

Shining a Light On Commercial Building Solar Ready Requirements

Massachusetts Energy Code Technical
Support Program

Who Is Mass Save®?

- Mass Save® is an initiative sponsored by Massachusetts' gas and electric utilities and energy efficiency service providers, including
 - The Berkshire Gas Company
 - Cape Light Compact
 - Columbia Gas of Massachusetts
 - Eversource Energy
 - Liberty Utilities
 - National Grid
 - Unitil
- The Sponsors of Mass Save work closely with the Massachusetts Department of Energy Resources to provide a wide range of services, incentives, trainings, and information promoting energy efficiency that help residents and businesses manage energy use and related costs.

Credits

We thank the following organizations and sources for some of the graphics, photos and content included in this presentation:

- Performance Systems Development (PSD)
- NYSERDA NY-Sun Program Training – <https://training.ny-sun.ny.gov/trainings>
- Solar America Board for Codes and Standards:
<http://www.solarabcs.org/about/publications/index.html>

Many of the Graphics and Photos are available freeware on the NREL Resource site here:

- NREL - <https://images.nrel.gov/bp/#/>

Agenda

- 9th Edition Changes – Commercial
 - Solar-ready provisions
- Additions for Greater Detail

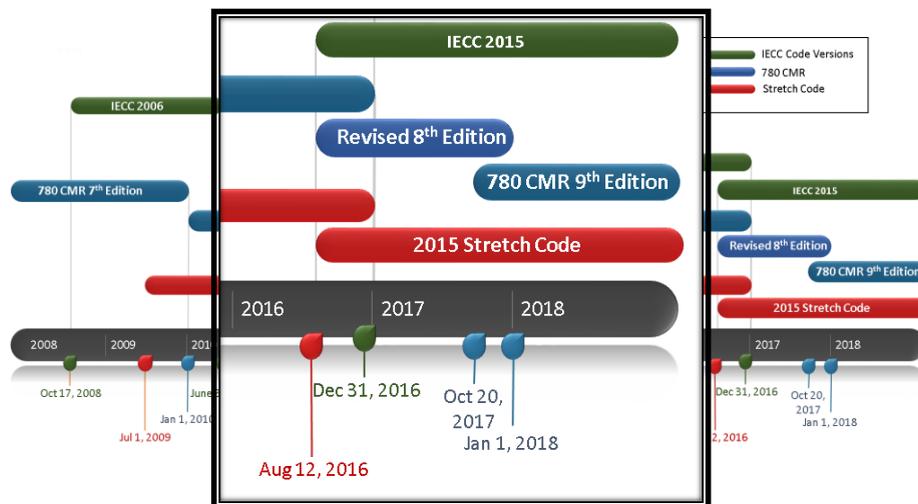
ACEEE State Energy Efficiency Scorecard 2017



Table ES1. Summary of state scores in the 2017 State Scorecard

Rank	State	Utility & public benefits programs & policies (20 pts.)	Transportation policies (10 pts.)	Building energy efficiency policies (8 pts.)	Combined heat & power (4 pts.)	State government initiatives (6 pts.)	Appliance efficiency standards (2 pts.)	TOTAL SCORE (50 pts.)	Change in rank from 2016	Change in score from 2016
1	Massachusetts	19.5	8	7	4	6	0	44.5	0	-0.5
2	California	13	9	8	4	6	2	42	-1	-3
3	Rhode Island	20	7	5	4	5.5	0	41.5	1	2
4	Vermont	18	6	7	2	5.5	0.5	39	-1	-1
5	Oregon	12.5	7.5	7	2.5	6	1	36.5	2	1.5
6	Connecticut	14.5	6.5	6	2.5	6	0	35.5	-1	0
7	New York	10	8	7.5	3.5	5.5	0	34.5	-2	-1
7	Washington	11.5	7	7.5	2.5	6	0	34.5	1	0
9	Minnesota	14.5	4	6	2.5	6	0	33	1	2
10	Maryland	8.5	6.5	6.5	4	5.5	0	31	-1	-1
11	Illinois	9.5	4.5	6	3	4	0	27	2	0.5

MA Code Timeline



9th Edition Concurrency & Changes

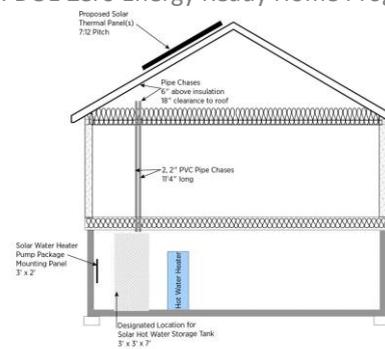
Concurrency period: Oct 20, 2017 to Jan 1, 2018.

