ready home would be sufficient to cover approximately 36 to 69% of the total household annual energy usage, depending on the energy performance rating of the new home and the peak power output of the installed PV array.

In the case of the *R2000 Net-Zero Energy Pilot house*, this PV array would meet or exceed the average annual energy usage of the household.

LOADING: *Structural loading considerations are outside the scope of the Photovoltaic Ready Guidelines. Homeowners should be aware that, depending on the solar system they choose to install, structural reinforcements of the roof may be needed. Homeowners should consult their builder, solar installer or local building code authority for potential structural implications of having solar systems installed on their Photovoltaic Ready home.*

V PHOTOVOLTAIC (PV) READY CHECKLIST AND BUILDER'S DECLARATION

Each of the following specifications should be completed by the builder in according to Section II of the Photovoltaic (PV) Ready Guidelines.

NOTE: Builders may wish to consult with local building authorities for guidance on issues associated with installing photovoltaic (PV) systems on roof structures.

1. On the Roof	Completed
Roof orientation and mounting angles: Area 1:_____ azimuth ***(degrees)*** _____ slope ***(degrees)*** Area 2:_____ azimuth ***(degrees)*** _____ slope ***(degrees)*** Area 3:_____ azimuth ***(degrees)*** _____ slope ***(degrees)***	☐
Unobstructed, unshaded roof space for PV system: Area 1: _____ m^2 or ft^2 *(circle one)* Area 2: _____ ***m^2*** or ***ft^2*** ***(circle one)*** Area 3: _____ ***m^2*** or ***ft^2*** ***(circle one)*** Total Area: _____ ***m^2*** or ***ft^2*** ***(circle one)***	☐
Roof structure design will support additional loads associated with the PV system	☐
Roof access areas and pathways should be included in the roof plan where recommended	☐
2. Solar PV Conduit	
Minimum one solar PV conduit sized 3.8 cm / 1-1/2" run to the electrical service panel location ***(Conduit with bends/elbows greater than 45 degrees has a nylon pull-rope installed for future convenience)***	☐
3. Termination of Conduit	
Electrical panel area workspace, conduit capped ***(account for pull-rope if present)***	☐
Check one of: Attic termination workspace, conduit capped ***(account for pull-rope if present)***	☐
or Roof termination workspace, conduit capped ***(account for pull-rope if present)***	☐
4. Space / Electrical	
Designated wall space provided for PV inverter	☐
5. Code Compliance	
Electrical Safety Code and Building Code Inspections Passed	☐
6. Identification of Components	
PV Ready components identified in drawings and labelled on-site	☐

7. Declaration, Name & Signature

I hereby confirm that the PV Ready upgrades have been installed in this house according to Section II of NRCan's Photovoltaic Ready Guidelines

Home Address	City, Province, Postal Code
Name	Signature
Company Name	Date (yyyy-mm-dd)

Note: Builders should leave a copy of the final two pages of NRCan's Photovoltaic Ready Guidelines (Sections IV and V) with the homeowner.

Appendix I: Descriptions of Figures

Figure 1. Specifications for roof space, orientation and mounting angle of solar PV modules:

- Roof space allocation for photovoltaics sized to potentially achieve annual net-zero energy budget.
- The area should be unobstructed (clear of chimneys, roof vents, skylights, gables and other protrusions).
- Roof plan should include access areas and pathways.
- Optimal orientation of the allocated roof space is south facing.
- Orientations ranging from East to West facing will also work well.
- Optimal solar collector angle is equal to site latitude (figure shows 12/12 pitch (45°) as an example).
- Mounting angles of less than site latitude are discouraged due to implications of snow build up.
- Common roof pitches of between 5/12 to 18/12 (23° to 56°) will also work well.

Figure 2. Specifications for shading considerations of solar PV systems:

- The builder should ensure (through visual site inspection) that the roof area allocated for the photovoltaic system will not be significantly shaded by surrounding buildings/mature trees at any time in the year.

Figure 3. Gable Roof Access and Pathway Requirements:

- A 91.4 cm (36”) roof access area between roof ridge and top of array on each roof face with PV modules.
- Two 91.4 cm (36”) wide clear pathways from roof ridge to eave on each roof face with PV modules.

Figure 4. Hip Roof Access and Pathway Requirements:

- A 91.4 cm (36”) Roof access area between roof ridge and top of array on each roof face with PV modules.
- At least one 91.4 cm (36”) wide clear pathway from roof ridge to eave on each roof face with PV modules.

Figure 5. Hip-and-Valley Roof Access and Pathway Requirements:

- A 91.4 cm (36”) Roof access area between roof ridge and top of array on each roof face with PV modules.
- At least one 91.4 cm (36”) wide clear pathway from roof ridge to eave on each roof face with PV modules.

Figure 6. Solar PV conduit specifications:

- One 3.8 cm (1-1/2”) continuous conduit is recommended for future solar PV system wiring (elbows ok).
- Solar PV conduits with bends or elbows greater than 45 degrees should have a nylon pull-rope installed.

Figure 7. Workspace specifications for attic termination of Solar PV conduit:

- Allow 45.7 cm (18”) vertical distance between the conduit(s) ends and the underside of the roof sheathing.
- Conduit(s) runs should terminate at least 15.2 cm (6”) above the attic insulation.
- Conduit(s) should be properly sealed around attic penetration(s) and capped to maintain home air tightness and fire ratings.

Figure 8. Allocation of Wall Space and termination of the Solar PV conduit adjacent to the Electrical Panel:

- A 91.4 cm x 91.4 cm (36” x 36”) wall space for future solar PV inverter and connection hardware.
- Solar PV penetrations through the electrical room ceiling should be sealed around the penetrations and capped to maintain home fire ratings.
- Minimum workspace specifications include:
    - 15.2 cm (6”) of horizontally accessible workspace on one side of the solar PV conduit
    - 5 cm (2”) of vertically accessible workspace underneath the solar PV conduit