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

Mark S. Graham
Associate Executive Director, Technical Services
National Roofing Contractors Association
Rosemont, Illinois

Emerging technologies

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

2

Reflective roof ≈ "Cool" roof

3

Benefits of cool roofs

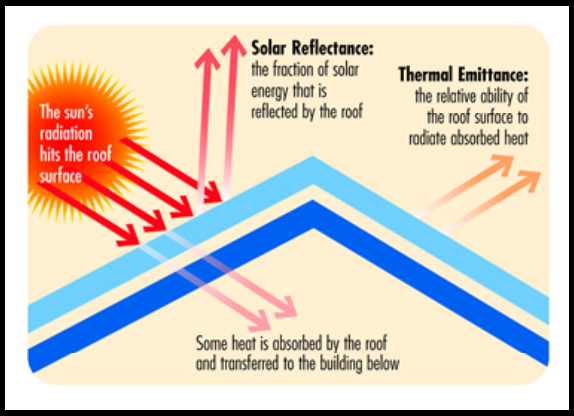
- Energy savings
- Improved occupant comfort
- Reduction of urban heat islands effect and smog
- Global warming mitigation
- Comply with codes and green building programs

4

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.

5



Courtesy of the Cool Roofs Rating Council

What's cool?

"Coolness" is measured by two properties:

- Solar reflectivity
- Thermal emittance

7

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.

