



Low Slope Roofing Systems
The University of Wisconsin Madison
Madison, Wisconsin – December 11-13, 2013

Latest Roofing Technologies:
Reflectivity, Vegetative Roof Systems
and Rooftop Photovoltaic Systems

presented by

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Rosemont, Illinois

Emerging technologies

- Reflective roofs (“white roofs”)
- Vegetative roofs (“green roofs”)
- Rooftop photovoltaics (“blue roofs”)

Reflective roof \approx “Cool” roof

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Benefits of cool roofs

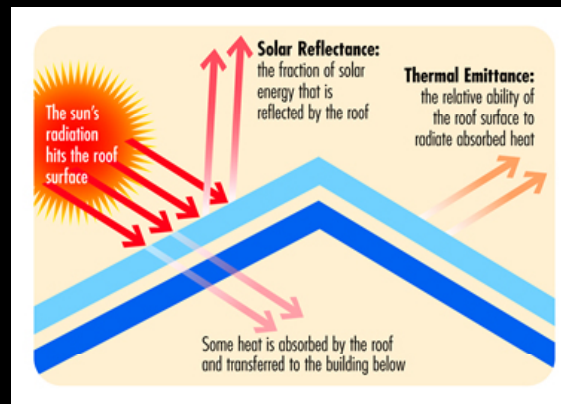
- Energy savings
- Improved occupant comfort
- Reduction of urban heat islands effect and smog
- Global warming mitigation
- Comply with codes and green building programs

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What is a cool roof?

A cool roof's surface reflects and emits the sun's heat back to the sky instead of transferring it to the building below.

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Courtesy of the Cool Roofs Rating Council

What's cool?

“Coolness” is measured by two properties:

- Solar reflectivity
- Thermal emittance

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Definitions

Solar reflectance: The fraction of solar flux reflected by a surface expressed within the range of 0.00 and 1.00.

Thermal emittance: The ratio of radiant heat flux emitted by a surface to that emitted by a black body radiator at the same temperature expressed within a range of 0.00 to 1.00.

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Definitions – cont.

Solar reflectance index (SRI): The relative steady-state surface temperature of a surface with respect to the standard white (SRI = 100) and standard black (SRI = 0) under standard solar and ambient conditions.

--ASTM E 1980

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Some example values

Roofing Industry Alliance for Progress, "Roof Reflectivity Study –Year 3 Report", September 2010

Product	Solar reflectance ^{1, 2}
Acrylic coatings	0.41 - 0.65
Aluminum roof coatings	0.23 - 0.54
Built-up membrane, aggregate-surfaced	0.19 - 0.28
Concrete pavers	0.31 - 0.50
EPDM membrane (black)	0.06 - 0.10
PVC membrane (white)	0.30 - 0.85
SBS modified bitumen (white granules)	0.25 - 0.62
TPO membrane (white)	0.55 - 0.72
¹ Measured using ASTM C1549, also referred to as the D & S method. ² Age of roofs tested range from 1 month to 28 years	

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“Cool” recognition programs

- Energy Star® roof products program
- Cool Roofs Rating Council (CRRC)

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Energy Star® roof products program

www.energystar.gov

Characteristic	Performance Specification
Low slope roofs:	
Initial solar reflectance	Greater than or equal to 0.65
Maintenance of reflectance	Greater than or equal to 0.50 three years after installation under normal conditions
Warranty	“...equal in all material aspects to...comparable non-reflective roof products...”
Steep- slope roofs:	
Initial solar reflectance	Greater than or equal to 0.25
Maintenance of reflectance	Greater than or equal to 0.15 three years after installation under normal conditions
Warranty	“...equal in all material aspects to...comparable non-reflective roof membrane products...”

