C3 – Energy. Ideas. Change.

Edmonton's Energy Transition Plan

2.3.5 New Buildings – Solar Ready

January 31, 2014

2.3.5 NEW BUILDINGS – SOLAR READY

EXECUTIVE SUMMARY

Solar energy and the ability to have new homes ready to utilize solar technology will support future proofing individual homeowners, neighbourhoods and cities to be prepared when existing energy costs increase and solar technology becomes financially viable. To a small extent, it can go further to build resiliency by evolving neighbourhoods to be distributed energy nodes in a broader distributed network.

Enabling homes to be equipped to take advantage of solar technology requires considerably more than simply providing conduits and wiring that run from the attic to the mechanical room of the home. It is a great start to help enable the use of solar technology and is a considerable saving over a retrofit installation. However, if the house is shaded with vegetation or the roof is not well positioned, receiving sunlight is the ultimate requirement the potential energy available from the sun is reduced and the performance of any future system is compromised from the beginning.

This report provides references and insight into making homes solar ready from the technical, planning and regulatory perspective, because there is significant precedent from various jurisdictions in Canada, but in particular from the United States. In developing this report, we did not feel there was a list of recommendations or conclusions to provide, because, the approach taken by each jurisdiction is, in fact, custom to their circumstance. The City of Edmonton has considerable resources and references in this report to evaluate and determine: what is the best approach that will work best for its citizens and our market conditions.

There is one consideration that this research did point to. Broad based regulations to simply install solar supporting conduits (similar to the installation of central vac systems) will not be successful unless planning, zoning, and permitting aspects are developed concurrently or in advance of solar ready regulations. Current house siting will only work for 30% of homes: paying attention to roof lines and house orientation will increase the success of solar energy overall. Supporting a solar ready program with grounded regulations that developers and builders can support, combined with a rapid approval and permitting process supported with a public education (even demonstration) program, would have a much higher level of success and a lower level of frustration.

Supporting solar ready is worthwhile; because it broadens the energy system from centralized plants with large inefficiencies to individual homes where the energy is consumed. It is renewable, rather than carbon based, although carbon based electricity will remain for the foreseeable future as the base supply. Experience learned from many jurisdictions is demonstrating that a holistic approach to making homes solar ready is the best way to go. These experiences have shown that municipalities and even regions can be successful at advancing solar ready, but support from higher levels of government can propel the acceptance and success. It is important to continue to keep the channels of communication open so that if a cooperative and complimentary approach can be taken.

TABLE OF CONTENTS

INTRODUCTION TO SOLAR READY

‘Solar ready’, planning for the eventual installation of solar when designing a building minimizes the impact of the system cost in the long term. Solar ready modifications at the time of initial construction are low-to no-cost, while similar modifications can often be costly later in the building’s life unless incorporated into a major retrofit. The lifespan of houses being many decades, the continued construction of new houses that are incompatible with solar technology results in a significant barrier to the widespread adoption of solar technologies and the ability of homeowners and communities to ‘future proof’ themselves through flexible energy sources and delivery system options. While the economics for actually installing a solar system at initial construction may not be compelling, future costs of equipment could be lower, just as future costs of current energy sources could be higher. Solar ready allows building owners to take advantage of future solar options that offer good return on investment.

While there is one key difference – access to the sun is required – solar ready is similar in nature to the rough in of central vacuum systems. It requires the buy-in of builders and the support of an industry. The central vacum industry was very small before it became part of a standard offering by homebuilders. It became a standard offering because the industry created a standardized, low-cost rough-in kit that builders could install for minimal labour prior to drywall. In fact, where the rough-in has become such a ‘hidden’ part of a standard package, and homebuyers request the system be installed so commonly, many builders simply include central vacum as part of their standard offering.

Similarly, a standardized rough-in kit or procedure for solar ready can serve to lower the cost of a future installation by making it faster and easier, eliminating barriers to solar installations and aids market growth. Solar Ready allows building owners to take advantage of changing energy markets, offering flexibility as fuel costs rise and solar equipment prices go down.

Access to the sun – they key difference between a solar ready and a central vac rough in – requires some coordination between designers, builders, developers, and planners. At the planning stage, planners and developers need to consider the building orientation, the roof orientation, available roof space, roof material, and local ordinances that could impact the overall orientation and appearance of a house. In the design stage, wiring to accommodate photovoltaic (PV) and wiring and plumbing to accommodate solar hot water (SHW) systems must be addressed. Accessible space in the attic and in the utility or mechanical areas must be factored in, as well as increased roof loads.

Solar ready must also take into consideration building code requirements for fire and occupant safety, and ensure that conduit, piping and wiring that is pre-installed is code compliant, especially in two-family homes where fire separation is a key issue. Legislation and guidelines must reflect the prevailing standards for installation of solar equipment. It must also refer back to pertinent fire safety, plumbing, and electrical code requirements, and look forward to solar access and long-term solar rights.

SOLAR READY DEFINED

There is no uniformity to a definition of solar ready, or the scope to which ‘solar ready’ should be applied. At one level, it applies to minor changes in the design and construction of individual houses or buildings to ‘rough-in’ the necessary elements to accommodate a future photovoltaic (PV) or solar hot water (SHW) system. At another level, it applies to right-to-light legislation, zoning, code compliance and municipal policies relating to solar. Solar ready ‘rough in’ guidelines exist in the form of voluntary ‘green building’ programs for builders and developers to feature in their new house offerings, as one item on a picklist for energy efficient or sustainable house rating systems, and as a mandatory item for code-compliance in local building codes and ordinances.

For the sake of clarity in this report ‘solar ready’ (SR) will refer to the physical rough-in requirements in one or two family homes and any legislation, regulation or certification that pertains specifically to the rough-in requirements, and ‘Solar Readiness’ will refer to the broader range of issues around solar access, planning and zoning.

Net Zero Energy (NZE), refers to a building has been designed and built to produce as much energy in a year as it consumes, and Net Zero Energy Ready refers to a building that has been designed and built to a Net Zero Energy target but stops short of having the renewable energy production system installed.

THIS REPORT IS BROKEN OUT INTO THE FOLLOWING AREAS:

Solar Ready Guidelines – describes guidelines published by national agencies in Canada and the US, used by builders and referenced by building energy standard programs.

Solar Ready Programs – describes optional or voluntary and mandatory programs run by municipalities. These programs build on the guidelines noted above and often are part of a broader ‘solar readiness’ initiative.

Solar Ready Regulations and Legislation – describes bylaws, ordinances, regulations or code-compliance requirements for solar ready in new construction.

Solar Readiness – describes the broader issues related to successful solar policy and planning initiatives.

Discussion – Technical Issues (Installation Concerns, Industry Support, Hard Costs), Administrative issues (Soft Costs, Program Successes), Legislative/Code Issues, and solar ready in the broader picture of energy reduction and carbon mitigation. Some feedback from Alberta New Home Builders has been provided to illustrate the current designmeasures, operational issues and concerns they have (See Appendix 2)

SOLAR READY GUIDELINES

In their most basic form, Solar Ready guidelines address the need for adequate roof area, appropriate orientation to the sun with zero or minimal obstruction and shading, a direct route for conduit or piping from the roof to the utlity or mechanical area, and enough room to install the balance of system for photovoltaics or solar hot water, or both. These were the aspects addressed by the first iteration of Solar Ready guidelines. As solar ready was incorporated into builder's offerings through energy efficient and green building programs and standards, more complex guidelines were developed to address site planning, building form and massing, space planning, mounting strategies, structure, roof pitch and many other details that go into optimizing a building for solar at the planning stage – details that are difficult to work around once the buildings is constructed. Solar readiness guidelines, developed to support larger solar initiatives at the municipal or regional scale, address broader issues related to municipal ordinances and zoning issues.

In Canada, comprehensive Solar Ready Guidelines were developed by Natural Resources Canada in partnership with the Canadian Solar Industries Association. These guidelines encompass both PV and SHW. In the US, guidelines have been developed under the wing of the National Renewable Energy Laboratory (NREL) with funding from the Department of Energy (DOE), Solar America Communities program. The Solar America Communities program is focused on PV. The Renewable Energy Ready Homes (RERH) Specficiations developed by the US environmental Protection Agency (EPA). RERH is made up of a specification and a checklist to be used by a builder and project design team to assess and evaluate homes for solar. RERH is broken out into two distinct sets of specifications and checklists, one for PV and the other for SHW. In addition, the EPA had developed the RERH Site Assessment tool to determine the solar resource available to a proposed solar array location. A matrix summarizing the requirements of all three sets of guidelines (NRCan, NREL, EPA) is found at Appendix A.

Most municipal and regional programs reviewed for this project refer back to the guidelines developed by NRCan and NREL. Most building programs in the US, such as Energy Star for New Homes and the DoE Challenge Home Program, both delivered by the US Department of Energy, Energy Efficiency and Renewable Energy (EERE), reference the EPA developed Renewable Energy Ready Home guidelines. The Earth Advantage Net Zero Ready Certification and LEED for Houses Solar Ready credit reference the RERH guidelines as well.