8

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

9

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

10

"Cool" recognition programs

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

11

Energy Star® roof products program

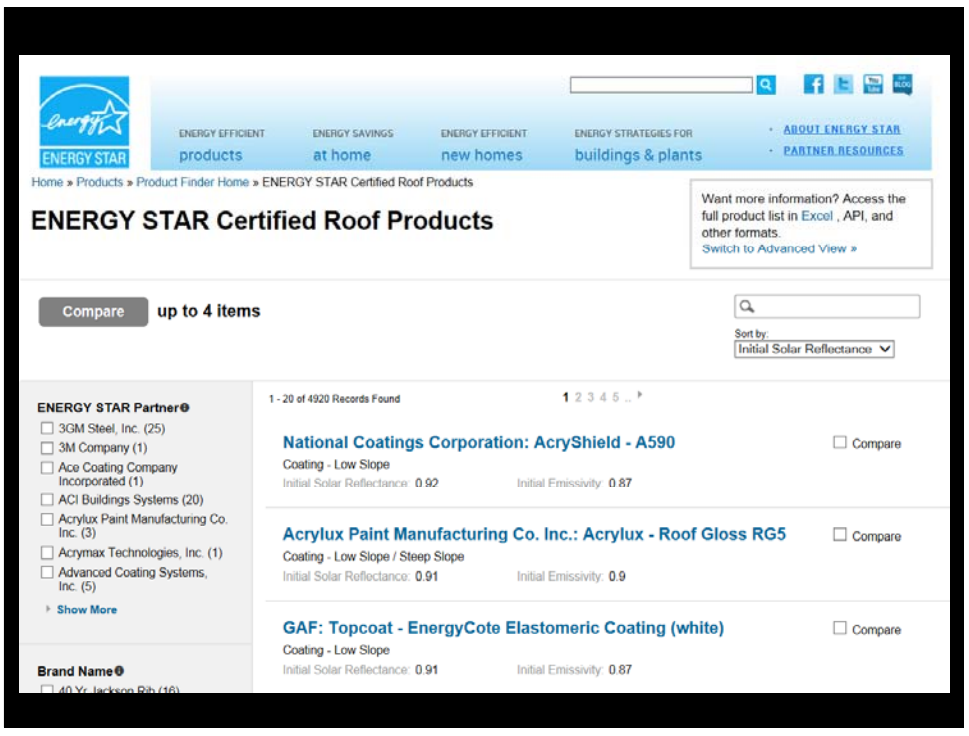
www.energystar.gov

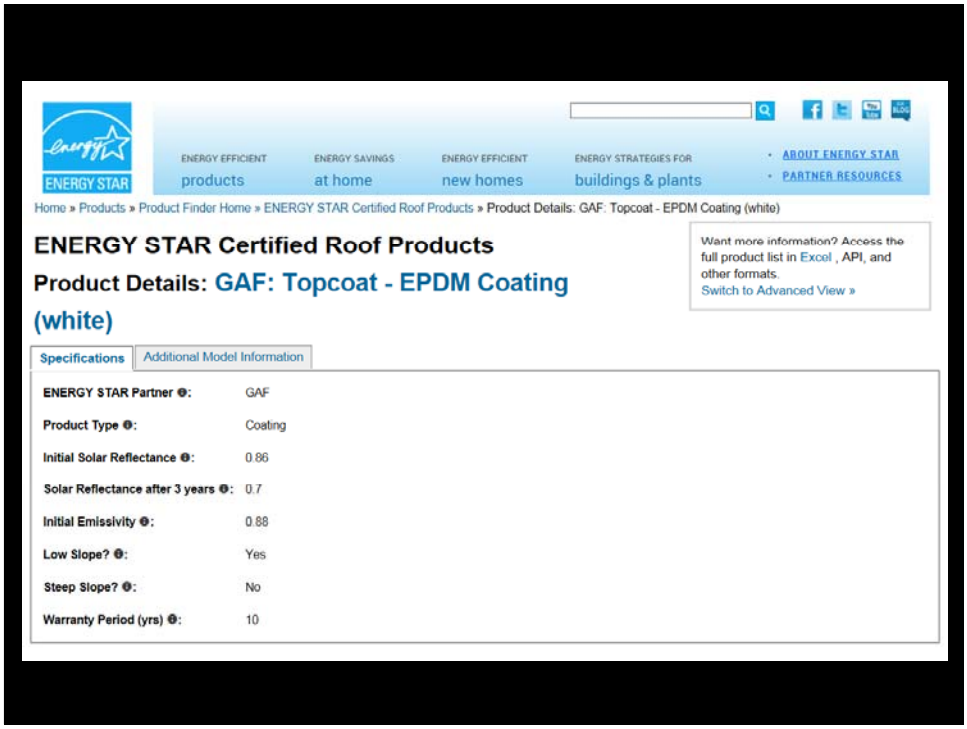
Characteristic	Performance Specification
Low slope roofs:	
Initial solar reflectance	Greater than or equal to 0.65
Maintenance of reflectance	Greater than or equal to 0.50 three years after installation under normal conditions
Warrantee	"…equal in all material aspects to…comparable non-reflective roof 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
Warrantee	"…equal in all material aspects to…comparable non-reflective roof membrane products…"