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**Products complying with the Energy Star[®]
 criteria are eligible to use the
 Energy Star[®] logo**

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ENERGY EFFICIENT products
ENERGY SAVINGS at home
ENERGY EFFICIENT new homes
ENERGY STRATEGIES FOR buildings & plants

[ABOUT ENERGY STAR](#)
[PARTNER RESOURCES](#)

Home » Products » Product Finder Home » ENERGY STAR Certified Roof Products

ENERGY STAR Certified Roof Products

Compare up to 4 items

Sort by:
Initial Solar Reflectance

1 - 20 of 4920 Records Found

<p style="font-size: small; margin: 0;">ENERGY STAR Partner[®]</p> <ul style="list-style-type: none"> <input type="checkbox"/> 3M Steel, Inc. (25) <input type="checkbox"/> 3M Company (1) <input type="checkbox"/> Ace Coating Company Incorporated (1) <input type="checkbox"/> ACI Buildings Systems (20) <input type="checkbox"/> Acrylux Paint Manufacturing Co. Inc. (3) <input type="checkbox"/> Acrymax Technologies, Inc. (1) <input type="checkbox"/> Advanced Coating Systems, Inc. (5) <p style="font-size: small; margin: 0;">Show More</p>	<p style="margin: 0;">National Coatings Corporation: AcryShield - A590</p> <p style="font-size: small; margin: 0;">Coating - Low Slope</p> <p style="font-size: x-small; margin: 0;">Initial Solar Reflectance: 0.92 Initial Emissivity: 0.87</p> <p style="text-align: right; font-size: small; margin: 0;"><input type="checkbox"/> Compare</p>	
<p style="font-size: small; margin: 0;">Brand Name[®]</p> <ul style="list-style-type: none"> <input type="checkbox"/> 40 Yr. Jackson Bldg (16) 	<p style="margin: 0;">Acrylux Paint Manufacturing Co. Inc.: Acrylux - Roof Gloss RG5</p> <p style="font-size: small; margin: 0;">Coating - Low Slope / Steep Slope</p> <p style="font-size: x-small; margin: 0;">Initial Solar Reflectance: 0.91 Initial Emissivity: 0.9</p> <p style="text-align: right; font-size: small; margin: 0;"><input type="checkbox"/> Compare</p>	
	<p style="margin: 0;">GAF: Topcoat - EnergyCote Elastomeric Coating (white)</p> <p style="font-size: small; margin: 0;">Coating - Low Slope</p> <p style="font-size: x-small; margin: 0;">Initial Solar Reflectance: 0.91 Initial Emissivity: 0.87</p> <p style="text-align: right; font-size: small; margin: 0;"><input type="checkbox"/> Compare</p>	

The screenshot shows the Energy Star website interface for a product page. At the top, there is a navigation bar with the Energy Star logo and links for 'ENERGY EFFICIENT products', 'ENERGY SAVINGS at home', 'ENERGY EFFICIENT new homes', and 'ENERGY STRATEGIES FOR buildings & plants'. Below this is a breadcrumb trail: 'Home » Products » Product Finder Home » ENERGY STAR Certified Roof Products » Product Details: GAF: Topcoat - EPDM Coating (white)'. The main heading is 'ENERGY STAR Certified Roof Products' followed by 'Product Details: GAF: Topcoat - EPDM Coating (white)'. A sidebar on the right offers a link to 'Want more information? Access the full product list in Excel, API, and other formats. Switch to Advanced View >'. The main content area has two tabs: 'Specifications' (selected) and 'Additional Model Information'. The specifications table is as follows:

ENERGY STAR Partner Ⓞ:	GAF
Product Type Ⓞ:	Coating
Initial Solar Reflectance Ⓞ:	0.86
Solar Reflectance after 3 years Ⓞ:	0.7
Initial Emissivity Ⓞ:	0.88
Low Slope? Ⓞ:	Yes
Steep Slope? Ⓞ:	No
Warranty Period (yrs) Ⓞ:	10

Cool Roofs Rating Council

www.coolroofs.org

Products Roof complying with CRRC's criteria are eligible to use their label

	<u>Initial</u>	<u>Weathered</u>
	Solar Reflectance 0.85	Pending
	Thermal Emittance 0.86	Pending
	Rated Product ID	0676-0005
	Licensed Manufacturer ID	0676
	Classification	Production Line

For Submittal Purposes Only

Cool Roof Rating Council ratings are determined for a fixed set of conditions and may not be appropriate for determining seasonal energy performance. The actual effect of roof reflectance and thermal emittance on building performance may vary.
Manufacturer of product should ensure that these ratings were determined in accordance with the applicable Cool Roof Rating Council procedures.