Guidelines for roughing in for a future solar installation were first developed in Canada around 2004, when the Canadian Solar Industries Association (CanSIA) published a set of guidelines. In 2007, Natural Resources Canada (NRCan) partnered with CanSIA to develop technical specifications of the initial Solar Ready Guidelines. A 2008 builder-led pilot project funded by NRCan provided an opportunity to demonstrate the Solar Ready concept. The goals of this project were to work with an established production builder to explore the "real" challenges of implementing Solar Ready in a typical subdivision setting; to develop a comprehensive guide to implementing Solar Ready in a subdivision setting which reflects the inherent challenges and limitations of this type of development; and, to gauge consumer interest in Solar Ready and Solar Equipped Homes. The pilot project, run by a production builder in Southern Ontario, 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.

SOLAR READY TRUSS LOADING GUIDELINES (CANADA)

In conjunction with NRCan's Solar Ready Guidelines, a Solar Ready Truss design procedure was developed by the Truss Plate Institute of Canada (TPIC) in 2012 to overcome potential structural design concerns related to additional loads associated with solar collectors. The document explains building code compliance, describes roles and responsibilities, provides truss design requirements and procedures, approved attachment methods and recommended load cases. It is the responsibility of the builder who is providing a solar ready house to note that solar ready truss guidelines must be used when submitting plans to the truss designer.

Technical bulletin #7 establishes compliance with the National Building Code of Canada; the CSA O86, Engineering design in wood and TPIC design procedures. (TPIC)

MODEL GUIDELINES

The guidelines developed for the Twin Cities Solar Ready Requirements, while based on the NREL guidelines, have become a well-referenced resource for solar ready initiatives. Prepared in 2010 for the Minneapolis Saint Paul Solar Citys program, the guide is modified somewhat to help architects, engineers, contractors and clients understand and plan for PV and SHW. The companion document, Solar Ready Construction Specifications, documents the solar ready system so it can easily be incorporated during the construction process. The guidelines and specifications address two specific building types: urban new signle family and duplex houses with pitched roofs; and 1 to 4 storey flat roof structures (multi-family residential, commercial/office or mixed use buildings). The intended audience for these publications includes:

- Public agencies
- Neighbourhood organizations
- District councils
- Community Development Corporations
- Non-profit/for profit development community
- Owners, architects, builders and contractors.

The complete guidelines from NRCan, NREL and the EPA are available at the following URLs:

NRCan Solar Ready Guidelines and TPIC Solar Ready Roof Truss Guidelines
https://www.nrcan.gc.ca/energy/efficiency/housing/research/5141

NREL Solar Ready Guidelines
http://www.nrel.gov/docs/fy10osti/46078.pdf

EPA Renewable Energy Ready House Guidelines

Solar Hot Water Specification, Checklist and Guide
http://www.energystar.gov/ia/partners/bldrs_lenders_raters/rerh/docs/Renewable_Energy_SWH.pdf

PV Specification, Checklist and Guide
http://www.energystar.gov/ia/partners/bldrs_lenders_raters/rerh/docs/Renewable_Energy_PV.pdf

The model guideline and Construction Specification from the Twin Cities Solar Program are available at the following URLs:

http://mn.gov/commerce/energy/images/Solar-Ready-Building.pdf

http://mn.gov/commerce/energy/images/Solar-Ready-Construction.pdf

CANADIAN CASE STUDIES, PILOT PROJECTS AND SOLAR READY BUILDERS

Two Canadian projects stand out for establishing solar ready as a viable and inexpensive option for new construction.

Koo's Corner, Vancouver, finished in 2002, consists of a retrofit/infill project that produced 6 row-house units, one of which was fitted with a solar thermal system. The other 5 units were made solar ready. The $1.4 million project included a wide range of green features, adding about 2.3% to conventional costs. The solar ready costs amounted to $200 per unit. (CMHC1)

Doug Tarry Homes (London, Ontario) was the builder chosen to work with NRCan on the Solar Ready Pilot Project (2008). The builder included solar ready in 100 new houses in the first year, and has continued to include SR in all new construction, at a cost of $300 per house. (SRPP)

A partial list of Canadian builders who include solar ready in their standard offering and promote solar ready on their websites:

- Doug Tarry Homes (Ontario)
- Scotian Homes (Nova Scotia)
- Urbandale (Ontario)

A partial list of Canadian builders who offer solar ready as an upgrade to standard package:

- Tartan Homes (Ontario)

BUILDING ENERGY STANDARDS AND CERTIFICATION PROGRAMS

In Canada, the R-2000 Standard renewal allows for NRCan's solar ready guidelines to be used as specifications but does not reward or require Solar Ready. The Built Green Program (established in 2003) awards two points for solar ready homes (specific to SHW). A fully commissioned SHW system garners 4 to 8 points, depending on the solar contribution to the overall domestic hot water load. The 2012 Energy Star for New Houses program in Canada does not reference solar ready in documents reviewed for this report.

In the US, the Department of Energy's DOE Challenge Home Program, which evolved out of the Builder Challenge Program that was established in 2008, requires all homes built under the program to accomodate the future installation of both solar photovoltaic and solar thermal systems, based on the EPA RERH Specifications. (DoECH) Energy Star for New Houses (US) also references the RERH specifications.

The Earth Advantage (EA) Net Zero certification recognizes homes that generate as much electricity as they use over the course of a year. The EA Net Zero Ready certification is for homes that are built to be "ready" for renewable systems to be built at a later date. EA Net Zero Ready homes must meet the EPA's RERH guidelines. (EADV)

LEED for Houses gives Pilot-Credits (PC-72: Active Solar-Ready Design) to 'homes that prepare for future installation of either technology by meeting EPA's specifications for readiness.' (LEED)

The International Construction Code (ICC) 700 National Green Building Standard and the Living Building Challenge, both give points for utilizing renewable energy. Points allowable for Solar Ready were not included in the documents reviewed for this report. (SSORG)

SOLAR READY PROGRAMS

Solar Ready, as distinct programs or as part of holistic green buildings programs at the municipal or regional level, encourage or require homebuilders and developers to design and build solar-ready homes. This impacts all industry stakeholders from architects and planners to builders and roofers. These programs are outside of building code requirements.

The difference must be recognized between legislation that requires a solar ready option and solar ready legislation that mandates solar ready. (NREL2) Legislation that requires a solar ready option is geared to educating the homeowner about solar technologies and providing them with the information required to make a decision about the value of solar ready and future solar options.

The table below shows the range of types of municipal or regional programs that include solar ready. Some Jurisdictions in Canada, including London, Ontario, are including solar ready as part of their Official Plan Review as they develop a long-term Community Energy Action Plan. (COL) From the Plan:

> Incorporate in to the Official Plan Review means to encourage new homes and buildings to be "future-ready" through low-cost design principles (e.g., provide conduits) that can accommodate the future installation of electric vehicle charging systems (i.e., "EV-ready"), solar energy systems (i.e., "solar-ready") and district thermal energy loops (i.e., "DE-ready").

Table 2.3.5.1: Jurisdictions including Solar Ready in Building Programs

	Name	Description
Vancouver, BC	Green Homes Program	The Green Homes Program goal is for all new homes to be carbon neutral by 2020. Since 2008, every new one or two family house must be equipped with 2 – 50 mm pipes or a vertical service shaft that runs from the water heater area to the attic. **SR Mandatory**
York, ON	Sustainble Home Incentive Program (SHIP)	A two-year pilot program established in 2009, focusing on low-density residential green buildings. This incentive program used LEED for Homes (Canadian Version) as 3rd party verification. The minimal renewable energy requirement under the program was solar ready conduit from roof to mechanical room. **SR Optional**
Minneapolis/Saint Paul (Twin City Solar)	Solar America Cities Initiative	Solar ready guidelines (based on NREL guidelines) and solar ready construction specifications developed as part of a broader solar initiative including solar thermal district energy, state policy stakeholder workgroup, solar-friendly zoning and solar permittine processes. A solar energy ordinance was enacted in Minneapolis in 2010. A similar ordinance was enacted for Saint Paul in 2011. **SR Voluntary (Saint Paul) Mandatory (Minneapolis)**

	Name	Description
California	California Green Buildings Standard (CGBS Title 24, Part 11)	Residential voluntary measures for 'space for future solar installation' and 'future access for solar system'. Local jurisdictions can make GBSC (or portions) mandatory, but there are no specifics. (These regulations fall under Title 24, Part 11, Green Buildings Standard, which differs from Title 24, Part 11, also known as the California Energy Code.California has a goal of all new houses being Zero Net Energy by 2020). **SR Voluntary**
Tuscon, Arizona	Pima County Regional Residential Rating System	Homes are rated and awarded points for environmentally responsible criteria. Solar Ready qualifies for points. This no cost program is combined with the permit an inspection process. **SR Optional**
Boulder CO	Boulder Green Points Building Program	A5.211.4 outlines non-residential voluntary measures for 'prewiring for future solar'. **SR Voluntary**
Aspen/Pitkin County CO	Renewable Energy Mitigation Program	A Renewable Energy Mitigation Program (REMP) helps mitigate high energy consumption in new and existing houses. Essentially, REMPs are points-based code checklists that require homeowners to build within a specified energy budget. If the energy budget is exceeded, the homeowners is required to install renewable energy systems or pay a hefty fee ($5,000 to $10,000, depending on the living area of the house. This model has been replicated in several other Colorado jurisdictions and in Martha's Vineyard. Building permit is not issued without enough points. Solar ready measures are one choice for points, but percentage of homes that incorporate solar ready is low. **SR Optional**

SOLAR READY INCENTIVES

Currenlty, Energy Trust of Oregon offers funding for builders who are installing solar ready water heating and/or solar ready electric systems. The incentive is $200 per rough in, if a builder installs both technologies; the maximum incentive is $400. The incentive is limited to sites with a total solar resource fraction of 80 percent or above.

