Natural Resources Canada
Ressources naturelles Canada

SOLAR ready GUIDELINES

for solar domestic hot water and photovoltaic systems

TABLE OF CONTENTS

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I. INTRODUCTION & KEY BENEFITS

The Solar 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 system. The design considerations and modifications include the following elements: roof space, SDHW and solar PV conduits, plumbing connections to an existing hot water heater, an electrical outlet, mechanical room floor space and mechanical / electrical room wall space. Structural loading considerations are not addressed explicitly 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 system in the future. The Solar Ready Guidelines are specifically targeted towards the installation of solar domestic hot water systems (SDHW) and/or solar photovoltaic systems (solar PV) as tested and/or certified according to Canadian Standards Association (CSA) relevant test standards; and as installed by certified installers. For more information on relevant CSA test standards and certified installers, see Section III, Part 8.

See Section IV for an explanation of the anticipated performance of SDHW and/or solar PV systems for homes built Solar Ready.

This Guideline is intended to help increase builder and consumer awareness of the opportunity solar energy affords.

A SOLAR READY HOME BENEFITS:

- Homeowners, by enabling them to save money on the installation of a future SDHW and/or solar PV 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 solar energy systems.

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

SOLAR READY BACKGROUND: *Natural Resources Canada partnered with the Canadian Solar Industries Association to develop the technical specifications of these Solar Ready Guidelines, while builder-led pilot projects provided an opportunity to demonstrate the Solar Ready concept. The pilot projects found that a few simple and inexpensive design modifications made "up front" in the design and construction phase of a new home would enable homeowners to save significantly on the future installation costs of a complete SDHW system.*

II. TECHNICAL SPECIFICATIONS

SOLAR ready GUIDELINES for solar domestic hot water and photovoltaic systems

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 at least 3.7 m (12') x 3.0 m (10') of unobstructed area (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);

1.2 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;

1.3 ensure the roof area identified in 1.1 is located below the roof ridge (of a sloped roof), does not extend beyond the roof edges and is located above the wall line (away from overhang areas);

1.4 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 Solar 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 solar 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 solar systems on roof structures.*

2. PV Conduit

2.1 To prepare for Solar PV, one solar PV conduit of at least 2.5 cm (1") 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 continuous from an accessible attic or roof location to the designated wall space for the PV electrical hardware (continuous, straight as possible; bends / elbows will be fine). **Reference: PV and the Electrical Code, CanSIA, 2004, Section 8.8**

3. SDHW Conduit(s)

3.1 Ideally, two 7.6 cm (3") nominal diameter, or a minimum of two 5.1 cm (2") nominal diameter, or one 10.2 cm (4") nominal diameter conduit(s) that run straight and continuous (very slight bends are acceptable; elbows are not) should be installed from an accessible attic or roof location to a designated location (as close as possible to the floor space allocated in 5.5) in the mechanical room and securely fastened. The conduit(s) should be installed entirely within the home envelope (except for the roof termination if applicable).

3.2 Pipe conduit materials should be chosen with consideration of the maximum temperatures and pressures encountered in SDHW systems (PVC pipe certified to ASTM D1785, Schedules 40, 80 or 120 will be suitable). **Reference: CSA Standard F383-08, Section 7.**

NOTE: *Most PVC conduits meeting ASTM D1785, Schedule 40, 80 or 120 have a maximum service temperature of 60°C (140°F) and a melting point of 93°C (200°F). These temperature ratings could be exceeded in cases involving the eventual installation of an evacuated tube SDHW system with conduit that runs through attic insulation. The scope of this concern is beyond that of the Solar Ready Guidelines. However, should this case be encountered or foreseen, it is recommended that the installer 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 solar pipe and the attic insulation.*

The choice of conduit number and size should be noted in the Solar Ready Checklist.

DESIGN EXCEPTION:

Where straight and continuous conduit(s) are not possible, builders may consider the installation of complete SDHW pipe runs according to the specifications outlined in Appendix 1, SDHW Pipe Runs.

4. Termination of Conduits

Attic (applicable where attics are present)

4.1A. Workspace should be allowed for around the termination of conduits in the attic; 15.2 cm (6") above the attic insulation while allowing about 45.7 cm (18") of vertical distance between the conduit(s)/solar pipe end(s) and the underside of the roof decking will be sufficient.

4.2A. As with all attic protrusions, solar PV and SDHW conduits terminating in the attic should be properly sealed around the attic penetration(s) and capped to maintain home air tightness and fire ratings.

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

4.1R. As with all roof protruding elements, solar PV and SDHW conduits 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 conduits, and capped to maintain air and water tightness. If the solar PV and SDHW conduits also pass through an attic, but terminate on the roof, the attic penetrations must be properly sealed to maintain home air tightness.
Reference: CSA Standard F383-08 Clause 9.1

Mechanical Room

4.1M. Solar PV and SDHW conduits must be properly sealed at the mechanical room penetration point and capped and sealed to maintain home fire ratings.

4.2M. As was the case in the attic, there should be workspace allotted around the termination point of conduits in the mechanical room. For the SDHW conduit(s), 10.2 cm (4") of vertical space between the termination point and any impeding element (e.g., basement I-beam); and 30.5 cm (12") of horizontal space in one direction will be sufficient to allow future installers to access the conduit and bend solar pipe runs as required.

4.3M. For the solar PV conduits, 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 wire through as required, will be sufficient.

5. Plumbing, Mechanical and Electrical

Plumbing Connections to Existing Domestic Hot Water Heater

The following applies to standard tank-type water heaters, instantaneous water heaters and boilers with domestic water heating loop. See Section III, Part 5, example 3 for plumbing connections to solar tank-type water heaters (e.g. drainback systems).

5.1. Two copper (ASTM certified) "tee" connections should be installed on the existing water heater's cold water inlet line.

5.2 One copper or bronze ball valve (ASTM certified) should be installed on the pipe between the "tees" and left in the "open" position.

5.3 Two copper or bronze ball valves (ASTM certified), left in the "closed" position, should be connected to both "tees" specified in 5.1 via a short length of copper pipe.

5.4 The two ball valves installed in 5.3 should be capped off to prevent flow-through if valves were to be inadvertently opened by the homeowner.