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CRRC
CERAMIC ROOF RATING COUNCIL

HOME ABOUT CRRC RESOURCES MEMBERS PRODUCT RATING **RATED PRODUCTS DIRECTORY**

Product ID or keyword search

Manufacturer: All

Brand: All

Model: All

Product Market: All

Product Type Color Minimum Radiative Properties

Slope: All Low Steep

- Asphalt Shingles
- Built-Up and Modified Bitumen Sheet Roofing
- Concrete/Clay Tile and Slates
- Field-Applied Coatings
- Fluid Applied Membrane Roofing
- Metal Products
- Metal Shakes/Shingles (including Granular Coated Metal)
- Polymer/Composite Steep-Slope Products
- Roof Pavers
- Single-Ply Thermoplastic and Thermoset Roofing
- Spray Polyurethane Foam Roof Products
- Stone Aggregate/Ballast Products
- Wood Shakes/Shingles

Clear filters – show all products

Results per page: 10 20 50

2481 SEARCH RESULTS

Selected filters

1 2 3 > 100 >

CRRC PROD. ID	MANUFACTURER, BRAND MODEL	PRODUCT TYPE	COLOR	SOLAR REFLECTANCE		THERMAL EMITTANCE		SRI		MORE INFO
				Initial	3 year	Initial	3 year	Initial	3 year	
0986-0004	A-1 Grit Company: Arctic White Granule size: #11. Tested over a white adhesive. Manufacturer recommends 100% granule coverage for proper performance.	Other Roof Products: Stone Aggregate/Ballast Products		0.73	0.56	0.92	0.90	91	67	+
0986-0005	A-1 Grit Company: Glacier White 3/8 inch aggregate. Tested over black asphalt with a maximum solar reflectance of 0.05. Manufacturer recommends 100% granule coverage for proper performance.	Other Roof Products: Stone Aggregate/Ballast Products	Bright White	0.70	pending	0.85	pending	85	pending	+
0986-0003	A-1 Grit Company: White-C 7/16 inch aggregate. Tested over a white adhesive. Manufacturer recommends 100% granule coverage for proper performance.	Other Roof Products: Stone Aggregate/Ballast Products		0.61	pending	0.79	pending	70	pending	+
0862-0001	Ace Coating Company Inc.: Alpha 8 505	Field-Applied Coatings: Acrylic		0.84	0.72	0.79	0.86	104	88	+
1156-0003	Acrylabs: Acrylic Coating 2100 HT White	Field-Applied Coatings: Acrylic	Bright White	0.85	pending	0.88	pending	107	pending	+
1156-0002	Acrylabs: Acrylic Coating 2100F W/2150 White	Field-Applied Coatings: Acrylic	Bright White	0.83	pending	0.91	pending	104	pending	+
1156-0001	Acrylabs: Acrylic Coating 2100F White	Field-Applied Coatings: Acrylic	Bright White	0.84	pending	0.88	pending	105	pending	+

Additional resources

- Energy Star®:
 - www.energystar.gov
- Cool Roofs Rating Council:
 - www.coolroofs.org
- DOE calculator:
 - <http://web.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm>
- ORNL calculator:
 - <http://rsc.ornl.gov/>

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Vegetative Roof Systems

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Definition

The NRCA Vegetative Roof Systems Manual, Second Edition

Vegetative roof system: A roof area of planting/landscaping installed above a waterproofed substrate at any building level that is over habitable space.

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Benefits of vegetative roofs