12

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

13

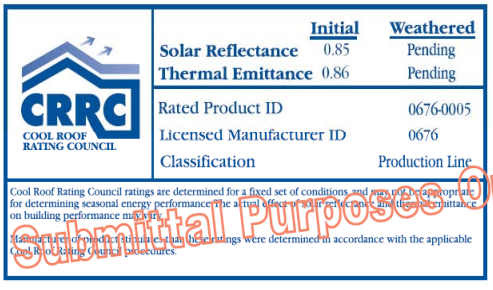




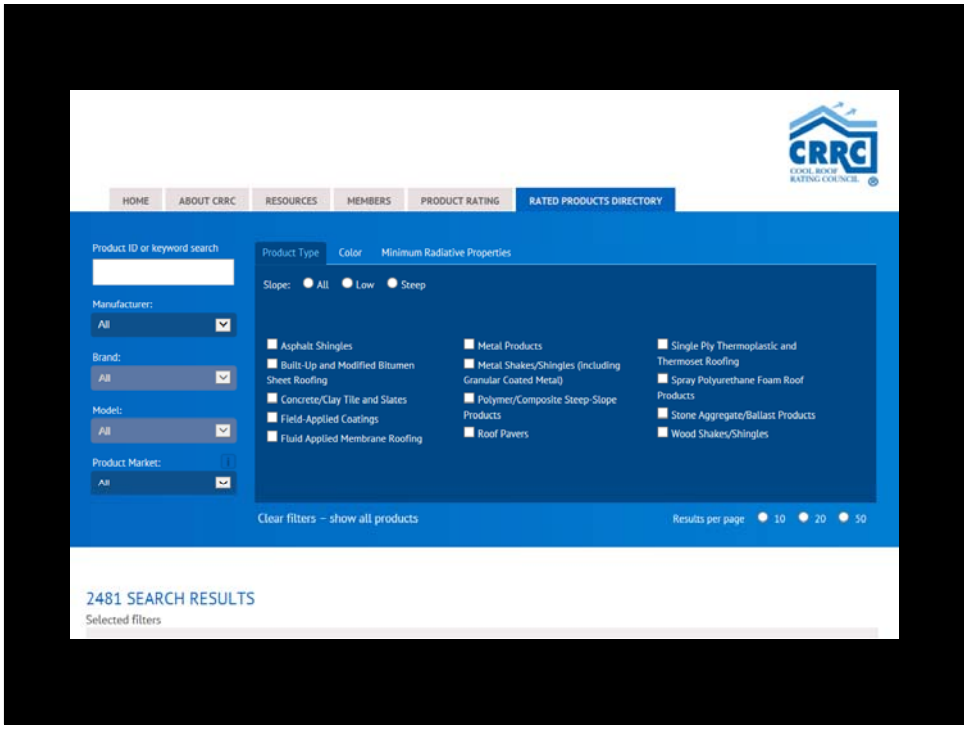
Cool Roofs Rating Council

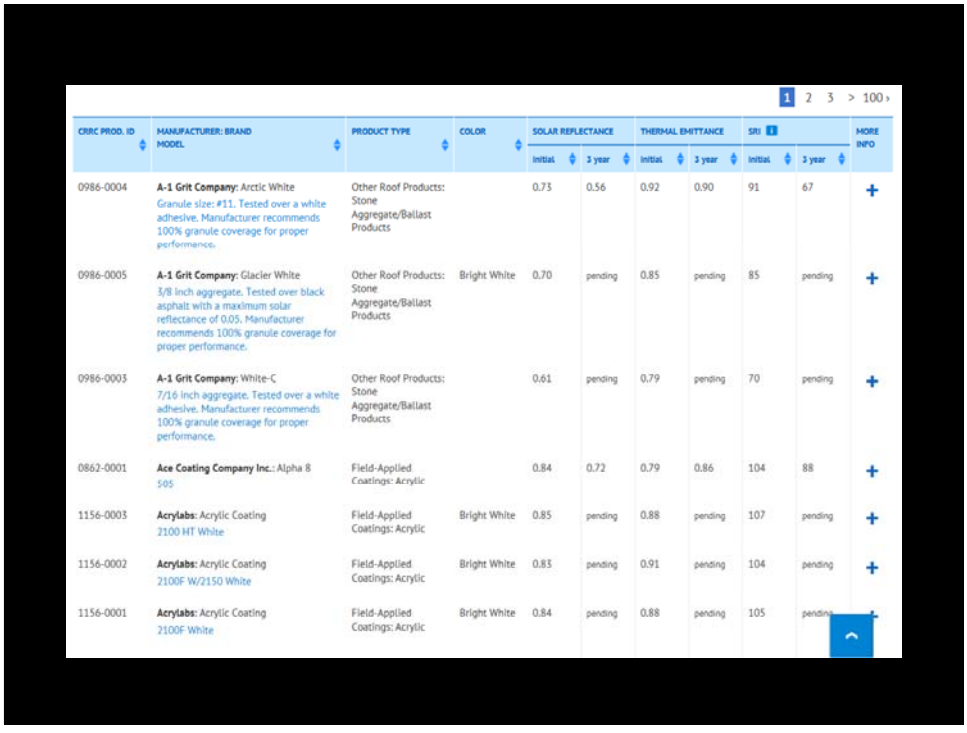
www.coolroofs.org

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



16





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/

19

Vegetative Roof Systems

20

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.