Floor space in Mechanical Room for Future SDHW Storage Tank

5.5 Floor space should be set aside in the mechanical room to allow for the future installation of a SDHW storage tank. 91.4 cm (36") x 91.4 cm (36") with a clearance height of 182.9 cm (72") with design load limits capable of supporting a minimum weight of 453.6 kg (1000 lb) located as close as possible to the existing domestic water heater, in such a way that an installed tank would not impede doorways, hallways and emergency exits and would not reduce access to appliances, plumbing or heating, ventilation and air conditioning equipment will be suitable.
Reference: CSA Standard F383-08, Section 6

DESIGN EXCEPTION:

Builders installing solar tank type water heaters for drainback SDHW systems (see Section III, Part 5, Example 3) should allocate an area above the installed tank or on a shelf or table next to the installed tank of 50.8 cm (20") x 50.8 cm (20") with a clearance height of 76.2 cm (30") capable of supporting a minimum weight of 74.8 kg (165 lb).

5.6 One 110 volt standard outlet should be installed/allocated to the SDHW system within 182.9 cm (72") of the area allocated in 5.5 (dedicated circuit not necessary).
Reference: Canadian Electrical Code, Part 1

Wall Space for SDHW / Solar PV Hardware

5.7 Wall space should be allocated in the mechanical room for the future installation of a SDHW controller, expansion tank (if required) and pump(s) and/or solar PV system inverter, controls and connection hardware: 91.4 cm (36") x 91.4 cm (36") will be suitable.

6. Code Compliance

6.1. Building, electrical and plumbing work should be completed in compliance with the most current versions of the National Building Code of Canada, the Canadian Electrical Code, Part 1 and the National Plumbing Code of Canada including provincial/municipal amendments where applicable. Refer to Section III, Part 8 of the Solar Ready Guidelines for a list of useful documents and links.

1. ON THE ROOF

Roof Space, Orientation and Mounting Angle

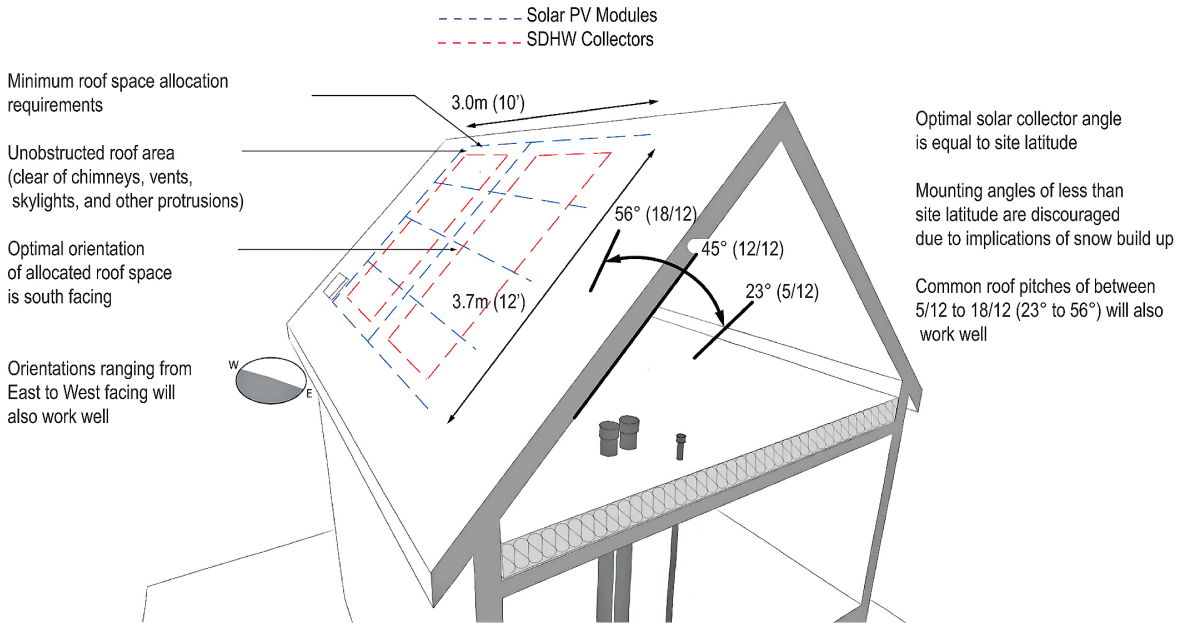

Figure 1: Roof space, orientation and mounting angle of SDHW collectors and solar PV modules

ROOF SPACE

In most residential applications, roof-mounted equipment is the most cost effective way to install solar energy systems. The roof space specifications for Solar Ready enable the rooftop installation of a minimum of: two 1.2 m (4') x 2.4 m (8') flat-plate solar thermal collectors (allowing 30.5 cm (12") of work space around each collector); or one evacuated tube collector consisting of about 30 tubes; or approximately eight 0.9 m (3') x 1.5 m (5') solar PV modules. Figure 1 describes the recommended roof space, orientation and mounting angle of the SDHW collectors and/or 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. Solar Ready shading considerations are described in Figure 2.

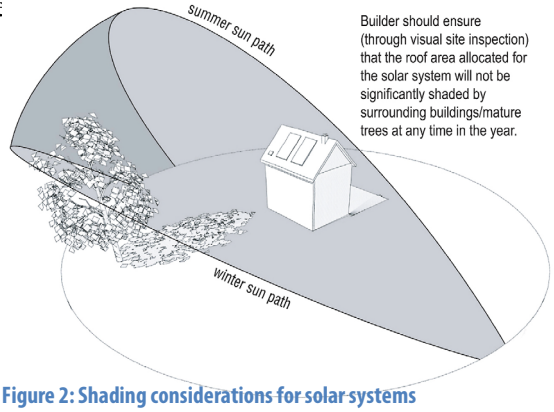

Figure 2: Shading considerations for solar systems

NOTE TO BUILDERS - LOADING

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

This commentary is provided to give builders a starting point from which to consider accommodating additional loads resulting from future solar system installations. A National Building Code Standing Committee is working to address the issue of installing solar systems. This section will be revised to reference their work once it is completed.

DEAD LOAD

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

When designing the roof structure to accommodate a solar system, an additional design dead load of 0.24 kPa (5 psf) accommodates the weight of SDHW collectors and/or solar PV modules as well as all mounting hardware and internal fluids 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), ballasted systems and/or SDHW systems incorporating the use of roof mounted storage tanks may incur additional loads beyond the 0.24 kPa (5 psf) dead load.

It is the installer's responsibility to both select and install a solar 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 Solar 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 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).

SDHW COLLECTOR / SOLAR PV MODULE MOUNTING ANGLE

From the standpoint of maximizing the annual solar energy collected, the ideal collector/module mounting angle is generally equal to site latitude. Builders can consult the Solar Resource Maps of Canada (see Section III, Part 8). Vertical mounting of solar collector/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 Solar 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.