In 2008, a $200 rebate per home was available through Conserve Nova Scotia (closed in 2011, all energy efficiency programs taken on by new corporate entity, Efficiency Nova Scotia since that time). Uptake of the rebate was extremely low and it was discontinued by 2010.

SOLAR READY: CODES AND ORDINANCES

Where 'solar ready' programs can be voluntary or optional for builders, they can also be part of stand-alone regulations, or amendments to existing regulations in a range of departments within any level of government. However, they are typically not part of the local or regional building code until solar ready becomes established practice. For example, the Vancouver Green Homes Program (2008), included solar ready as a mandatory to new construction in Vancouver, but was incorporated into the City of Vancouver Building Code several months after the Green Homes Program was introduced. Similarly, in 2009, a bill was signed into Colorado law requiring builders to give homebuyers the choice of solar ready or installation of PV or SHW. It wasn't until 2013 that Boulder County updated the local building code to include solar ready requirements for PV and SHW in all new construction.

A quick look at other Canadian jurisdictions shows the 'ad hoc' nature of solar ready legislation.

- The BC Solar Hot Water Ready Regulation is a provincial regulation. While it is part of 'greening' the BC Building Code, communities can voluntarily adopt the regulation.
- While it was under discussion prior to the release of the Ontario Building Code 2012, the final OBC2012 version does not include solar ready requirements. (CHBA1)
- In 2013, CanSIA included Solar Ready as a non-financial recommendation to the Government of Québec, stating that the building code should be updated to require all new buildings to be solar ready in order to save money on future installations and promote the adoption of solar technologies. (CANSIA 3) Québec already supports solar thermal and photovoltaic systems for municipal and institutional buildings. (CANSIA 4)

SOLAR READY: A NORTH AMERICAN ISSUE

Solar Ready has been surpassed in most European jurisdictions, with solar obligations being part of local building energy standards and regulations in Spain (2006), Israel (1980), Germany (2009), and Portugal (circa 2007). Local jurisdictions in Italy and Ireland have also introduced solar obligations into building energy standards and regulations. According to the European Solar Thermal Industry Federation (ESTIF), solar obligations – regulations requiring that solar energy provide a minimum share of heating demand – are the single most powerful tool for promoting the use of renewables in new buildings. (ESTIF1)

Figure 2.3.5.1: Timeline of Jurisdictions Enacting Solar Ready Regulation

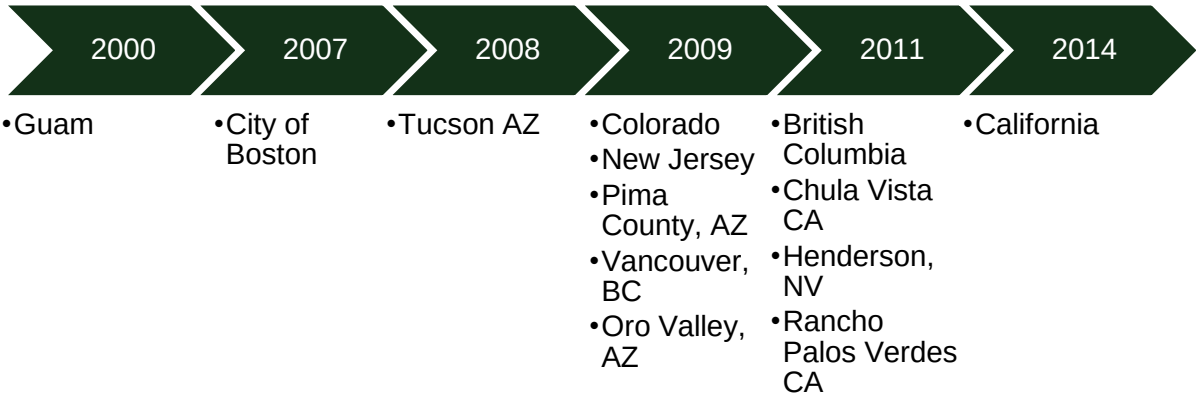


Table 2.3.5.2: Jurisdictions with Solar Ready Ordinances and Code Amendments

	Name	Description
British Columbia June 2011	BC Solar Hot Water Ready Regulation	Based on NRCan guidelines with specific requirements for installation standard and roof design loads. Requires all new residential construction to be solar ready once the regulation is adopted by a jurisdiction. The regulation applies to single-family homes with or without accessory secondary units. It is not required if it can be shown that the conditions are not conducive to solar hot water. As of January 2014, 36 communities in BC have adopted the regulation
York Region, ON	Modified York Region Official Plan	Article 5.2.26 in the Sustainable Buildings Section of the Plan states that development shall include a solar design strategy which identifies approaches that maximize solar gains and facilitate future solar instalaltions (ie, solar ready), with a reference to NRCan Solar Ready Guidelines.
US/Other		
California January 2014	California Energy Commission 2013 Building Energy Efficiency Standards	25% more efficient than previous standards for residential construction. Includes solar-ready roofs to allow homeowners to add PV in the future. (This is Title 24, Part 6, also known as the California Energy Code, which differs from Title 24, Part 11, Green Buildings Standard, where solar ready is one of many options for builders to choose from.)
Chula Vista, CA 2011	Municipal Code, Title 15, Buildings and Construction, (Section 15.24.065, Photovoltaic Pre-Wiring Requirments; Section 15.28.015, Solar Water Heater Pre-Plumbing	All new residential untis shall include electrical conduit specifically designed to allow the later installation of PV system. All new residential units shall in clude plumbing specifically designed to allow the later installation of a system that utilizes solar energy as the primary means of heating domestic potable water. No Building Permits will be issued without these requirements being fulfilled.
Henderson NV 2011	Development Code, Table 19.7.12-1 Menu of Site and Building Design Options for Sustainability, part 1.9: Solar Ready Design	For stand-alone buildings, design and build the project so that it will readily accommodate the installation of PV or SHW devices, including all necessary conduit, chases, roof penetrations roof pitch and orientation.

	Name	Description
Rancho Palos Verdes, CA 2011	Municipal Code, Title 15, Buildings and Construction, Section 15.04.070, Rewnable Eenrgy Systems	New homes and major remodels (>50% of existing interior/exterior walls removed) shall provide a roof layout plan that illustrates how a future PV or SWH system can be accommodated. Property owner is required to provide for installation of one system only. Photovoltaic Systems. Installation of conduit leading from an exterior south-facing, east-facing or west-facing roof, where a minimum of four hours of direct sunlight is achieved, to a stubbed junction box next to the electrical panel. All exposed conduit shall be capped and provided with adequate flashing. The conduit shall not be located on or in the direction of a north-facing roof. Roof reinforcements shall be addressed at the time of installation. Solar Water Heating System. Installation of three-fourths inch hot and cold copper water pipes from a south-facing, east-facing or west-facing roof, where a minimum of four hours of direct sunlight can be achieved, to an existing water heater/tank. Both ends of the three-fourths inch copper pipes shall be stubbed out and shall not be located on or in the direction of a north-facing roof. All exposed pipes shall be capped and provided with adequate flashing. Roof reinforcements shall be addressed at the time of installation.
Oro Valley, AZ 2009	Ordinance No (O)09-11, Amending Chapter 6, Article 6-1-7, to add'Residential Solar Ordinance"	All one and two family residences shall install sleeves, conduits, water stub-outs, root-to-water ehater space conduit or other connections required for the future connection of solar systems. Space near service equipment for PV controls, and electrical service quipment to be sized and space provided so that one 240V circuit breaker may be backfed from a PV system. Rough in for both PV **and** SHW required
Colorado May 2009	HB1149	Requires builders to offer solar as standard feature to all prospective buyers of single family homes. Builders are required to give the buyer the option of either a PV system or a SHW system installed or roughed in. Also, HB-1270 revised existing law so installation of renewable energy or energy efficiency equipment cannot be prohibited by homeonwers associations or common interest communities (CICs)
New Jersey March 2009	Solar Energy Option Requirement for Residential Developments NJ//P.L. 2009, Chaper 33/3	Legislation requires 'wherever technically feasible', developments with 25 or more single family dwelling units must offer to install or provide for installation of solar system during negotiations with prospective purchaser. Developers are required to disclose option on advertising materials and must include information on system costs, energy savings and incentive programs

	Name	Description
Tucson AZ June 2008	Solar Design Requirement for Homes	Requires all new single family homes and duplexes to be solar ready. Option 1 requires two capped insulated pipes and a conduit from water heater area through roof. Option 2 requires conduit only, but there must be a straight line from water heater area to roof. Must also be a minimum 3,800 volt-ampere PV electrical load entry on service load calculation and an Electrical Panel Schedule with a 240-V circuit breaker space labeled 'reserved for photovoltaic'
City of Boston 2007	City of Boston Department of Neighbourhood Development (DND)	DND coordinates the construction of affordable housing units and since 2007, has required all affordable housing development be built to NREL solar ready guidelines. Solar ready incorporated into DND housing through Green Affordable housing Program (GAHP) as part of $1.8 million grant.
Carbondale, AZ 2007	Municipal Code Chapter 15.30 Residential Efficient Building Program	The Carbondale Energy Plan outlines the desire of the community to construct buildings in a more environmentally responsible and energy efficient manner, which includes energy efficiency and renewable energy provisions. Subsection 6.2 deals with mandatory rough in for future PV (electrical conduit) and SHW (2 runs of copper pipe) systems.
Marin County CA	Marin County Code 19.04.100	All new residential construction must include plumbing and electrical conduit specifically designed to accommodate the easy installation of solar water heaters and PV systems.
Guam October 2000	Solar Ready Residential Building Requirement	Mandates piping stub-outs be provided for water heaters installed in low-rise residential buildings.