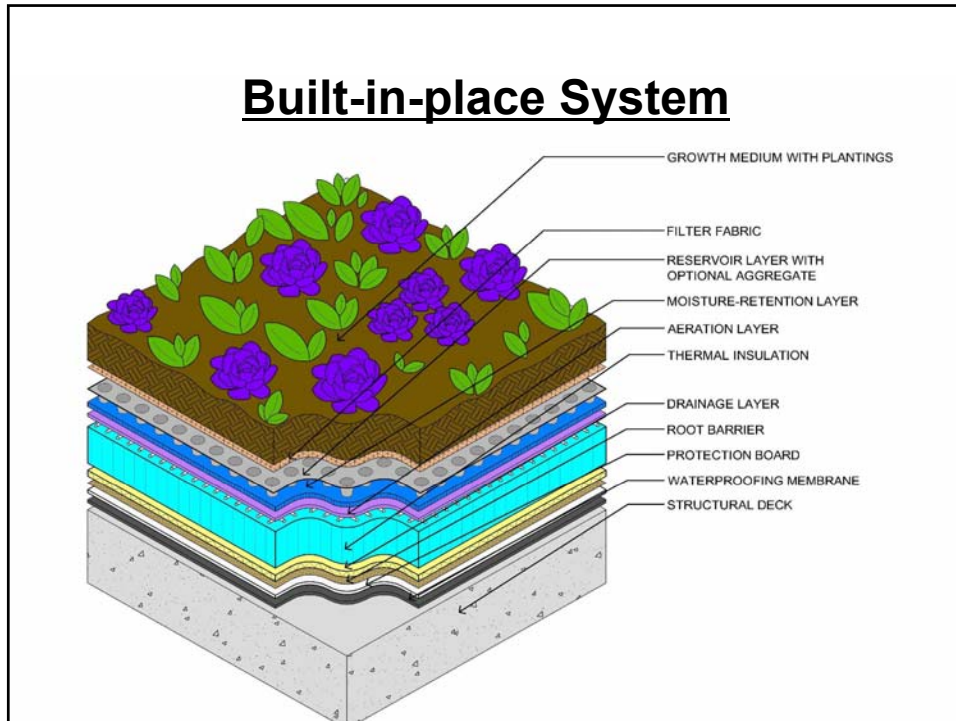
- Aesthetic improvement
- Storm water management
- Mitigation of heat island effect
- Energy efficiency
- Air quality improvement
- Noise reduction
- Increased roof system durability
- LEED® credit
- Rebates and other incentives

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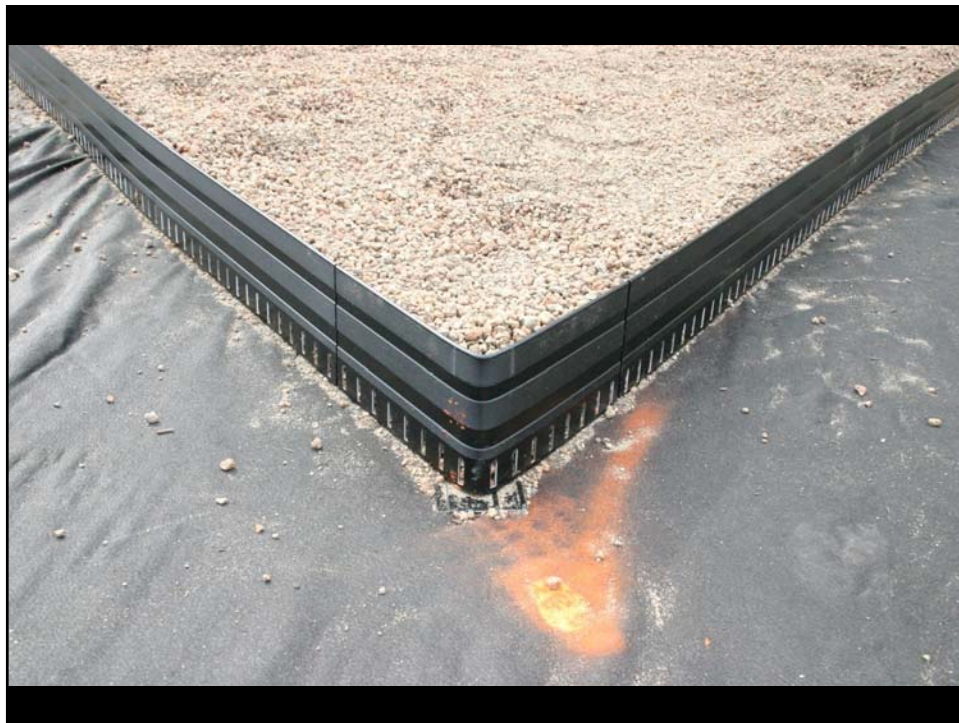
Basic configurations

- Modular systems
- Built-in-place systems





Construction Details for Vegetative Roof Systems







Membrane Integrity Testing

- Flood test
- Flowing water test
- Electronic field vector mapping

Vegetative roof systems
require regular maintenance

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Useful design standards

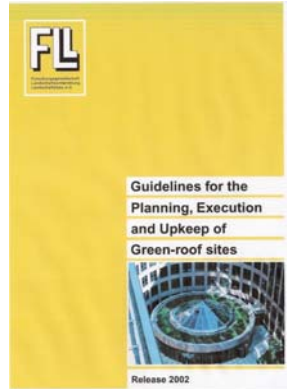
Available at www.spri.org

- ANSI/SPRI VF-1, “External Fire Design Standard for Vegetative Roofs”
- ANSI/SPRI RP-14, “Wind Design Standard for Vegetative Roof Systems”