“Solar-ready roof-tops” is the one change from 8th Edition to 9th Edition with respect to Commercial Buildings

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Commercial Solar-Ready Provisions

- 9th Edition 780 CMR, Chapter 13
- Replacing 2015 IECC C402.3 (Roof reflectance/thermal emittance)
- Residential provisions in 2015 IECC, Appendix RB
- Also: DOE Zero Energy Ready Home Program checklist



[Detail to help contractors and building owners understand how the components of the Consolidated Renewable Energy Home checklist fit together]. Retrieved May 9, 2018, from <https://bas.c.pnnl.gov/resource-guides/solar-plumbing-and-wiring-chase#quicktabs-guides=1>

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9th Ed. 780 CMR Solar-Ready Provisions

Intent of Ch 13 402.3

- Ability to plan ahead for solar installation
- Solar-ready zones and roof load documentation helps solar contractors in installing solar PV
- Easy identification of unobstructed areas
- Easy identification of pathway to run conduits & wiring

...saving \$\$ if the owner wants to install solar in the future.

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9th Ed. 780 CMR Solar-Ready Provisions

C402.3 through C402.3.6

- These provisions shall be applicable for new construction, **except additions.**

GENERAL DEFINITION

SOLAR-READY ZONE: A section or sections of the roof or building overhang designated and **reserved for the future installation of a solar** photovoltaic or solar thermal system.

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Commercial Solar-Ready Provisions

Scope 780 CMR C402.3

- New Low-rise Commercial Buildings and Additions
 - Less than 4 stories above grade (i.e. 3 stories or less) **NEW!**
 - 2400 ft² or greater roof area
 - Flat or oriented between 110 degrees and 270 degrees of true north
 - Includes required fire access/setback area
 - Area for array must be 1600 ft² or greater



Commercial Solar-Ready Exceptions

780 CMR C402.3

Buildings with permanently installed on-site renewable energy systems



Solar-ready zone shaded for more than 70% of daylight hours



Other Exceptions:

- Group A-2, A-3, and High Hazard Group H buildings
- Flat roof designed for rooftop parking
- Shown in construction docs to be outside of scope

Commercial Rooftops... *Opportunity!*



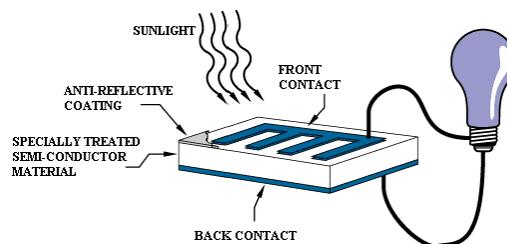
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But FIRST...

How do they work? (PV, Solar)

Solar PV Systems

- **PV Cells** convert sunlight into electricity
- Cells are connected in a frame to make a photovoltaic (**PV**) **Module**
- **Modules** designed to supply electricity at a **certain DC voltage**
- The DC current is dependent on **how much light strikes the module.**
- DC current and voltage **converted to AC by the Inverter.**
- AC electricity from the inverter used to power the electrical needs at the site or exported to the utility.

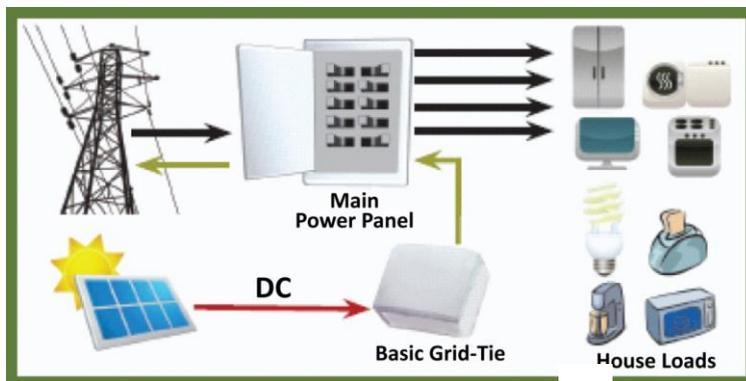


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But FIRST...