SDHW COLLECTOR / SOLAR PV MODULE ORIENTATION

From the standpoint of maximizing solar energy collected, the ideal collector/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, Solar Ready recommends roof space orientations varying between east and west facing.

SEASONAL OPTIMISATION

Solar systems can be designed to perform best in summer or winter, depending on the intended use and site location. As most SDHW installations tend to "over-perform" in summer and "under-perform" 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, SDHW 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.

This same tendency applies to solar PV systems, however, since solar PV systems are typically intended to maximize summer output, steeper mounting angles may be less desirable.

Should builders wish to allocate wall space for the SDHW installation, they should first consult a solar professional and ensure compliance with CSA Standard F383-08, Clause 5.6.

2. SOLAR PV CONDUIT

Solar Ready suggests one solar PV dedicated conduit of at least 2.5 cm (1") diameter for a potential future solar PV system installation. For homes designed to accommodate larger solar PV system arrays or systems designed to use micro-inverters, builders may wish to install a 5 cm (2") diameter conduit. This conduit need not be straight, as wiring can be "snaked" around elbows. The solar PV conduit details are described in Figure 3.

3. SDHW CONDUIT(S)

Note: All SDHW conduit(s) should be installed entirely within the house envelope (except for conduits terminating on the roof).

The goal for SDHW conduits is to run a pair of conduits or one conduit from an accessible attic space or roof location straight to an accessible location in the mechanical room (terminating as close as possible to the hot water heater) to allow for the future installation of fluid lines, insulation around the fluid lines and sensor wires. Slight bends in the conduit(s) will work fine, but elbows may obstruct future installation of the fluid lines. Two 7.6 cm (3″) nom diameter pipes provide the greatest inst flexibility and space for insulation. The conduit details are described in Figure

In a two-storey home, the provision of wall that goes from the mechanical roo the attic will facilitate straight conduit Building plans may require some redesign to get a common stacked wall location. The stacked wall location should be designed such that it does not fall directly below a truss or terminate directly above an I beam. Workspace recommendations described in Section III, Part 4 have been devised to cover this aspect.

SDHW PIPE RUNS

Where the planned route for SDHW conduit(s) between the attic or roof space and the utility room will necessitate the use of elbows, the actual SDHW pipe runs between the attic or roof space and mechanical room should be installed. *See Appendix 1: Specifications for SDHW Pipe Runs for details.*

Builders should be aware that pre-installation of SDHW pipe runs may limit the selection of SDHW system types and suppliers at the time of purchasing a solar water heating system.

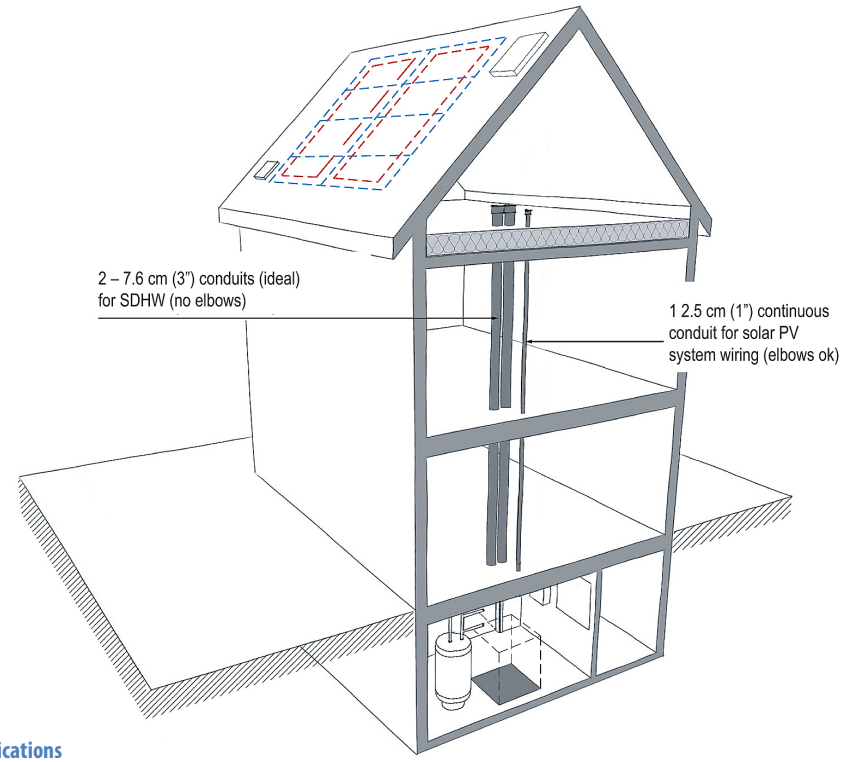

Figure 3: SDHW and solar PV conduit specifications

4. TERMINATION

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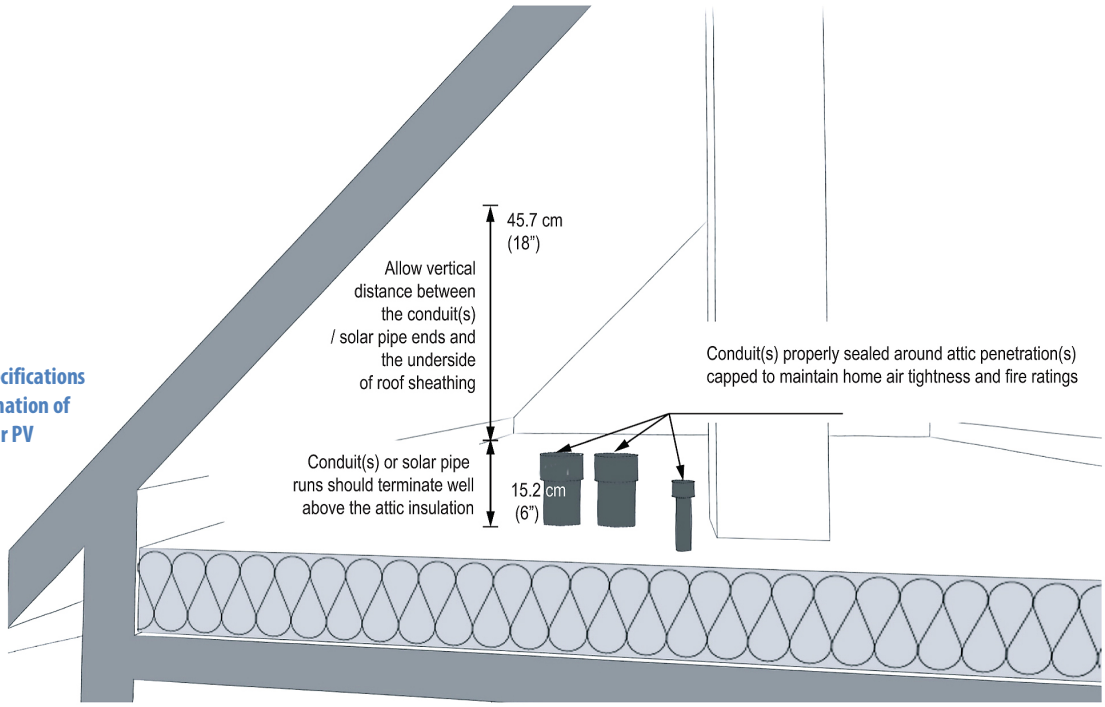