21

22


NATIONAL GEOGRAPHIC


Ford
24

Benefits of vegetative roofs

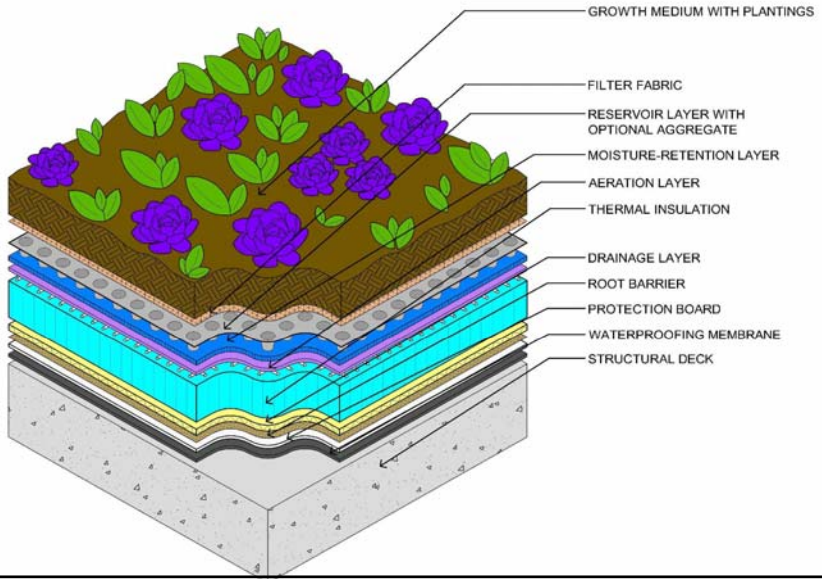
- Aesthetic improvement
- Storm water management
- Mitigation of heat island effect
- Energy efficiency
- Air quality improvement
- Noise reduction
- Increased roof system durability
- LEED® credit
- Rebates and other incentives

27

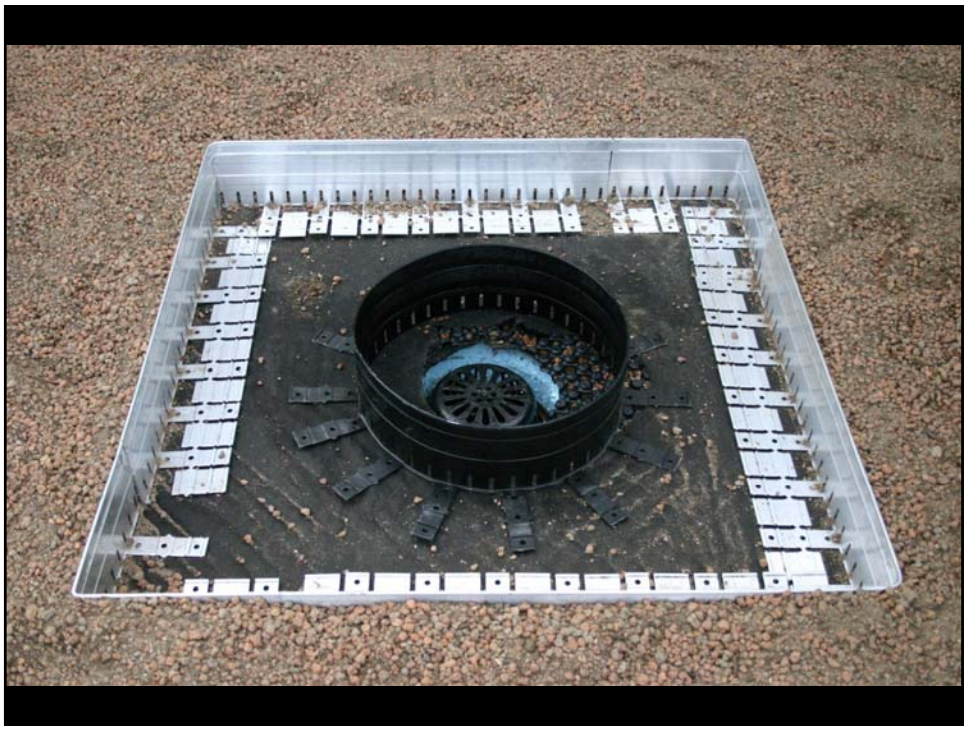
Basic configurations

- Modular systems
- Built-in-place systems

Built-in-place System



Construction Details for Vegetative Roof Systems



Membrane Integrity Testing

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

Vegetative roof systems
require regular maintenance

39

Useful design standards

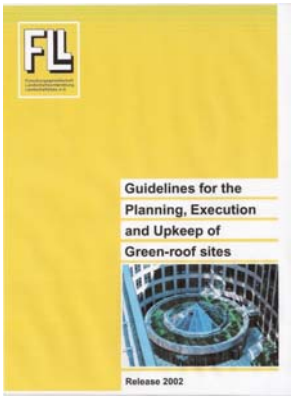
Available at www.spri.org

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

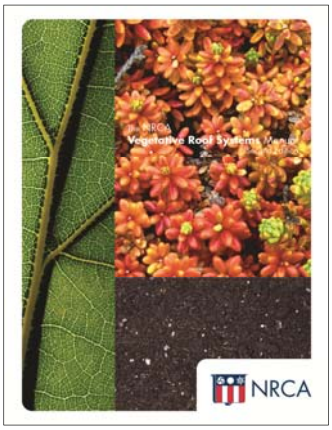
These have not been incorporated into the Code