How do they work? (PV, Solar)

- Remember – PV produces DC electricity when there is sunlight on the module
- Non battery backed up Inverters stop producing electricity when the AC source (usually the utility) is disconnected from it.

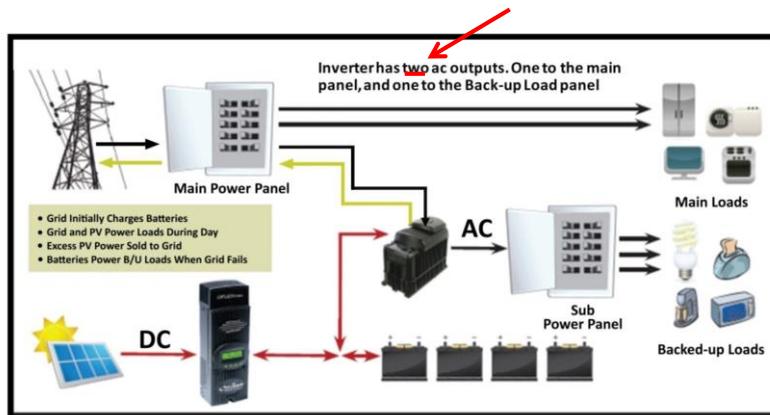


A basic Grid-Tie system generates power when the sun shines and the grid is operational; it does not provide back-up power.

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How Do Photovoltaic (PV, Solar) Systems Work ?

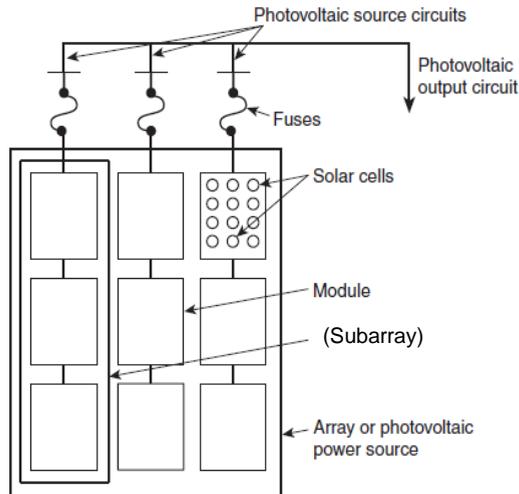
Battery backed up Inverters will still supply electricity to a separate subpanel unless the battery bank that supplies energy to the Inverter is turned off.



Grid-Tie system with battery back-up generates power when the sun shines and the grid is operational. It also provides power to essential backed-up loads during a power outage.

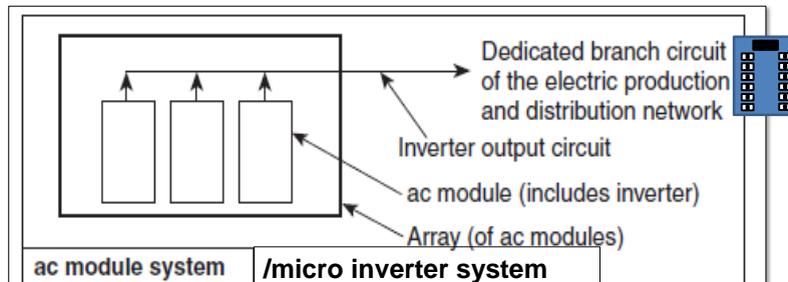
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Some PV Terms



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PV Terms



Notes:

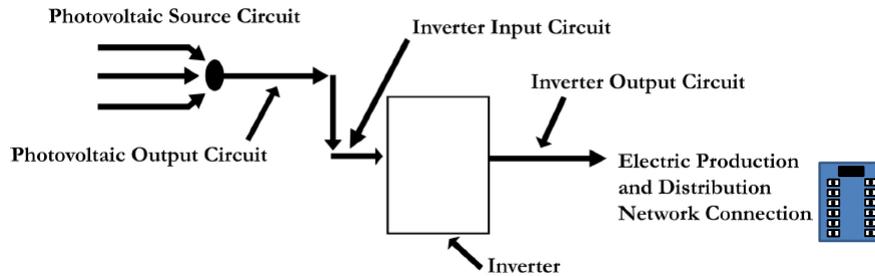
1. These diagrams are intended to be a means of identification for photovoltaic system components, circuits, and connections.
2. Disconnecting means required by Article 690, Part III, are not shown.
3. System grounding and equipment grounding are not shown. See Article 690, Part V.