THE BC SOLAR HOT WATER READY REGULATION

The BC Solar Hot Water Ready Regulation (SHWRR) was created in 2011, as a provincial building regulation applicable to single-family homes to 36 municipalities could 'opt-in'. As noted in the minutes from a public meeting held by the City of North Vancouver in regards to the SHWRR in June 2010, the opt-in process has been used successfully before by the BC Building Code, with a Toilet Regulation. (CNV) The SHWRR includes single-family homes and single-family homes with secondary suites only.

The regulation was updated in June 2013 to clarify some technical requirements and add 12 local goverments to the list of jurisdictions with the opportunity to adopt the regulation. The technical upgrades focused on amendments to Section 4, regarding loading requirements for stick-frame roofs and point loads for truss roofs. BC Housing notes that taking the roof loading aspects into consideration saves significant costs when the homeowner does elect to install a SHW system after intiial construction.

The SHWRR was designed to provide consistency in regulation across the province yet allowing local governments to adopt provisions that work for their community. The SHWRR recognizes that noe all communities will benefit from solar installations, but supports flexible and sustainable innovation and 'future proofing' of housing stock.

Similarly, the Berkeley, CA specifications for solar readiness include a note about exemptions for sites with poor solar resources, (COB)

At the 2010 public meeting in the City of North Vancouver that dealt with the SHWRR, the question arose about why the Regulation only covered new single-family homes and not duplexes or other residential units. The answer from the planner in attendance at the meeting focused on the fact that because many low-density attached forms of housing have to go through rezoning and variances, the projects often come in front of Council and Council could request that the low-density projects include solar ready as part of the rezoning or variance resolution. It was noted that most single family homes do not require rezoning or variances, and simply follow the BC Building Code, so adopting the regulation put solar ready into all single family homes. (CNV)

TUCSON SOLAR READY ORDINANCE

In 2009, two separate ordinances were enacted for solar ready: one for PV and the other for solar hot water. Tucson had a strong solar position prior to the ordinances being enacted – Tucson was recognized by the US DoE as a Solar City in 2007, primarily through the city's push for large-scale solar installations. While the municipality is focused on creating more large-scale solar projects, the appropriate framework is in place for small-scale, consumer-scale projects as well. The ordinances state that all new single family homes or duplexes include:

- At least a site plan for a PV installation in order to receive a building permit. The site plan must identify the best locations for PV system, provide a strong enough roof structure to support the system, show an electrical load calculation and include a labeled electrical panel with a 240 volt circuit breaker.
- At least a stub out for a SHW system, if not a complete system. The water heater area must include a reserved 120V electrical outlet and have sufficient floor area for an 80 gallon water heater, an expansion tank and a heat exchanger. (NREL3)

BROADER CODE-BASED ISSUES NOT ALWAYS ADDRESSED BY SR ORDINANCES

Code-based issues include fire safety and roof loads. Roofs must be designed to accommodate properly installed collectors, or at least be warranted to accommodate them. This must be reflected in solar ready programs and regulations to ensure that roof warranties are not void.

The BC SHWRR Section 4 addresses roof loads as follows:

> Subsection 1 describs additional loading requirements for stick framed roofs (roof joists or rafters) and other structural members. Assuming the solar collector will bear directly on the roof, an additional uniform load of 0.24 kPa is required in the design of the designated roof area that will hold the solar collector. If it is known that the collectors will

sit on racks or brackets, point loads must also be considered, an engineer will be required to calculate point loads, as Part 9 of the building code does not accommodate point loads.

Subsection 2 describes additional loading requirements for roof trusses that are outlined in the Truss Plate institute or Canada (TPIC) Bulletin #7 (March 12, 2012). While the crietera in the bulletin is designed for the NRCan Solar Ready program, which requires a larger roof space than the BC SHWRR, the same design criteria can be applied. (BCREG2013)

The 2013 International Fire Code was seen to pose challenges to small-scale rooftop solar installations in Washington State. Evergreen State Solar Partnership (ESSP), part of the US DoE's Rooftop Solar Challenge Program, worked with the Washington Building Code Council to ensure that the new code minimized the restrictions on rooftop solar (note that Boulder and the State of Oregon adopted similar exceptions to Fire Code for solar PV – the published international code being very restrictive when applied to small roofs). (ESSP)

With regards to incorporating solar collectors, structural loads, and fire access in the National Building Code of Canada, which is the underlying document to nearly every local building code in the country, a review of the impact collectors have on wind and snow loads on roofs and other issues has been taken on by the Canadian Commision on Building and Fire Codes, Canadian Home Builders Association and other stakeholders. Standing committes will bring recommendations to a coordinating task group, but the process has been delayed because of staff changes. The review and recommendation process will not be finished in time to include any changes in the 2015 National Building Code Update. (CHBA1)

RESOURCES – REGULATIONS AND ORDINANCES IN FULL

BC Solar Hot Water Ready Regulation and accompanying guide can be found at:

http://www.housing.gov.bc.ca/building/green/solar/Updated%20Regulation.pdf

http://www.housing.gov.bc.ca/building/green/solar/Guide%20to%202013%20Solar%20Hot%20Water%20Ready%20Regulation.pdf

Complete ordinances for Chula Vista, Henderson, Oro Valley, Rancho Palos Verdes and Tueson are available through the American Planning Association (APA) website at: https://www.planning.org/pas/infopackets/open/pdf/30part5.pdf

SOLAR READINESS

Lack of overall solar readiness on the part of a municipality or region can lead to poor outcomes to solar initiatives. Solar readiness at the municipal or regional level takes the form of long-term vision and a policy underpinned by expert advice and dedication to a whole suite of solar planning options: permitting processes, zoning issues, layout of new developments, orientation

and pitches of rooflines, orientation of streetscapes and house fronts, fire regulations, roof load and other structural safety issues.

Table 2.3.5.3: Solar Readiness issues (beyond the rough-in)

Zoning/Planning	Size, shape of lots
	Streetscape orientation
	Restrictions on roof type/shape repetitions
	Neighbourhoods with design and/or historic district guidelines
Solar Access	Vegetation
	Future construction
	Height restrictions for roof-mounted units
Installation of actual system	Permitting process
	Fees

In many cases, adding solar ready to homes in subdivisions or neighbourhoods that were not planned to optimize solar access can lead to limited success. For example, lots under 1 Acre create challenges in positioning the house for optimal solar orientation. Production builders are especially compromised in this area, as tract-style lots, in subdivisions with no solar planning, have very limited choice in terms of building orientation. In addition, production builders have a set number of house models and can be restricted by the design of their existing rooflines. City ordinances or subdivision covenants that are in place to ensure variation in street elevations and roof lines may restrict useable roof faces, especially on long, straight roads. (SRPP)

Most developers are not prepared to change the street orientation to optimize solar performance. Covenants and restrictions in subdivisions can require the front elevation of the house to be parallel to the street. In a typical subdivision, with no solar planning, this can reduce the number of lots with suitable solar access to 30 percent. (SRPP)

Where no solar access ordinances or common law rights to light are in place, vegetation, future construction and other obstructions can become hindrances to a successful solar initiative. Zoning and planning conventions often do not take into consideration the size and shape of lots, in relation to solar access. Small lots can be problematic in regards to solar access due to shading from neighbouring buildings or vegetation. (NREL2)

Nearly 80 percent of the American states have implemented some form of solar access law. However, the policies and ordinances vary greatly, from voluntary agreements to protect solar easements, to restrictions on vegetation and construction to protect solar easements. Little data or documentation on the effectiveness of solar access laws is available. (NREL2)

In addition to the lack of regulatory underpinnings that support and encourage a strong solar market, many jurisdictions also have cumbersome permitting processes and complicated fee structures. The fees and costs associated with jumping through many permitting hoops can easily account for up to half of the installed cost of solar systems. (DoESS)

Some US initiatives expand the definition of 'Solar Ready' from checklists for individual buildings to full on solar readiness at the community scale including planning, zoning, building and fire code regulations. One such state-driven initiative is Michigan's Renewable Energy Tools Program, funded by the Michigan Energy Office and supported by several key partners, including local economic development corporations, the state planning association, municipal league and townships assocations, among others. The focus of the initiative is to prepare local communities to take advantage of emerging technologies, but also to support local industry in an economically strategic way, as the region is one of the largest producers of raw materials for solar technologies. (CEC-MI)

Oregon Energy Trust focuses on broader issues, but funds opportuntiies for builders to incorporate energy efficiency measures and solar options into their offering to new home buyers through a 'trade allies' program. Their website offers a one-stop shop for getting an energy assessment; determining eligibility; finding a qualified contractor to help get cash incentives; an finding and filling out all required paperwork for everything from an energy efficiency upgrade to existing houses or construction of a new house to solar electric and solar hot water and pool heating for homes. Solar ready rough-ins are supported by incentives. (OET)

Most of the other regional programs are funded through one of several US Department of Energy programs that fall under the SunShot Initiative.