40

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

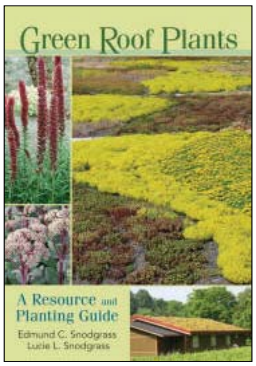


The NRCA Vegetative Roof Systems Manual, Second Edition



Green Roof Plants

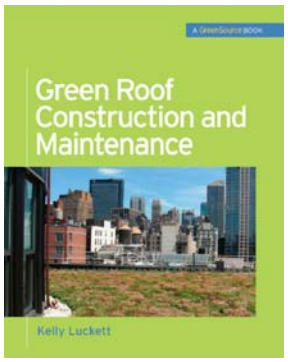
Authors: Edmund C. Snodgrass & Lucie L. Snodgrass



43

Green Roof Construction and Maintenance

Author: Kelly Luckett



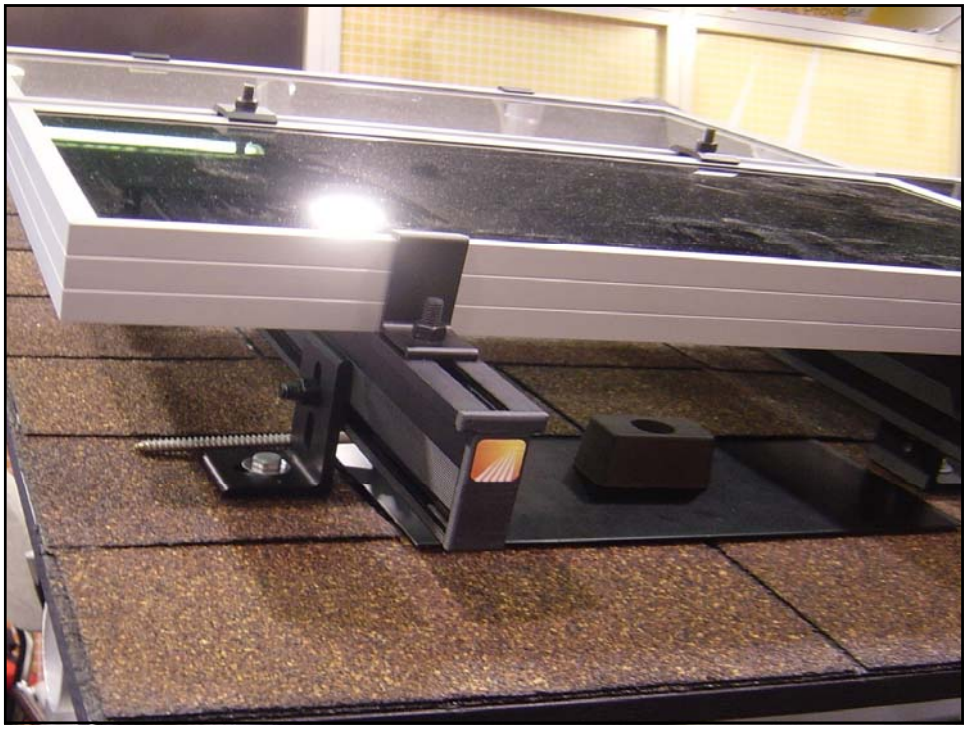
www.greenroofs.com

45

Rooftop Photovoltaics (PV)

46

47



General definition

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

51

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.