Figure 4: Workspace specifications for attic termination of SDHW and solar PV conduits

The optimal location of the roof protrusions needed for a future solar system is difficult to ascertain ahead of time. It is for this reason that termination in the attic is the preferred option. However, for situations where attic termination is not feasible (e.g., cathedral ceilings), roof terminations are also possible. For roof terminations, the builder should make every effort to locate the conduit protrusion(s) as close as possible to the perimeter of the allocated roof space.

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

Conduit terminations in the mechanical room should also be completed with sufficient surrounding workspace such that future SDHW or solar PV system installers will be able to readily access the conduit ends. See Figure 5 for guidance.

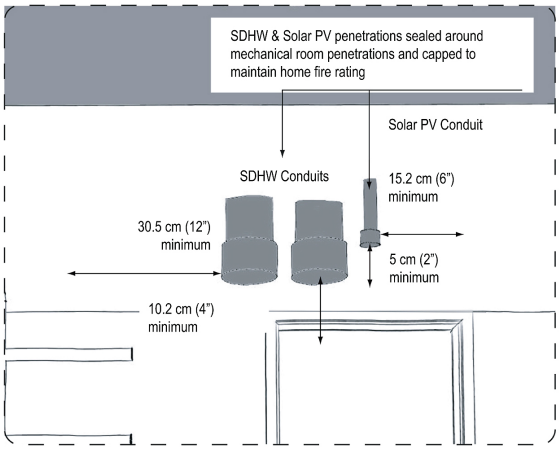

Figure 5: Workspace specifications for mechanical room termination of SDHW solar PV conduits

5. PLUMBING, MECHANICAL & ELECTRICAL

The existing domestic hot water heater may be a standard tank type water heater (as described in Figure 6); instantaneous water heater/boiler with domestic water heating loop (as described in Figure 7); or solar tank type water heater with drainback reservoir (as described in Figure 8).

EXAMPLE 1: PLUMBING CONNECTIONS TO EXISTING STANDARD TANK TYPE WATER HEATER

Builders should complete plumbing connections for Solar Ready to prepare the existing hot water heater for connection to a future solar tank. These connections are in addition to isolation valves and/or mixing valves that may be required by applicable codes. The builder should ensure ball valves (marked with a number 3 as shown) are installed in the "closed" position and capped (to prevent leaks if the homeowner inadvertently switches the ball valves to the "open" position). The ball valve marked with a number 2 should be installed in the "open" position.

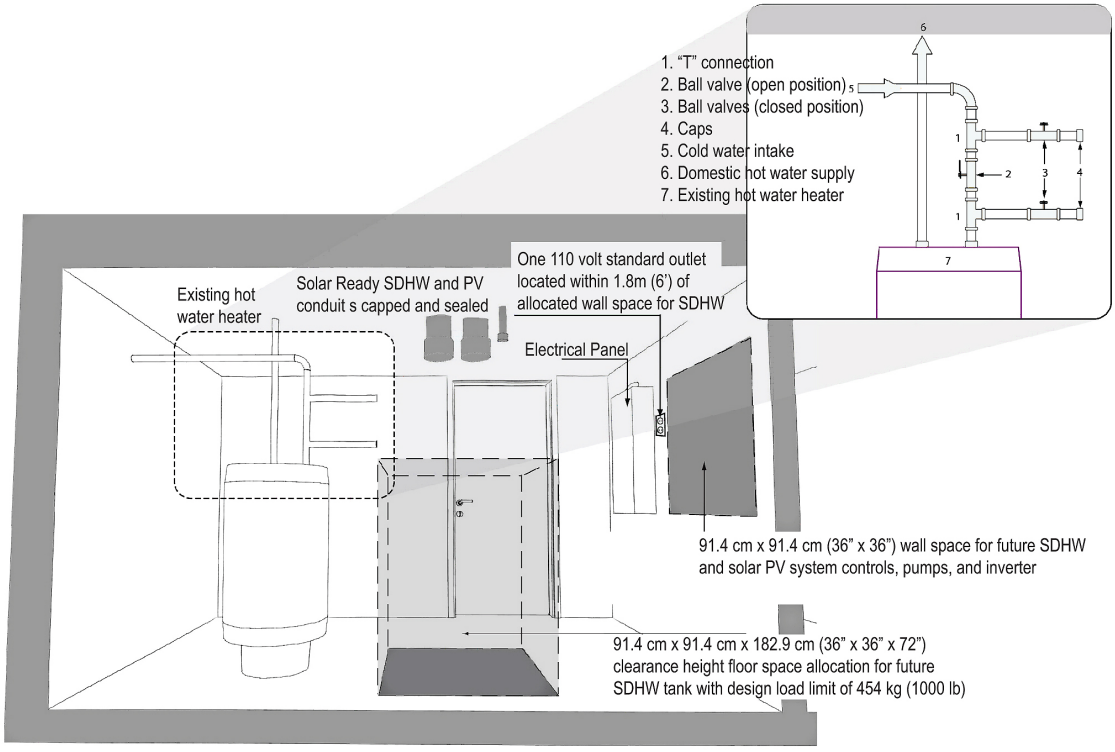

Figure 6: Plumbing, mechanical and electrical specificationsfor a standard tank type water heater

5. PLUMBING, MECHANICAL & ELECTRICAL

EXAMPLE 2: PLUMBING CONNECTIONS TO EXISTING INSTANTANEOUS WATER HEATER / BOILER BASED SYSTEM

This arrangement applies to instantaneous and boiler-based systems. In this case, builders should source systems that modulate firing rates according to incoming water temperature and allow flow-through without firing when preheated water is of a sufficiently high temperature. Condensing systems may be affected when operated in conjunction with solar preheating.