The Rooftop Solar Challenge has funded several regional programs to promote solar, particularly PV. The program funding is based on streamlining permitting processes and reducing soft costs as the most effective and efficient means of facilitating solar installations. The first round of funding was in 2011 and the second round was announced in November 2013. The goal of the Rooftop Solar Challenge is to:

- Streamline permit processes
- Update planning and zoning codes
- Improve standards for connecting solar to the grid
- Increase access to financing

Nine regional organizations awarded funding to explore ways to make solar energy cost-competitive by the end of the decade, are estimated to reach nearly 150 million people (RSCII). Here are three examples:

EVERGREEN STATE SOLAR PARTNERSHIP

Solar readiness in Washington State is guided by the Evergreen State Solar Partnership (ESSP) and led by the Washington Department of Commerce. In 2012, proposals were developed in the following target areas (ESSP1):

- Permitting and Interconnection
- Building Codes and Zoning
- Net Metering and Interconnection Standards
- Financing

Permitting processes in Washington cities now follow Best Practices as established by ESSP and Northwest Solar Communties (NWSC1):

- Standard checklist for an expedited permit
- Low, flat permit fee
- 'One stop shop' online information and permitting

TWIN CITIES SOLAR

In Minneapolis and Saint Paul, Solar America Cities funding, implemented in 2008, resulted in Solar Ready Guidelines, a Construction Specification and a broad-reaching Solar Energy Ordinance, among other accomplishments and significant increases in solar capacity in a very short time frame.

Prior to the Solar America Cities funding, the City of Minneapolis assisted in a bulk purchase program for solar thermal (2006), installed solar systems on four city buildings, partnered with the local electrical utility and other stakeholders to create an 'Energy Innovation Corridor along a proposed light-rall line connecting downtown Minneapolis and Saint Paul, and received funding for two Million Solar Roof grants. The objectives of the Twin Cities Solar initiative was to:

- Quintyple market penetration of solar capacity in the Twin Cities by 2010.
- Develop a long-term strategic plan for large-scale deployment of solar by 2015
- Demonstrate leadership in renewable energy by expanding solar capacity in public buildings. (NREL4)

Key activities relevant to this study included developing policy and standards changes relevant to solar installations, innovative financing mechanisms and ways to integrate solar technologies into the fabric of the city. The city worked with land use and solar energy advocates to create a solar energy ordinance for Minneapolis that addressed potential conflicts between zoning regulation, solar installations and solar access. (NREL4) A similar ordinance will be, or has been, enacted in Saint Paul.

With funding from the Solar America Cities program, Minneapolis and Saint Paul worked with cities across the US to develop zoning and development code modifications regarding solar energy systems. While the Twin Cities had already recognized solar energy systems as an allowed accessory use on a property, new regulations developed out of these consultations and studies now recognize solar energy systems as different from other accessory use cases, and considers solar access for existing solar installations when rezoning or other variances are requested on surrounding properties. In addition, a 'solar carve out' was created – allowing for pole or ground mounted systems within the lot coverage standards. It is not clear from the documents available for review on line if solar ready is included in the ordinance, however the

Minneapolis Solar Ready Guidelines and Construction Specifications have become the base model for several other programs and have been referenced by American Planners Association (APA) as well as the Architecture Institute of America (AIA).

Next steps include addressing solar and historic areas, how to adapt zoning incentives to apply to solar. A state-wide solar energy mandate, proposed in 2013, would include incentives for home and business owners to install solar systems. (TCCI)

SOLAR READY KANSAS CITY (KC)

Solar Ready KC, a program run by the Mid-America Regional Council (MARC), includes 'Solar Readiness' in its Solar Best Management Practices (BMPs). The Solar Ready KC program is estimated to reach over 10 million people in nine counties in two states and focuses on rooftop PV. The program has a broad mandate to promote and enable solar installations. The 'Solar Readiness' (i.e., pre-install or rough-in for future PV systems) part of Solar Ready KC fits into a much broader strategy for increasing solar capacity within the region, that go far beyond improving permitting processes, including:

- Developing GIS mapping tools for solar access
- Certification program for installers
- Market research panels
- Expanding financing options

Solar Ready (rough in) is included in the process as part of BMP Planning Step 2-1A: *Improve Solar Readiness: Develop a Solar Ready building checklist for new construction*. Step 2-1A uses as examples the Twin Cities, Minnesota Solar Ready Guidelines and the City of Boston, Massachusetts Department of Neighbourhood Development Solar Ready Guidelines, which both reference back to the NREL Solar Ready Building Planning Guide.

Solar Readiness is addressed in Step 2-1B: *Adopt new ordinance or building codes to promote solar ready construction*. Step 2-1B uses the Tucson, Arizona Citywide Residential Solar Readiness Ordinance as an example.

RESOURCES – ZONING, ACCESSORY USE AND CODE ISSUES

Minneapolis Ordinance Amending Title 20, Chapter 535 of the Minneapolis Code of Ordinances relating to Zoning Code: Regulations of General Applicability.

This document is an example of an ordinance defining zoning regulations as they pertain to solar energy systems, their installation and the requirements for solar access

http://www.ci.minneapolis.mn.us/www/groups/public/@cped/documents/webcontent/convert_285502.pdf

American Planning Association: Solar Briefing Papers

This series of 6 briefing papers was prepared as part of APA's participation in the US DoE SunShot Solar Outreach Partnership.

- Solar Community Engagement Strategy for Planners
- Solar Mapping
- Integrating Solar Energy into Local Plans
- Integrating Solar Energy into Local Development Regulations
- Balancing Solar Energy Use with Potential Competing Interests
- Recycling Land for Solar Energy Development

https://www.planning.org/research/solar/briefingpapers/

Become a Solar-Ready Community! A Guide for Michigan Local Governments

According to the executive summary of this guidebook, solar readiness includes:

- Being proactive in solar policies and procedures
- Supporting local solar industries
- Creating cost-effective solar installation process

http://cec-mi.org/communities/programs/michigan-renewable-energy-tools/solar-ready-community/

DISCUSSION

TECHNICAL ISSUES

While south-facing roofs are optimal, it has been shown that west-facing roofs are also reasonable to consider for solar thermal, because they are exposed to the late afternoon sun. If the roof – and therefore the future solar collection system – is at an optimal angle to capture either the winter sun or the summer sun, the system can then be designed to seasonally optimize solar energy. The orientation of the house on the lot and the orientation of the primary roof faces have to be taken into consideration prior to the construction phase. Changes that have to be made to production builders' offerings to accommodate solar ready must be made well in advance of lot purchase, making solar ready a clearly considered feature on the part of the builder, if not the developer. (SRPP)

Roof orientation and pitch relative impacts the efficiency of a PV or SHW system and can make the difference between a system that can meet the performance requirements of an incentive program, a leasing model or utility rebate model, all which are likely to be based on production, not system capacity as the market matures and becomes more sophisticated. Designing the house to prevent production losses optimizes the potential for the building to move from solar ready to solar because of the better economics.

Some design features are also challenging to solar ready requirements: beyond the any roofline changes, most floorplans will need some modification to ensure a short and straight run for conduit from roof through attic to utility space. Vaulted ceilings with zero or little attic access, skylights and roof vents interrupting possible collector locations, and west or south-facing gable ends are also noted as design challenges in the results from NRCan Solar Ready Pilot.