52

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

53

PV definitions--illustrated

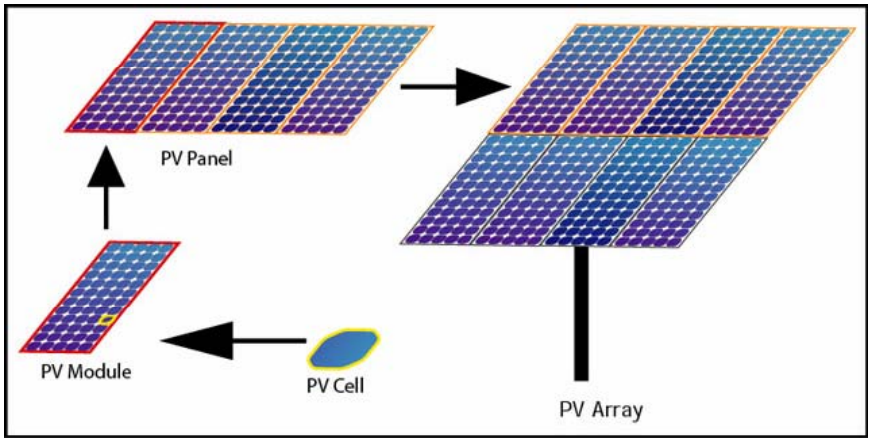


Illustration courtesy of Solar Energy Institute (SEI)

54

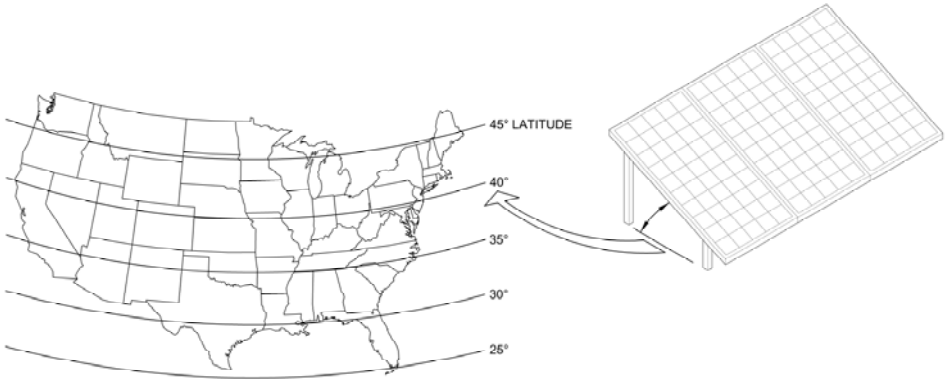
PV Module Types

- 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.

55

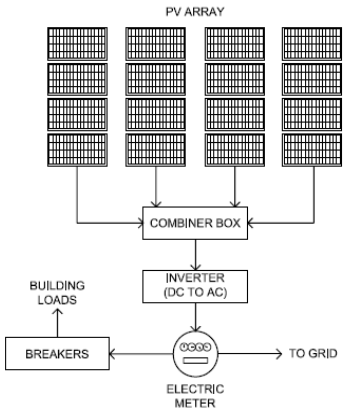
Orientation and angle



56

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



57

Article 690:
Solar Photovoltaic Systems

"…qualified person…"

58

Article 690--Solar Photovoltaic Systems

Required certification of electrical components

PV panels: UL 1703

Inverters, controllers, etc.: UL 1741

Utility interface: IEEE 929

59

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"

60

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

61

Other code requirements

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

62

Rooftop PV Installation Types

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

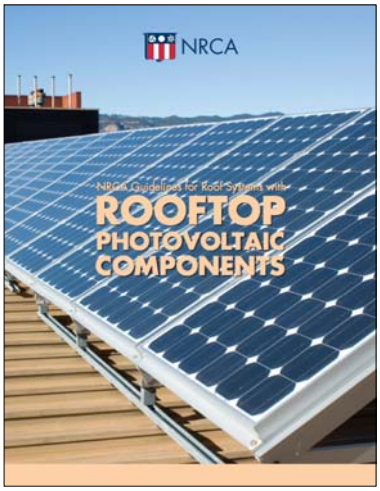
63

Suggested Roofing Guidelines

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

64

NRCA Guidelines for Roof Systems with Rooftop Photovoltaic Components



Database of State Incentives

www.dsireusa.org

66

Emerging technologies

- Surface reflectivity
- Vegetative roof systems
- Rooftop PV

67

Mark S. Graham
Associate Executive Director, Technical Services
National Roofing Contractors Association
10255 West Higgins Road, 600
Rosemont, Illinois 60018-5607

(847) 299-9070
1-800-323-9545
FAX: (847) 299-1183

www.nrca.net
mgraham@nrca.net
Twitter: www.twitter.com/MarkGrahamNRCA
Personal website: www.marksgraham.com