The DC circuit length is usually less than 1 foot in these systems

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PV Terms

String or Central Inverter Grid Interactive System, w/o batteries.
(Historically, the most common system)



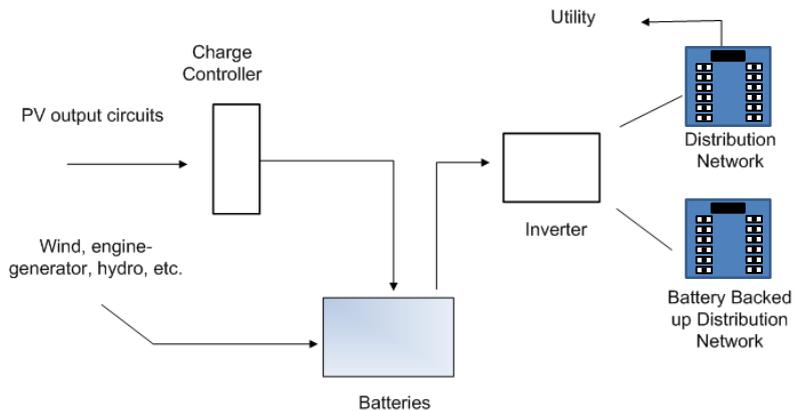
String inverters can be combined with DC-DC optimizers and be Rapid Shutdown System compliant per NEC 2014 requirements.

Adapted from NEC
Figure 690.1(b)

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PV Terms

Utility Integrated Solar, (and/or Wind, Hydro) or any combination (Hybrid) System with Batteries. Also known as Multimode Systems

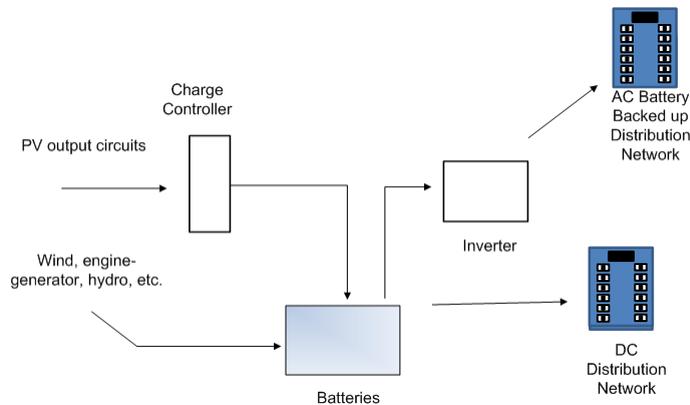


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PV Terms

Stand-Alone or Grid-Isolated System

These are usually cabin, camp, or boat systems. There is no utility interconnection.



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Some Useful Reference Resources

- Home Power Magazine www.homepower.com
- Solar Pro Magazine www.solarprofessional.com
- North American Board of Certified Energy Practitioners (NABCEP) www.nabcep.org
- Photovoltaic Systems, 3rd edition, James P. Dunlop, ISBN 978-1-935941-05-7, www.jimdunlopsolar.com
- Solar America Board for Codes and Standards (Solar ABCs), www.solarabcs.org
- International Association of Electrical Inspectors (IAEI), www.iaei.org

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Reference Resources...cont'd

Sample of Relevant Articles

Inspecting and Code Detail Videos by Southwest Technical Institute

<http://tdi.nmsu.edu/PVGuidePost/index.php>

Grounding

<http://solarprofessional.com/articles/design-installation/grounding-compendium-for-pv-systems>

Conductor Sizing

<http://solarprofessional.com/articles/design-installation/code-compliant-conductor-sizing>

Changes Specific to Solar PV in NEC 2014

<http://solarprofessional.com/articles/design-installation/understanding-the-nec-2014-and-its-impact-on-pv-systems>

Changes Specific to Solar PV in NEC 2011

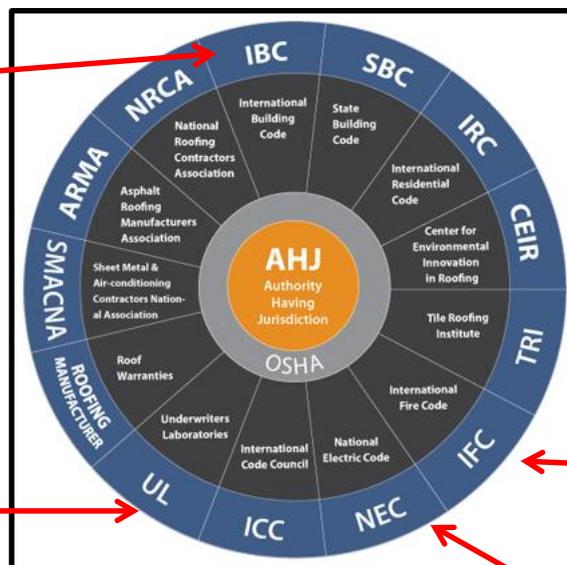
<http://solarprofessional.com/articles/design-installation/code-red-notable-changes-in-the-2011-nec>