Additional technical information from the builder-led 2008 Solar Ready Pilot Project includes:

- Try to design potential space on 3 faces of the roof, relocate roof vents if required
- Check final roof design to avoid truss placement issues
- Use 2 2" conduits vs. one 4" conduit for greater installation flexibility (the 2" conduit bends more easily and fits inside 2x4 wall cavities)
- Stack the conduits, may require floorplan redesign
- Optimize the mechanical room location and layout
- Label conduit, valves, connections and electrical outlet or breaker panel
- Plans include all appropriate notes for future installation (location of panels, conduits and any other pertinent information, including generic installation diagrams for both PV and solar thermal). Add notes that ensure mechanical/plumbing stacks are kept out of designated areas for solar ready conduits
- Termination of conduit must be in mechanical room, not in future finished basement space but electrical panel may be located elsewhere. In this case, the wire would need to be fished through a mechanical bulkhead from the electrical panel to the conduit
- Train jobsite foreman or crew chief and key subtrades in entire installation process to avoid problems with mis-communication

SCHEDULING IN CONSTRUCTION PROCESS

- The biggest hurdles in scheduling Solar Ready can be overcome at the design stage. However, the lead foreman or crew chief and the core trades involved in electrical and plumbing installations should be instructed in the whole Solar Ready installation process to ensure that there are minimal problems encountered with conflicting uses of stacked walls or mechanical chases. (SRPP)

HARD COSTS

Hard costs associated with a SR rough-in vary according to the source and whether or not the rough-in accounts for PV and/or SHW. A very clear breakdown of hard costs for a solar hot water ready rough in was documented in NRCan's Solar Ready Pilot (2007/2008). Doug Tarry Homes estimated the hard cost of solar ready rough-in over a sample of 80 homes as follows (SRPP):

Table 2.3.5.4: Doug Tarry SHW Hard Costs

Items	Cost
Plumbing	$60.00
Electrical Outlet	$40.00
2 – 2" Central vacuum conduits	$150.00
Design Time (per plan set)	$50.00
Stickers	$2.00
Total	**$302.00**

A breakdown of estimated costs for solar ready or retrofit from the NREL shows a much higher cost than the Doug Tarry hard costs. The costs reflect the assumption that ¾" copper pipe was used in the NREL costing versus the 2 runs of 2" conduit used in the Doug Tarry estimate, although it still shows a significant difference in costs in favour of solar ready (66%). (NREL2)

Table 2.3.5.5: NREL Estimated SHW Hard Costs

	Estimated New Construction	Estimated Retrofit
Add mounting hardware	$ 28	$ 58
Pipes to roof	$1,516	$3,180
Stub out pipes	$ 45	$ 108
Relocate roof vents	n/a	$ 300
Install panels on multiple pitches	n/a	$1,000
TOTAL	**$1,589**	**$4,646**

A similar breakdown of estimated costs for installing a PV system shows a 60% reduction in costs when the system is installed at initial construction. (NREL2)

Table 2.3.5.6: NREL Estimated PV Hard Costs

	Estimated New Construction	Estimated Retrofit
Increase size of electrical panel	$939	$1,659
Run conduit	$790	$1,414
Relocate roof vents	n/a	$ 300
Install panels on multiple pitches	n/a	$1,000
TOTAL	**$1,729**	**$4,373**

Other projects and programs have a range of hard costs. Notably, the cost of connecting rooftop collectors to the mechanical room is exponentially higher than the cost of the rough-in at initial construction. The hard costs listed under the BC Solar Hot Water Ready Regulation are based on information provided by NRCan through the Solar Ready Pilot Project. The hard costs listed under Twin Cities Solar Ready and Solar Ready KC is based on early NREL projections.

Table 2.3.5.7: Range of Estimated Hard Costs from Different Programs and Projects

Program/Project	PV	SHW	Estimated New Construction	Estimated Retrofit
Builder/Developer				
Doug Tarry Homes (Ontario)		√	$300	n/a
Chesterman Group (BC)		√	$200	n/a
Municipal Programs				
Edmonton Green Home Guide	√	√	$400 – 900	n/a
Twin Cities Solar Ready Program	√		$1000	$5000
Regional Initiatives				
BC Solar Hot Water Ready		√	$200 – 500	n/a
Solar Ready KC	√		$1000	$5000

In addition to increased hard costs, retrofit projects can also have a larger impact the aesthetics of a house than a solar ready rough in at initial construction. According to Mayor Mussatto of the City of North Vancouver, reflecting on his own investment in solar hot water at a 2010 public meeting discussing the BC Solar Hot Water Ready Regulation:

"…if you look at my solar hot water you got the pipes running across the roof, down the side of the house, all the way to the basement. It is not a big problem but I think if this regulation would have been in, it would have been a lot more sightly and easier to put in <as a> retrofit." (CNV) Adoption of the Regulation was passed unanimously.

INDUSTRY SUPPORT

One of the prominent code-related issues facing solar ready has been roof design and concerns about the roof structure being able to take on the extra load of the solar collectors. Guidelines, specifications, ordinances and regulations in most jurisdictions now include a requirement for documentation that the roof loading is adequate.

In other areas, manufacturers are offering more 'solar ready' mechanical equipment, from hot water tanks with integral heat exchange coils to heat pumps.

SOFT COSTS

Soft costs associated with Solar Ready include permitting, zoning, design costs for solar optimization, installation costs and maintenance. In addition, programs require promotion and marketing which typically would require developing and delivering the program message online, radio and print media. Costs are also associated with print and online technical specifications, labeling and other support documentation.

Financial barriers are consistently identified as one of the major barriers to market uptake for solar technology. While the up-front costs of solar systems have been decreasing, and are expected to decrease further over the next few years, the systems still require a substantial initial capital investment for building owners. Where new construction budgets are pushed to the limit with increasing costs associated with land, labour and materials, adding the cost of solar systems can result in the solar system being one of the first '*frills*' that gets cut from the project budget.

Soft costs can make up half of the overall price tag of a solar installation. Permitting, land use codes and zoning ordinances are fragmented across thousands of local jurisdictions, utilities and these are all subject provincial or state-level government policies and laws. Streamlining the process of permitting has resulted in tangible improvements in the US DoE's SunShot program: Permitting times are averaging 40% faster and 12% cheaper, saving one week overall per installation – that's roughly 540 years of red tape NOT associated with the 37,960 residential PV systems installed under the Rooftop Solar Challenge program. (DoESS)

Soft costs will be higher in jurisdictions where solar ready rough-in guidelines or requirements stand alone from combined policy and planning that encompasses solar energy as part of a broader range of clean energy, sustainable community or Net Zero Energy features and inititatives.

SOLAR READY REGULATIONS

BC's Solar Hot Water Ready Regulation, an optional provincial regulation associated with the BC Building Code, is an example of a successful way to encourage solar ready while taking into consideration solar resource issues that relate to northern climates. In the case of provincial regulations, a blanket policy requiring solar ready would be less relevant to communities at high latitudes with only seasonal access to abundant sun, or to communities whose physical location in a steep mountain valley render their access to solar resource minimal.

In 2013, in a letter to the Canadian Commission on Building and Fire Codes, the CHBA brought up the issue of 'ad hoc' code changes made by local jurisdictions in regards to solar ready requirements, both in terms of the process of uniform code development and the rapid pace at which solar technologies are evolving. The CHBA requested a comprehensive review of the building and fire codes in regards to solar for the next iteration of the building code (2015), however, that process has proved to be slower than expected and it is anticipated that the review will not be concluded in time for inclusion in the 2015 NBCC. (CHBA1, CHBA2)

In the US, Tucson's city-wide solar ready ordinance has been used as a model for other municipalities and regions. The success of solar ready (for both PV and SHW) in Tucson is in part because of the funding the city has garnered from national initiatives to increase solar energy production, but the impetus behind applying for the funding comes directly from the political will of the city's government.

The top takeaways from Tucson's success:

- The importance and value of partnerships and sharing expertise
- Using creative financing
- Ongoing education of city and citizens (NREL3)

Some of the next steps that Tucson will be taking:

- Creating a 'solar one-stop shop', partnering with Pima County to establish and maintain a central location and access point for consumers, business and the solar industry.
- Solar and solar-ready integration into green buildings codes and infrastructure planning as well as refinements to city and county zoning as well as land use codes and most standardized permitting processes.
- Attracting solar manufacturers and installers to the area to provide for job growth and local economic development. (NREL3)

SOLAR-FRIENDLY ZONING

As seen in the Twin Cities Solar America Cities initiative, solar-friendly zoning encompasses several aspects of zoning, from allowed accessory uses and solar access to lot coverage standards. Local development regulations can creat significant obstacles in increasing solar capacity where solar systems are not defined separately from other accessory use cases, or are considered rooftop equipment that has to be screened – defeating the usefulness of the solar system. In other cases, where solar systems are not specifically discussed in an ordinance, zoning staff assume the systems are not allowed. (NREL4)

Incorporating language into zoning regulations that is specific to the accessory use case presented by solar energy systems is the key way to eliminate vague interpretations. In Minneapolis and Saint Paul, solar was added to the existing zoning ordinance, and needed to repeatedly demonstrate that the solar zoning was actually clarifying regulation. (NREL4)

Height restrictions, lot coverage limitations and set back requirements are all demonstrable barriers to solar-friendly zoning, as are screening requirements for rooftop equipment and landscaping requirements. Other regulatory barriers to solar energy systems include homeowner's association or developer-led covenants and design review requirements restricting or prohibiting installations. (APA) As these covenants effectively eliminate solar ready as an option in new construction, municipalities interested in developing solar ready policies will

also have to address the mechanisms outlining the scope of restrictions allowable under covenants and design reviews. These kinds of limitations on homeowners' associations and developers covenants has precedents in other areas, such as the 2010 amendment to the Halifax City Charter that allows homeowners in developer-controlled subdivisions to use clotheslines in their backyards. Clotheslines were previously prohibited because of their 'unsightly' nature.

SOLAR ACCESS/SOLAR RIGHTS LEGISLATION

An underlying assumption in promoting or legislating Solar Ready in new residential construction is that the solar resource will remain accessible. This means that some investigation of solar rights or solar access legislation should also be undertaken prior to any municipality mandating Solar Ready.