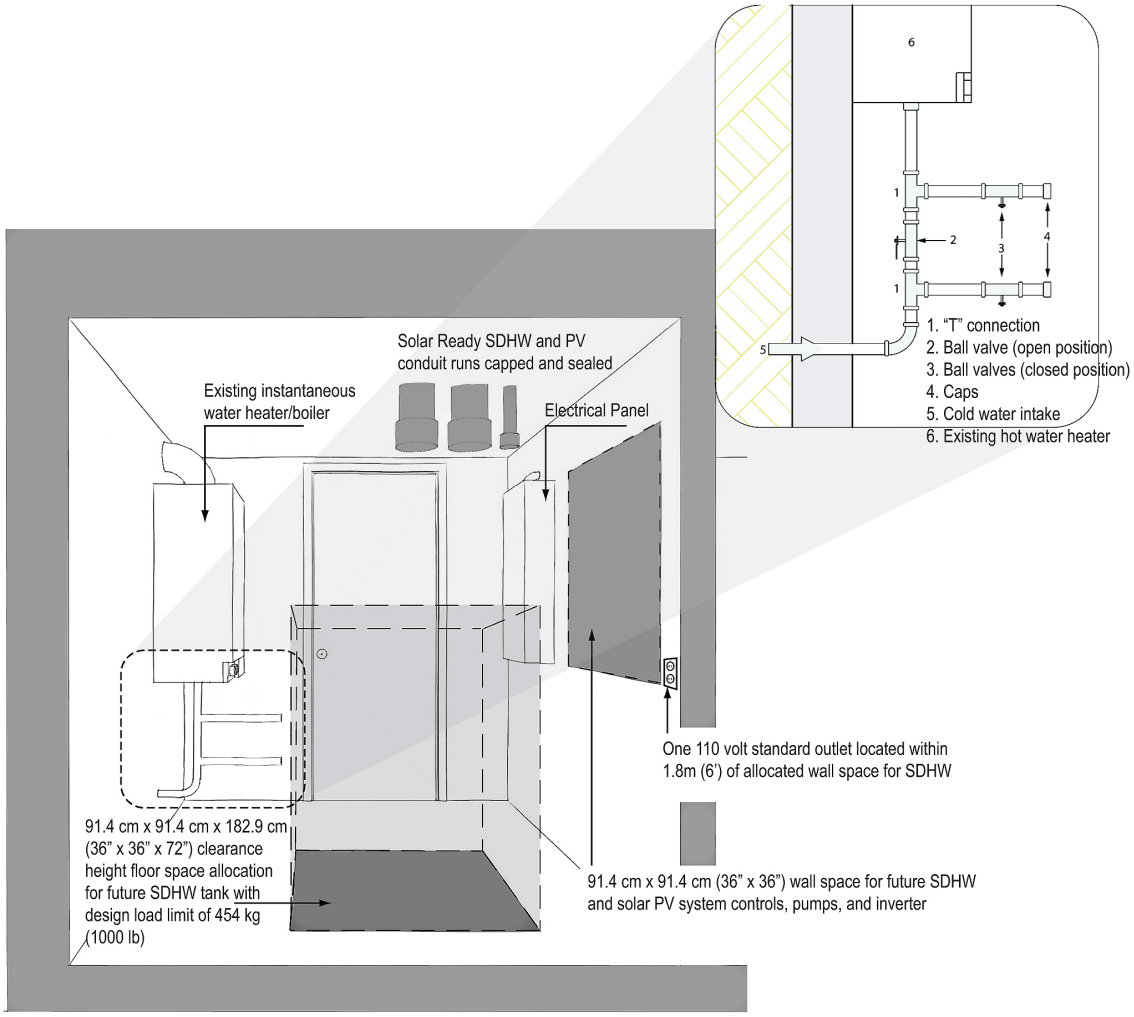

Figure 7: Plumbing, mechanical and electrical specifications for an instantaneous water heater/boiler with domestic water heating loop

5. PLUMBING, MECHANICAL & ELECTRICAL

EXAMPLE 3: PLUMBING CONNECTIONS TO EXISTING SOLAR TANK-TYPE WATER HEATER WITH DRAINBACK RESERVOIR

This arrangement applies to solar tank-type water heaters. Builders should note that this arrangement will require up front installation of a solar storage tank with two additional top or side ports for connection to an indirect solar loop.