Solar Inverter Interconnection Methods in NEC 2014

<http://www.homepower.com/articles/solar-electricity/design-installation/article-705-interconnected-electric-power-production>

Solar-Ready: Other Standards

- NEC
- IFC
- UL
- IBC
- MOST have been superseded by 9th Edition, check with Jurisdiction (JHA)



Other Standards: Fire Codes

- Depends upon state and/or local codes and requirements
- Generally, Fire codes require minimum 3' on sides and top
- Located on structurally supported portion of roof

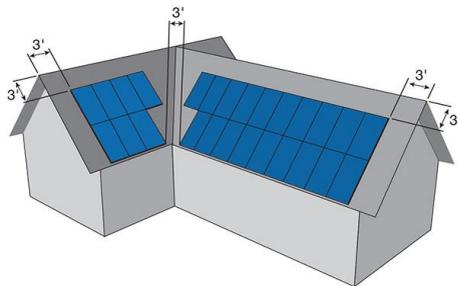


Figure 3 Where installers position PV modules on both sides of a roof hip or valley, the fire codes require an 18-inch setback on either side. As shown here, this results in an additional 3-foot pathway for emergency access or egress.

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Other Standards

Electrical Code (NEC) and International Fire Code (IFC)

- Access, labeling requirements & equipment locations
- Clearances around rooftop PV equipment
- Location of DC Connectors – to differentiate from all AC
- Exempt: Detached, non-habitable Group U structures...agricultural buildings, barns, carports, garages, parking structures



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Solar-Ready Provisions - Revisited

General

- These provisions shall be applicable for new construction, **except additions.**

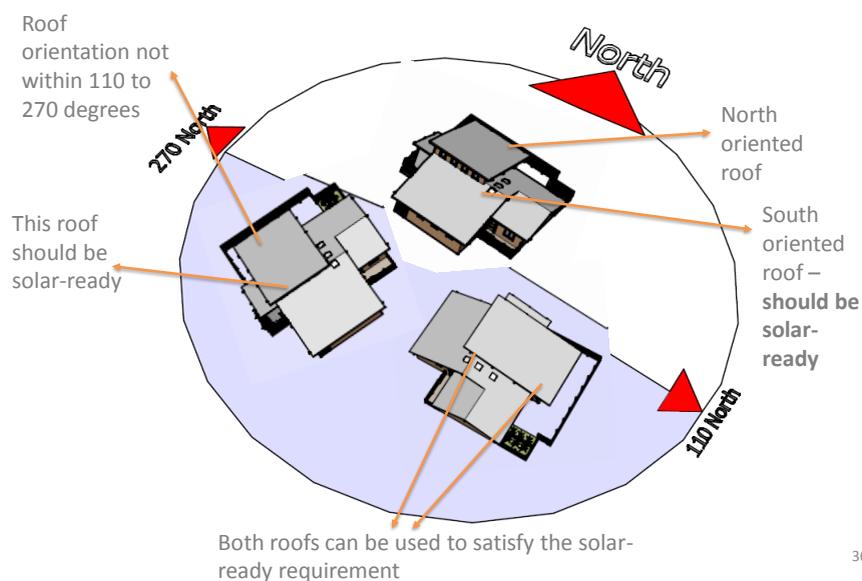
GENERAL DEFINITIONS

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Solar-Ready Provisions – Exposure