Bylaws such as these would provide some assurance of access to solar as a right, allowing those who invest in solar technologies to be sure of their return. The business model for solar developers would have more gravitas in any jurisdiction where the risk of decreased (or no) solar productivity is mitigated by legislation.

In Canada, solar access legislation is spotty as well, and has been investigated since the 1980s, including Alberta. The 2013 QUEST Nova Scotia report refers to a document titled A LEGAL REVIEW OF ACCESS TO SUNLIGHT IN SUNNY ALBERTA, by the Alberta Environmental Research Trust published in 1981. (HRM3). In some areas, right-to-light common law is in effect, but amalgamation of municipal entities has cancelled out common law, leaving some urban entities with no mechanisms for addressing or resolving solar access disputes. For example the City of Halifax, incorporated the Act Respecting Ancient Lights (1860) into the city charter, eliminating any post-1860 common law in respect to windows and other apertures. The effect of amalgamation in 1996 resulted in the 1860 Act being repealed. Once repealed, common law rights cannot be revived, leaving the former City of Halifax without the right to ancient light, but possibly leaving ancient light rights intact in the remainder of the Halifax Regional Municipality (HRM). In addition, the 1860 act addressed windows and apertures, leading to questions about solar collectors having right to light in all (or none) of HRM. (HRM3)

The issue of who is responsible for what can bog down a Solar Ready initiative. In 2013, Halifax (Nova Scotia) Enviroment and Sustainability Standing Committee reviewed Solar Ready in terms of the National Building Code (privately owned buildings) and the Municipal Facility Solar Ready Policy. Under the existing building code, there is no requirement for 'Solar Ready'. Solar Ready has been taken into consideration on new and retrofit Municipal buildings under the rubric of sustainability, as a way to 'create flexible platforms for future opportunities'. (HRM1) It was concluded that an absence of a Solar Ready policy has not stood in the way of incorporation of solar in municipal buildings as they are constructed or retrofitted. Concern was raised that a stand-alone policy could detract from many other progressive practices and future emerging practices. (HRM1)

In a subsequent report, which presented ten recommendations for municipal action related solar energy, incentives were determined by HRM staff to be provinicial, policy-based mechanisms, better run through through the Department of Energy Demand Side Management and Efficiency

NS. (HRM2) A Solar Ready by-law (undefined in the QUEST Solar Recommendations summary document) was determined to be outside the scope of the Community Energy Plan; however the staff report indicated that the Community Energy Plan could carry out information activities to promote a regulation that is agreed upon by all stakeholders.

SOLAR OBLIGATIONS OR TARGETS

ESTIF (European Solar Thermal Industry Federation) notes that solar obligations, which are typically part of broader solar initiatives and green building programs (ie, regulations that require solar provide a proportion of space heating requirements or electrical load) change how the market grows. To avoid problems stemming from 'cheapest possible solution(s)', ESTIF recommends quality assurance measures be incorporated into any solar obligation. (ESTIF1)

Future solar obligations can be met through solar ready rough-ins, code clarity, streamlined permitting processes and solar-friendly zoning. Minimizing hard and soft costs can improve the uptake of future community-wide solar programs. And community-wide programs to meet solar obligations (bulk-purchase, leasing or 'embedded' energy programs), can improve the efficiency of the systems installed. The solar leasing model, for instance, takes the variable of homeowner understanding out of the equation and can thus can lead to better systems being installed: when the owners' bottom line is based on system output, it is in their best interest to ensure optimal performance of the installed. At a community scale, embedded PV can reduce the installed cost per watt, and allows individuals who don't own property, or who don't own property with decent solar access, to invest in solar energy. Like a leasing program, an embedded PV system is based on prioritizing performance and maintenance. (DURBAN)

SOLAR READY: VOLUNTARY, OPTIONAL, CERTIFIED, MANDATORY

Solar ready in and of itself does not reduce energy or replace conventional energy, or reduce carbon emissions. As a widespread standard practice for new construction however, it does allow adequate flexibility in the housing stock to catalyze market expansion, and be part of a cost effective strategy to reach future municipal, regional or national solar obligations or targets.

There are three primary mechanisms used to promote solar ready: stakeholder education, certification programs for solar ready design and construction and solar ready legislation. The three mechanisms overlap, and can work synergicstically to improve the uptake of 'green' community and regional initiatives in general.

Stakeholder education is an important step in widespread adoption, and often preceeds an adoption of solar ready certification. Legislation that requires a solar ready option versus legislation that mandates a solar option falls into this category. As houses are often built by and for the ultimate buyer, the developer or builder may not see the solar ready option as appealing.

Tools are available to help developers and builders make informed decisions about the most viable type of system for a particular location and a particular roof. In some jurisdictions, developers and builders are required to provide this kind of information to builders and/or homebuyers. (NREL2)

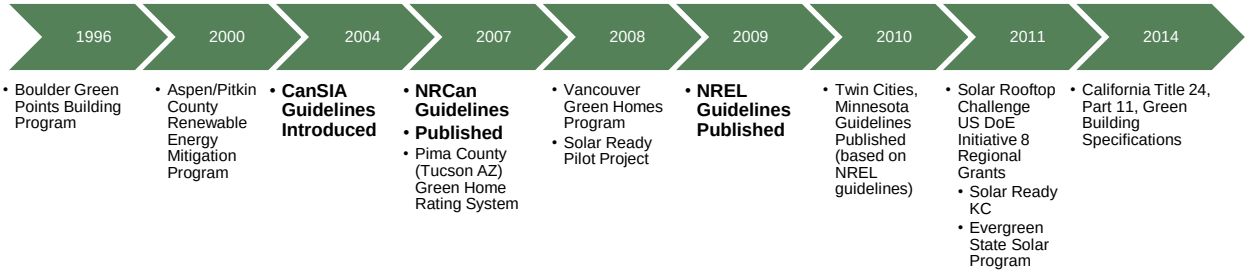
Solar Ready Certification benefits builders and homebuyers by resulting in points awarded on a rating system such as LEED for Homes, the ENERGY STAR program, or another green building standard. Certifying a building as solar ready helps the building owner advertise the flexibility and 'future proofing' integrated into the building and can help raise awareness among homeowners and other stakeholders who might otherwise not have considered solar. A certification recognizes and ensures a standard of installation that otherwise is missing and provides a measurable metric. As a voluntary option, it may be more readily accepted than legislation. The downside is that Solar Ready Certification rewards a measure that may never save energy, produce clean energy or reduce emissions. (NREL2)

As a stand-alone certification, instead of a part of a broader program like R-2000, Built Green or a Net Zero Energy Initiative, solar ready has some advantages, primarily around gaining brand recognition and raising awareness. However, in an industry swamped with many certification programs, a stand-alone label and program may end up with limited participation due to builder and homebuyer 'certification' burn-out, where too many options complicate the market to the point where another label has little value. (NREL2)

Financial incentives for solar ready have not been used in many jurisdictions, and where they are used, as in Oregon, there is a specific solar criterion required to be eligible. The challenge of creating financial incentives for solar ready is the fact that the building has the potential for clean energy, but may not actually ever produce clean energy. Non-financial incentives, such as expedited permitting or "density bonuses" could be more straightforward. One approach could be to have solar ready educational training mandatory in order to recieve an incentive or benefit. (NREL2)

As noted, solar ready is often included as an option in green building programs. These programs in turn, can be the precursor to solar ready being embedded in local building codes and ordinances. For example, in 2008, the Vancouver Green Homes Program was launched. This program included a solar ready option, which became part of the Vancouver building code. This program and the Vancouver Solar Homes Pilot led, in part, to the BC Solar Hot Water Ready Regulation, which came into effect in 2010, which 36 municipalities have signed into local ordinance. (SOLARBC1)

Figure 2.3.5.2: Timeline of SR Guidelines and Building Program Implementation



One of the earliest mentions of solar ready rough-in requirements is found in Boulder Colorado. Boulder instigated a Green Points Building Program in 1996, following on the successful

adoption of an ‘Energy Points’ building program. (NREL2) The Green Points program required a certain threshold of green features be incorporated in new construction, and led to Boulder County updating their building code to include solar ready rough-ins for both PV and SHW. (GRNDRM)

As noted, there is a wide variety of ‘solar ready’ technical requirements in municipalities and regions: from simple SHW stub-outs (Guam) to detailed SHW plans (BC), full site analysis and system plans for PV (Tucson), and many jurisdictions where solar ready is one of many options for a green building requirement (Aspen/Pitkin County).

When considering solar ready legislation, given the speed at which the technologies are evolving, it is important to consider how easy it is to update detailed technical regulations without requiring action from the legislature. Solar ready legislation combined with training and educational tools could effectively improve solar ready design practices. (NREL2)

Generally, municipalities and local governments are in a win-win situation when they lead solar efforts, and a combination of stakeholder education and legislation or policy seems to be the best route to significant uptake, confirming the findings from the Solar Rooftop Challenge that thought leadership and social responsibility are the foremost aspects of successful solar programs. Pairing education with a mandate and designing both to work in parallel requires stakeholders to consider solar ready, while at the same time ensuring that they understand the best practices.