These have not been incorporated into the Code

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FLL, “Guidelines for the Planning, Execution and Upkeep of Green-roof sites”

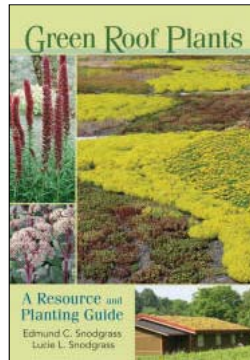


The NRCA Vegetative Roof Systems Manual, Second Edition



Green Roof Plants

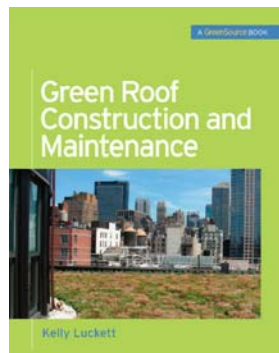
Authors: Edmund C. Snodgrass & Lucie L. Snodgrass

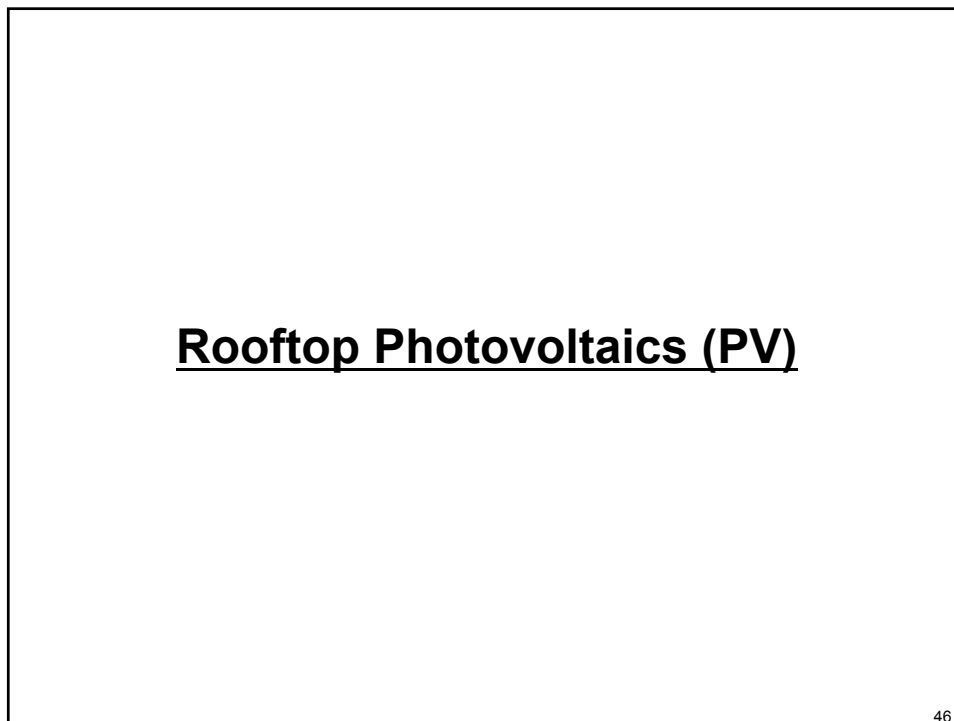


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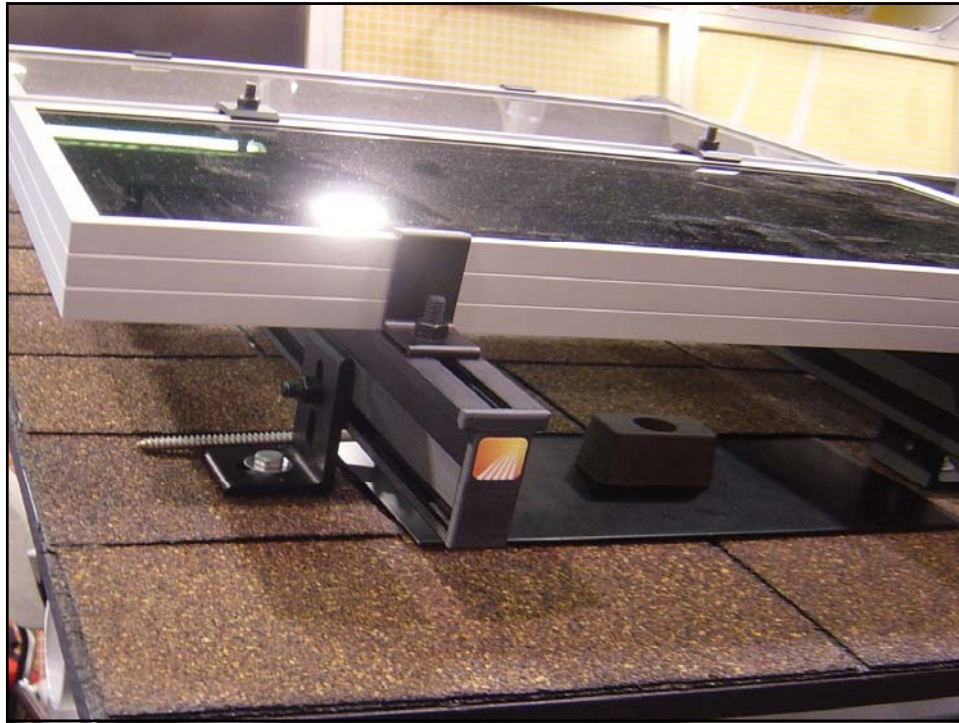
Green Roof Construction and Maintenance

Author: Kelly Lockett









General definition

Photovoltaic (PV) is the active solar technology which produces electricity from solar radiation using solar cells encapsulated in panels called PV modules

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Definitions