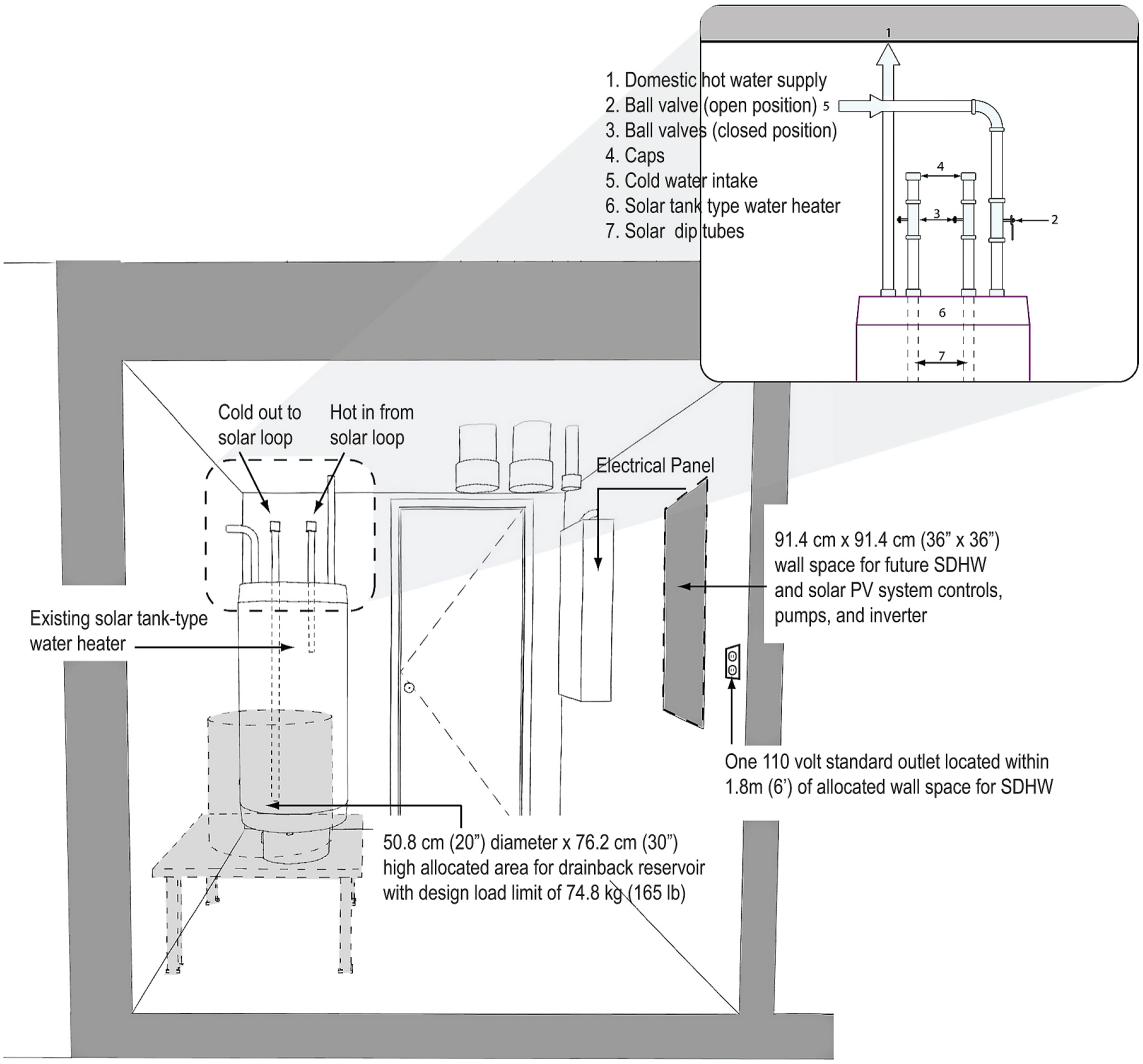

Figure 8: Plumbing, mechanical and electrical specifications for a solar tank-type water heater with drainback reservoir

5. PLUMBING, MECHANICAL & ELECTRICAL

FLOOR SPACE IN MECHANICAL ROOM FOR FUTURE SDHW SOLAR TANK

Builders should also allocate floor space with suitable design loads for the future solar tank as indicated in Specification 5.5. While the mechanical room in most homes will be located in a basement with cement/concrete floors, in some cases instantaneous water heaters/boilers with domestic water heating loops may be installed in a location other than the mechanical room. In these cases, builders should take extra precaution to ensure the chosen floor space can withstand the associated load. (Refer to Figure 6, Figure 7 and Figure 8 for system specific floor space specifications).

SDHW ELECTRICAL OUTLET

Most SDHW systems will require an electrical outlet for the pump or control operation. The builder should ensure a 110 volt receptacle is easily accessible (a dedicated circuit is not necessary).

WALL SPACE FOR SDHW/ SOLAR PV HARDWARE

Wall space should be allocated for the SDHW controller, pump(s) and pressure vessel (if required) as well as for the solar PV system controls and inverter hardware. (Refer to Figure 6, Figure 7 and Figure 8 for system specific wall space specifications).

6. CODE COMPLIANCE

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

7. IDENTIFICATION OF SOLAR READY COMPONENTS

PROVIDED BY THE BUILDER TO THE HOMEOWNER:

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

8. USEFUL DOCUMENTS AND LINKS

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

CODES:

Canadian Solar Industries Association. PV and the Electrical Code. Version 1.2. 2004.
http://www.cansia.ca
Canadian Standards Association. Canadian Electrical Code, Part 1.
http://www.csa.ca/cm/ca/en/standards/products/electrical
National Research Council. National Building Code of Canada, 2005.
http://www.nationalcodes.ca/eng/nbc/index.shtml
National Research Council. National Plumbing Code of Canada, 2005.
http://www.nationalcodes.ca/eng/npc/index.shtml

CERTIFIED PRODUCTS LISTING :

Canadian Standards Association. Certified Products Listings
http://directories.csa-international.org/directorymain.asp

SDHW AND SOLAR PV TEST AND INSTALLATION STANDARDS:

Canadian Solar Industries Association. CSA Standards.
http://www.cansia.ca/government-regulatory-issues/national-/-federal/csa-standards

SDHW SYSTEM CERTIFIED INSTALLERS:

Canadian Solar Industries Association. List of Certified Solar Hot Water System Installers.
http://www.cansia.ca/training-employment/cansia-certified-hot-water-system-installers

SOLAR PV SYSTEM CERTIFIED INSTALLERS:

Canadian Standards Association. Construction Electrician (NOC 7241) Solar Photovoltaic (PV) Systems (SPVC)
http://www.csa.ca/documents/pc/SPVC-Handbook-Application.pdf

OTHER REFERENCES :

National Renewable Energy Laboratory. PV Watt Solar Energy Calculator.
http://www.pvwatts.org
Natural Resources Canada. Comprehensive Energy Use Tables, Tables 39, 40, 42, and 43. 2007.
http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/trends_res_ca.cfm
Natural Resources Canada. Performance Directory of Solar Domestic Hot Water Systems.
http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/renewables/solar_thermal/sdhw_directory.html
Natural Resources Canada. Photovoltaic Potential and Solar Resource Maps of Canada.
https://glfc.cfsnet.nfis.org/mapserver/pv/index_e.php
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http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/renewables/standalone_pv/publications.html?2009-128
Natural Resources Canada. Solar Water Heating Systems, A Buyer's Guide. 2003.
http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/publications.html?ISBN:0-662-28486-0
Natural Resources Canada. Survey of Active Solar Thermal Collectors, Industry and Markets in Canada. 2008.
http://canmetenergy.nrcan.gc.ca/renewables/solar-thermal/publications/788
Natural Resources Canada. WATSUN Software for Performance of Residential Solar Water Heating Systems.
http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools.html

APPENDIX 1: Specifications for SDHW Pipe Runs

SOLAR ready GUIDELINES for solar domestic hot water and photovoltaic systems

NOTE: *This Solar Ready design exception requires the installer to have read and understood CSA Standard F383 in addition to completing the installation according to the following specifications:*

SPR 1. Two ASTM certified, drawn or annealed, Type M, L or K copper pipes or flexible tubes of 0.9 cm (⅜"),1.3 cm (½"), 1.6 cm (⅝"), or 1.9 cm (¾") nominal diameter, able to withstand a pressure of 10.3 bar (150 PSI) at a temperature of 170 ºC (338 ºF), should be installed from an accessible attic or roof location to a designated location in the mechanical room and securely fastened at regular intervals of at least every 1.8 m (6') to prevent tube sag when filled with fluid, and using fastening materials that will not corrode the copper pipes/tubes.