APPENDIX A: MATRIX OF SOLAR READY GUIDELINE CHECKLISTS

	NRCan	NREL	EPA PV	EPA SHW
SCOPE				
PV			√	
PV and Solar Thermal	√	√		
Solar Thermal				√
OVERARCHING				
Zoning laws		√		
Site Orientation		√	√	√
Safety Equipment Access and installation		√		
Code Compliance	√	√	√	√
ROOF				
Structural Loading Capacity	√	√	√	√
Wind Load Capacity		√		
Roof Warranty		√		
Roof Orientation	√	√	√	√
Roof Obstructions & Shading	√	√	√	√
Available Roof Area	√	√	√	√
Appropriate Roof Slope	√	√	√	√
Roof Type/Materials		√		
Panel Mounting Strategy	√	√	√	
Attic Access for Future installation	√	√		
Roof Truss Design Procedure	√			
Seasonal Optimisation	√			
UTILITY ROOM				
Adequate Floor Area	√	√		√
Floor Strength to Hold Extra Water Tanks (non-concrete floors)		√		√
Wall Area for Controls	√	√	√	√
Connection to Electric Panel Location		√	√	
Additional Electrical Outlet for SHW BOS				√
Additional Electric Circuit for PV			√	
Interconnection requirements		√	√	
CONDUIT/PIPE				
As short as possible		√		
Conduit Pre-Installed (PV)	√	√	√	

	NRCan	NREL	EPA PV	EPA SHW
Conduit Pre-Installed (SDHW)	√	√		√
Cap and seal conduits	√	√	√	√
Bypass valve/connection rough in for existing DHW equipment	√	√		√
NOTES AND LABELS				
Determine Hot Water Load to Size System Components		√		
Determine Energy Production of Proposed PV System		√		
Record Roof Specifications on Drawings	√	√	√	√
Add Mechanical Symbols and Notes to Drawings	√		√	√
Supply Drawings with Diagram of System Components			√	√
Provide Shading Study with % monthly or adjusted annual shading impacts			√	√
Label Top and Bottom of Conduits	√	√	√	√
Label Pre-Installed Plumbing Connections	√	√		√
Label Pre-Installed Electrical Circuits			√	

APPENDIX B: ALBERTA NEW HOME BUILDERS FEEDBACK ON SOLAR READY

In an effort to see what was is currently taking place in the Alberta New home industry a total of 9 home builders were contacted. The home builders were from custom builders to large multi-facied companies. The companies contacted were belived to be at a minimum offering solar ready. Each was presented with the following questions:

1. Did you use NRCan/CanSIA guidelines? If not, what guidelines (if any) did you use?
2. NRcan projects the additional hard costs to be between $200 and $500 for PV/SHW. Was this your experience? If not, what estimate would you put forward?
3. Did you rough in for both PV and Solar Hot Water?
4. Did you run into any significant soft costs (roof orientation/pitch, permitting or zoning issues) in designing the house to be solar ready?

Out of the 9 companies contacted 3 responsed. One could not respond in the timeframe provided, but did offer to get back to us latter.

Responses:

Ryan Scott, Avalon Master Builder

We have done a bit of solar ready in our projects. At the time we mostly made up our own guidelines but they reasonably resemble the NRCan/CanSIA guidelines. I would suggest that $500 is on the high side and depending on how many homes were being done $200 would be attainable. Our experience was just in roughing in for PV, though my pricing above would be for both. We had no issues with permitting etc due to the rough in process. Once we start putting the panels up, we have had some interesting challenges.

Kyle Kasawski, Manager of Landmark Power, Landmark Group

1. Did you use NRCan/CanSIA guidelines? If not, what guidelines (if any) did you use?

We started with NRCan guidelines but adopted these for our own use. We basically picked the most applicable parts of the NRCan guidelines. We have kicked the tires on Solar Thermal and determined that it isn't a fit for Landmark. We also think that photovoltaic solar panels are well suited to face any direction so lot orientation isn't important to being solar ready in our opinion. We have called our solar ready *Set for Solar*.

The most important aspects for being solar ready are:

1. The roof trusses are engineered to support the imposed loads of solar panels
2. There is a conduit for running wires from the attic to the electrical/mechanical room of the house.
3. There is appropriate breaker space dedicated for future solar power in the main electrical panel.

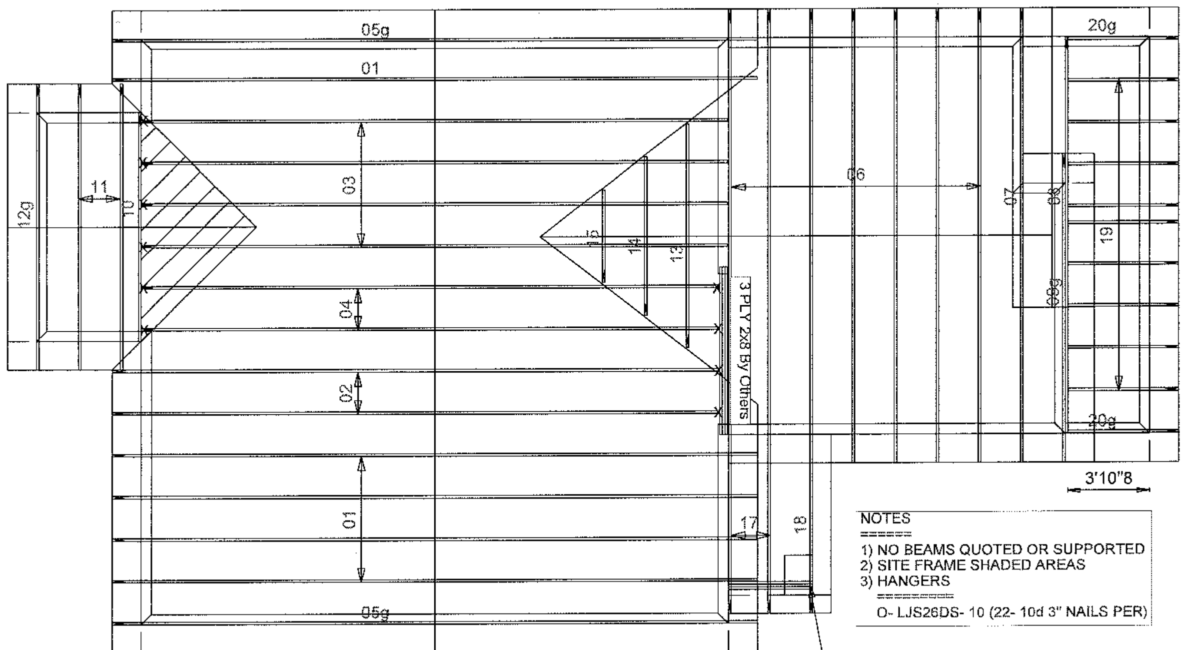
2. NRcan projects the additional hard costs to be between $200 and $500 for PV/SHW. Was this your experience? If not, what estimate would you put forward?
   This is about right. However, I estimate the value to customers at over $1,000. Engineering the roof trusses is really important and adds cost to retro-fit solar power systems.

3. Did you rough in for both PV and SHW?
   Just PV.

4. Did you run into any significant soft costs (roof orientation/pitch, permitting or zoning issues) in designing the house to be solar ready?
   Working with our truss manufacturer was our biggest hurdle but now they are totally on board.

Landmark provided the following truss detail for solar ready.

THIS ROOF IS SET FOR SOLAR. IT HAS BEEN BUILT TO HOLD THE IMPOSED LOADS OF A PHOTOVOLTAIC SOLAR ENERGY SYSTEM MOUNTED PARALLEL WITH THE ROOF. PHOTOVOLTAIC SOLAR ENERGY SYSTEM MEANS THE PHOTOVOLTAIC MODULES, ALL THE EQUIPMENT, HARDWARE AND ELECTRICAL CABLING TO INSTALL THE SOLAR ENERGY SYSTEM UP TO AN IMPOSED TOP CHORD DEAD LOAD OF 3.5 psf.



NOTES
======
1) NO BEAMS QUOTED OR SUPPORTED
2) SITE FRAME SHADED AREAS
3) HANGERS
=========
O- LJS26DS- 10 (22- 10d 3" NAILS PER)

488LBS UNFACTORED

HEEL: 7 9/16"
MIDPOINT OF ROOF(FROM TOP OF FACIA): 3' 7 3/4"
MIDPOINT TO RIDGE OF ROOF: 4' 6 1/2"

Design Date: 03-19-2013

Customer: Landmark Homes
Builder :
Job Name: Cambridge-28 Tudor A # 01
Address : 665-Armitage Cr. (Aspen Trails)

Designer: AARON KING
Salesman: AARON KING

JOB NO:
LM130705

PAGE NO:
1 OF 1

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CMHC1 Innovative Buildings: Koo's Corner Case Study http://www.cmhc.ca/en/inpr/bude/himu/inbu/upload/Koo%C3%A2-s-Corner.pdf Accessed 20 January 2014

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COL City of London Community Energy Action Plan, 2013 www.london.ca/residents/Environment/.../Community_Energy_Plan.doc Accessed 24 January 2014

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