PV cell: the basic photovoltaic device that generates electricity when exposed to light.

module: the complete environmentally protected unit constructed of PV cells, optics and other components, excluding a tracker, designed to generate direct current (DC) power when exposed to sunlight.

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Definitions – cont.

panel: a collection of modules mechanically fastened together, wired, and designed to provide a field-installable unit.

array: a mechanically integrated assembly of modules or panels with a support structure and foundation, tracker and other components, as required, to form a direct-current (DC) power-producing unit

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PV definitions--illustrated

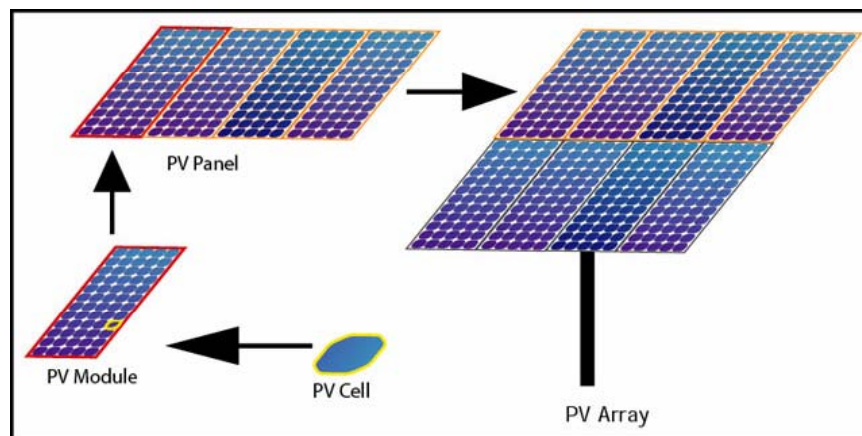


Illustration courtesy of Solar Energy Institute (SEI)