NOTE: *If flexible tubes are used, additional length of flexible line (that adheres to the applicable Specifications listed below) may be coiled up in the attic (and capped off) such that future SDHW system installers need only extend the coiled tube to connect to future SDHW collector(s).*

SPR 2. If 1.9 cm (¾") nominal size solar pipes (supply and return lines) are installed, they should be installed so that they will completely gravity drain, with a slope towards their beginning in the mechanical room of a minimum 1 in 50 slope or 0.6 cm (¼") vertical drop for every 30.5 cm (12") horizontal distance.
Reference: CSA Standard F383-08, Section 7.1.5

SPR 3. All solar piping should be pressure tested to 10.3 bar (150 PSI) for not less than 30 minutes.
Reference: CSA Standard F383-08, Clause 13.2.1

SPR 4. Upon successful completion of the pressure test (i.e., no leaks detected for 30 minutes), solar pipes should be insulated with insulation material having a minimum temperature rating of 105 ºC (221 ºF). If insulation types not specified by the manufacturer of a certified system are used for solar pipe runs that terminate on the roof, the last 1.8 m (6') of solar pipe should be insulated with insulation material having a minimum temperature rating of 170 ºC (338 ºF). All insulation material used should have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50 (as tested in accordance with CAN/ULC-S102). All insulation materials should be a minimum 1.3 cm (½") thickness. Insulation seams should be positioned so as to be located along the underside of the solar pipes.
Reference: National Building Code of Canada, 2005, Volume 1, Division B, Part 3, Clause 3.1.12 or local codes where applicable, CSA Standard F379-09, Clause 6.11.1 and CSA Standard F383-08, Clause 10.2.1, 10.2.3 and 10.4.1.

SPR 5. Sensor wiring (American Wire Gauge (AWG) 20, twisted pair, shielded is recommended) should not come in direct contact with the solar pipes and should be secured with strapping at intervals of at least one strap per 91.4 cm (36") of solar pipe run with at least 3.1 m (10') of extra length left coiled up in the attic, and enough additional wire length left coiled in the utility room to enable connection to the future solar storage tank.
Reference: CSA Standard F383-08, Clause 11.6

SPR 6. Solar pipe ends should be capped at both ends of the solar pipe run to maintain home fire ratings.

SPR 7. For solar pipe runs that penetrate the attic and terminate in the attic, or terminate on the roof, the attic penetration point should be properly sealed to maintain home air tightness and fire ratings.

SPR 8. For solar pipe runs that terminate on the roof, areas exposed to the ambient environment should be covered with conduit, the conduit should be capped, and the roof penetration point should be sealed and flashed.

SPR 9. The penetration point of solar pipe runs into the mechanical room should be sealed to maintain home fire ratings.

SPR 10. Workspace requirements for the termination of solar pipe runs should be completed according to Section III, Part 4, Figure 4 and Figure 5 of the Solar Ready Guidelines.

IV WHAT HOMEOWNERS CAN EXPECT FROM SOLAR READY HOMES

The Solar Ready provisions will simplify and lower the costs of the future installation, within the minimum allocated roof area and based on current technologies, of:

- Solar thermal collectors for a roof-mounted solar domestic hot water system (designed to provide about 50% of a typical family of 2-6 people's hot water needs)
  OR
- A 1.4 to 1.9 kilowatt roof mounted solar PV system to generate electricity
  OR
- Some combination of solar thermal and solar PV modules.

Homeowners can expect to save about $1000 on the installation of a SDHW system and/or solar PV system in a home built Solar Ready versus a home that has not been built Solar Ready. Note also that some provisions of Solar Ready may be useful for the future installation of solar systems used to generate hot water for heating or warm air for space heating.

The following paragraphs explain the anticipated performance of solar installations as per the Solar Ready Guidelines. Installed system performance may vary according to, among other factors, site location, system type and size and household hot water and electricity usage.

SOLAR DOMESTIC HOT WATER HEATING – PUT IN PERSPECTIVE

In Canada, an average solar domestic hot water heating system (sized to the needs of a family of four occupants) will produce about 2500 to 3000 kWh (9 to 10.8 GJ) of energy annually (depending on site location, system type and size and household hot water usage among other factors) (Source: See Section III Part 8). The average Canadian household uses about 5400 kWh (19.4 GJ) of energy for water heating (Source: See Section III Part 8).

Thus, the potential contribution of a SDHW system installed on the roof space allocated as per the Solar Ready minimum roof space requirements would cover about 50% of the annual energy required to meet the domestic hot water needs of the average Canadian household.

SOLAR PHOTOVOLTAICS – PUT IN PERSPECTIVE

Canada has an average solar PV resource of about 1150 kWh (4.1 GJ) / kW peak (Source: The Potential for Solar PV Power in Canada, presentation made at the CanSIA/NRCan PV Forum 2008). For location specific resource details, consult Section III Part 8.

With the minimum roof space requirement of Solar Ready, the installation of 1.4 to 1.9 kW of solar PV modules is possible (e.g., eight 180-235 W modules of about 0.9m (3') x 1.5m (5')). At optimal tilt and orientation (south facing, and tilt equal to site latitude), this represents an average system electrical output of the Solar Ready roof space of at least 1500-2000 kWh (5.4 to 7.2 GJ) annually (based on average weather conditions for urban centres across Canada, with a system derate factor of 0.77 (Source: See Section III Part 8). The average Canadian household uses approximately 6000 kWh (21.8 GJ) of electricity for lighting and appliances annually (Source: See Section III Part 8). Thus, the electrical production of solar PV modules installed on the minimum roof space allocated as per Solar Ready roof space requirements would be sufficient to cover approximately 30% of annual household lighting and appliance electricity use.

LOADING: *Structural loading considerations are outside the scope of the Solar 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 Solar Ready home.*

V SOLAR READY CHECKLIST & BUILDER'S DECLARATION

SOLAR ready GUIDELINES for solar domestic hot water and photovoltaic systems

Each of the following specifications should be completed by the builder.