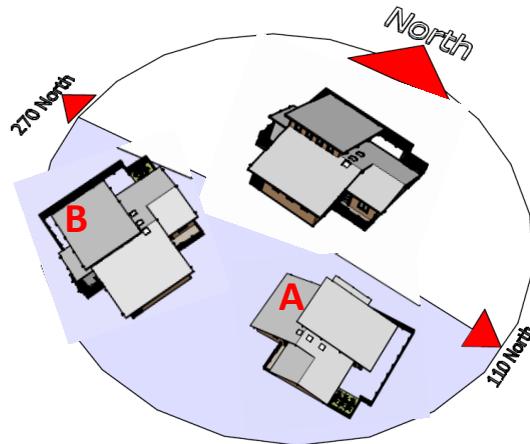
C402.3.2



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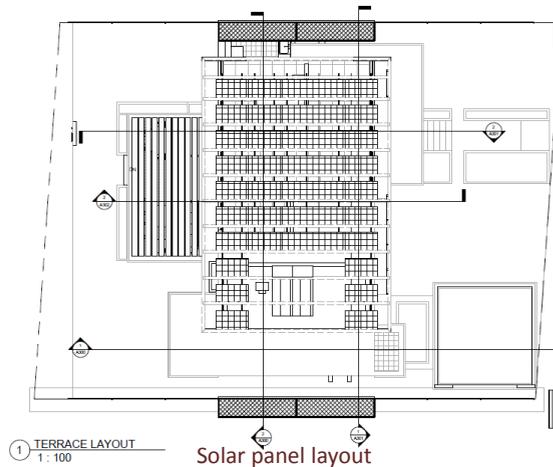
Poll Question

Commercial building B is 3 stories and has 2000 ft² of its roof oriented to 120 degrees of due north, plus 2100 ft² of its roof oriented approximately 290 degrees of due north. Is it required to designate a solar-ready zone?



Solar-Ready Provisions – Construction Documentation C402.3.1

Solar panel layout or solar-ready zone indicated on plans



*Not less than
1600 ft²
Or
50% of
applicable
roof area*

Solar-Ready Provisions —

Obstructions **C402.3.3**

The solar-ready zone should not be obstructed, including but not limited to:

- Vents
- Chimneys
- Roof-mounted equipment

Roof Load Documentation **C402.3.4**

The **structural design loads** for live and dead loads should be clearly indicated on construction documentation

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Solar-Ready Provisions: Roof Load Documentation

The **structural design loads** for live and dead loads should be clearly indicated on construction documentation

ROOF LOADS:	
GROUND SNOW LOAD, P_g	= 20 PSF
TERRAIN CATEGORY	= C
SNOW EXPOSURE FACTOR, C_e	= 1.0
THERMAL FACTOR, C_t	= 1.1
SLOPE REDUCTION FACTOR, C_s	= 1.0
IMPORTANCE FACTOR, I	= 1.1
MINIMUM FLAT ROOF SNOW LOAD, P_f	= 22 PSF
LIVE LOAD	= 20 PSF
MISCELLANEOUS MECHANICAL AND ELECTRICAL LOADS	= 5 PSF

Image Source: <http://seblog.strongtie.com/2017/01/snow-loading-trusses-specifying-roof-snow-load-isnt-enough/>

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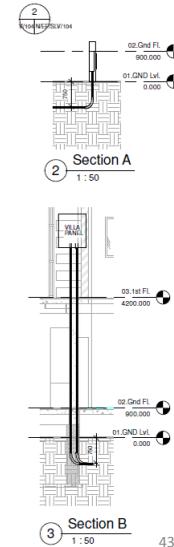
Solar-Ready Provisions: Interconnection Pathway C402.3.5

Construction drawings should indicate:

Pathway for electrical conduit from the solar-ready zone to the electrical panel (PV)

Or

Plumbing pathway from the solar-ready zone to the service hot water system (solar thermal)



Appendix U: Solar-Ready Provisions – ~~AU 103.7 Electrical Service Reserved Space~~

- ~~• The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar installation~~
- ~~• It shall be labeled "For Future Solar Electric"~~

The BBRs voted to delete this section
at their June 5, 2018 meeting

QUESTIONS



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Energy Code Support

Questions about the energy code?

Energy Code Support Hotline:

855-757-9717

Energy Code Support Email:

energycodesma@psdconsulting.com

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New Buildings and Major Renovations – Commercial



- Incentives for efficiency levels beyond code:
 - Whole building incentives
 - System incentives including
 - Air Compressors
 - Chillers
 - Lighting and Lighting Controls
 - Gas-Fired Heating Equipment
 - Variable Speed Drives
 - Custom Measures
 - And more

We also offer incentives and rebates for existing buildings.
Please visit www.MassSave.com for the details



We Speak Building



Thanks!

Massachusetts Energy Code Technical Support Program