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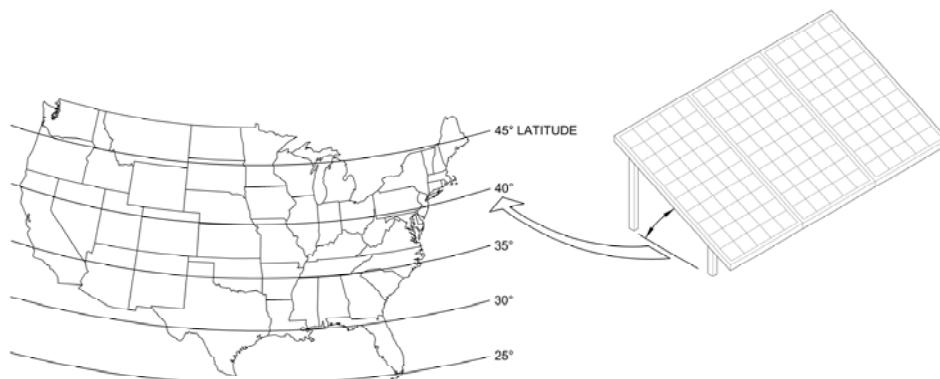
PV Module Types

- Monocrystalline silicone cells (13-17%)
- Polycrystalline silicone cells (11-15%)
- Thin films:
 - Amorphous silicone (5-8%)
 - Copper-indium-diselenide (6-8%)
 - Cadmium-telluride (9-10%)

(%) denotes module efficiency. Cell efficiency is invariably higher.

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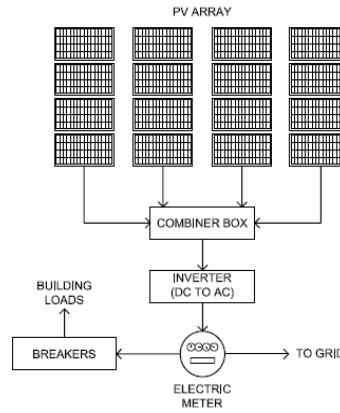
Orientation and angle



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Balance of System (BOS)

- PV array creates DC power
- BOS includes:
 - Combiner box (junction box)
 - Controller (with battery only)
 - Optional battery backup system
 - Inverter (DC to AC)
 - Micro-inverters
 - Meter/Grid or Breakers/Building
 - Shut-off switch/Disconnects
 - Dashboard and monitoring systems



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Article 690:
Solar Photovoltaic
Systems

“...qualified person...”

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Article 690--Solar Photovoltaic Systems

Required certification of electrical components

PV panels: UL 1703

Inverters, controllers, etc.: UL 1741

Utility interface: IEEE 929



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ANSI/UL 1703, “Flat-Plate Photovoltaic Modules and Panels”

- Construction, performance, testing, rating and marking of PV modules and panels
- Includes UL 790, “Standard Test Methods for Fire Tests of Roof Coverings”
 - “Listed” <control number> “Photovoltaic Module”
 - “Listed” <control number> “Photovoltaic Panel”
 - And “Class A” or “Class B” or “Class C” or “Not Rated”

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Compliance with UL 1703, “Flat-Plate Photovoltaic Modules and Panels,” can be verified by accessing www.ul.com, select “Certifications” in bottom menu bar and then enter *QIGU* in the Category Code field

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Other code requirements

- Building code:
 - *International Building Code, 2012 Edition*
 - Ch. 15: Roof Assemblies and Rooftop Structures
- Fire code:
 - *International Fire Code, 2012 Edition*
 - Sec. 105.5: Required Construction Permits
 - Sec. 605.11: Solar Photovoltaic Power Systems

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Rooftop PV Installation Types

- Rack-mounted
- Framed
- Thin-film/BIPV



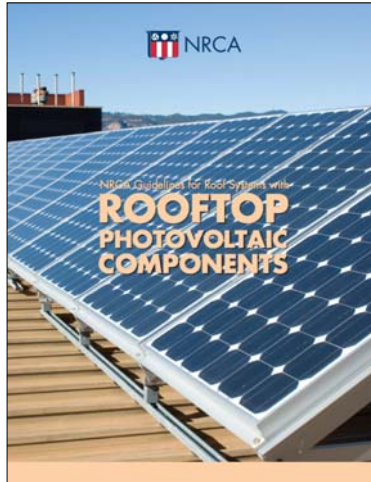
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Suggested Roofing Guidelines

- New PV system → New roof covering
- Roof durability \geq Life of PV system
- Roofing contractor needs to be involved
- Proper details are essential
- Electrician should be involved

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NRCA Guidelines for Roof Systems with Rooftop Photovoltaic Components



Database of State Incentives

www.dsireusa.org



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Emerging technologies

- Surface reflectivity
- Vegetative roof systems
- Rooftop PV

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