COMPLETED	SOLAR READY CHECKLIST (Items below should be completed by the builder according to Section II of the Solar Ready Guidelines)
☐	**1. On the Roof**
☐	Orientation and mounting angle
☐	Unobstructed roof space
☐	**2. Solar PV Conduit**
☐	Solar PV: one conduit of 2.5 cm (1")
☐	**3. SDHW Conduit**
☐	SDHW conduit(s) must be installed within home envelope
Check one of:	**Conduits**
☐	SDHW: two 7.6 cm (3") conduits **OR**
☐	SDHW: two 5.1 cm (2") conduits **OR**
☐	SDHW: one 10.2 cm (4") conduit
OR	**OR**
☐	**SDHW Pipe Runs**
☐	**4. Termination of Conduits**
☐	Mechanical room workspace, conduit ends capped
Check one of:	
☐	Attic termination workspace, conduits capped and sealed
	OR
☐	Roof termination, conduits capped, sealed and flashed

NOTE: *Structural loading considerations are outside the scope of the Solar 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 solar energy systems. Builders may wish to consult with building code authorities for guidance on issues associated with installing solar systems on roof structures.*

COMPLETED	SOLAR READY CHECKLIST (Items below should be completed by the builder according to Section II of the Solar Ready Guidelines)
☐	**5. Plumbing, Space and Electrical**
☐	SDHW electrical outlet
☐	SDHW and solar PV wall space
☐	SDHW floor space
☐	**6. Code Compliance**
☐	**7. Identification of Solar Ready Components**

NOTE: *Builders should leave a copy of the final two pages of these Guidelines (Sections IV and V with the homeowner*

I hereby confirm that (please print)

_____

(name of builder)

has installed a Solar Ready upgrade in this house according to Section II of NRCan's Solar Ready Guidelines.

Builder Representative

_____

_____

(signature)

Home Address (please print)

_____

_____

_____

Date _____

Solar Ready Technical Specifications developed by
Natural Resources Canada's CanmetENERGY, nrcan-rncan.gc.ca

Canada

Appendix II: Descriptions of Figures

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

- Minimum roof space allocation requirements include an area at least 3.7 m (12') x 3.0 m (10')
- The area should be unobstructed (clear of chimneys, roof vents, skylights, gables and other protrusions)
- 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 systems:

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

Figure 3. SDHW and solar PV conduits specifications:

- Two 7.6 cm (3") conduits are ideal for a future SDHW system (no elbows)
- One 2.5 cm (1") continuous conduit is recommended for future solar PV system wiring (elbows ok)

Figure 4. Workspace specifications for attic termination of SDHW and solar PV conduits:

- Allow 45.7 cm (18") vertical distance between the conduit(s) / solar pipe ends and the underside of the roof sheathing
- Conduit(s) or solar pipe 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 5. Workspace specifications for mechanical room termination of SDHW solar PV conduits:

SDHW and solar PV penetrations through the mechanical room ceiling should be sealed around the mechanical room penetrations and capped to maintain home fire ratings

Workspace specifications include:

- 30.5 cm (12") of horizontally accessible workspace on one side of the SDHW conduit(s)
- 10.2 cm (4") of vertically accessible workspace underneath the SDHW conduit(s)
- 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

Figure 6. Plumbing, mechanical and electrical specifications for a standard tank type water heater:

- An existing tank type water heater is shown with a "callout" to plumbing specifications. Plumbing work to be completed, in order of the flow direction of incoming water from the domestic cold water supply includes:
  - First, one "T" connection followed by a short length of tube with a ball valve and end cap (ball valve to be left in the closed position). This line is intended to allow flow of cold water to the cold inlet port of a future SDHW storage tank type water heater.
  - Following the "T", a ball valve is installed (ball valve to be left in the open position). This ball valve is intended to divert flow to a future SDHW storage tank type water heater.
  - Lastly, below the ball valve that has been left in the open position, a second "T" connection followed by a short length of tube with a ball valve and end cap (ball valve to be left in the closed position). This line is intended to allow flow of solar heated water coming from a future SDHW storage tank type water heater to the existing water heater.

Figure 6. (cont'd)

- SDHW and solar PV conduits protruding through the mechanical room ceiling are capped and sealed.
- A 91.4 cm x 91.4 cm (36" x 36") wall space for future SDHW and solar PV system controls, pumps and inverter
- One 110 volt standard electrical outlet located within 1.8 m (6') of the allocated wall space
- A 91.4 cm x 91.4 cm x 182.9 cm (36" x 36" x 72") clearance height floor space allocation for future SDHW tank with a design load limit of 454 kg (1000 lb)

Figure 7. Plumbing, mechanical and electrical specifications for an instantaneous water heater/boiler with domestic water heating loop:

- An existing instantaneous water heater/boiler is shown with a "callout" to plumbing specifications. Plumbing work to be completed, in order of the flow direction of incoming water flow from the domestic cold water supply includes:
  - First, one "T" connection followed by a short length of tube with a ball valve and end cap (ball valve to be left in the closed position). This line is intended to allow flow of cold water to the cold inlet port of a future SDHW system.
  - Following the "T", a ball valve is installed (ball valve to be left in the open position). This ball valve is intended to divert flow to a future SDHW storage tank.
  - Lastly, below the ball valve that has been left in the open position, a second "T" connection followed by a short length of tube with a ball valve and end cap (ball valve to be left in the closed position). This line is intended to allow flow of solar heated water coming from a future SDHW system to the existing water heater.
- SDHW and solar PV conduits protruding through the mechanical room ceiling are capped and sealed.
- A 91.4 cm x 91.4 cm (36" x 36") wall space for future SDHW and solar PV system controls, pumps and inverter
- One 110 volt standard electrical outlet located within 1.8 m (6') of the allocated wall space
- A 91.4 cm x 91.4 cm x 182.9 cm (36" x 36" x 72") clearance height floor space allocation for future SDHW tank with a design load limit of 454 kg (1000 lb)

Figure 8. Plumbing, mechanical and electrical specifications for a solar tank-type water heater with drainback reservoir:

- An existing solar tank-type water heater is shown with a "callout" to plumbing specifications. These specifications are outlined below.
  - A solar storage tank will have two top or side connections (in addition to the standard hot and cold connections) intended for connecting the tank to a drainback reservoir. Each of the two connections should have the following installed:
    - A short length of tube with a ball valve and end cap installed (ball valve to be left in the closed position).
    - One of these lines is intended to allow flow of cold water out of the solar storage tank to a future drainback reservoir. The second line is intended to allow flow of solar heated hot water from a future drainback reservoir to the existing solar storage tank.
  - A ball valve is installed on the cold water supply (ball valve to be left in the open position).
- SDHW and solar PV conduits protruding through the mechanical room ceiling are capped and sealed.
- A 91.4 cm x 91.4 cm (36" x 36") wall space for future SDHW and solar PV system controls, pumps and inverter
- One 110 volt standard electrical outlet located within 1.8 m (6') of the allocated wall space
- A 50.8 cm (20") diameter x 76.2 cm (30") high allocated area for a drainback reservoir with design load limit of 74.8 kg (165 lb)