

# **Southern Green Roofs**



**HORT 4000**  
**Katherine Hollifield**  
**July 23, 2016**

What images do you think of  
when you hear the term  
“Green Roof”?



- Green shingles on a roof



[http://www.materials-world.com/shingles/certaineed/independence/sub\\_HunterGreen.htm](http://www.materials-world.com/shingles/certaineed/independence/sub_HunterGreen.htm)

- A green metal roof



<http://ridgeline-metal.com/metal-roofing/>

- A sod roof



<http://landarchs.com/grass-roof/>

- A roof with solar panels



<http://www.directindustry.com/prod/solarworld-ag/product-54786-441838.html>



- Grass growing on a roof

<https://www.pinterest.com/mabely1227/grass-roof/>

- An old roof with moss growing on it



<http://www.sigroofing.co.uk/why-copper-wire-is-the-solution-for-a-moss-free-roof/>

- Carrabba's Italian Grill restaurant



<http://retailrestaurantfb.com/the-latest-news/carrabba-s-italian-grill-names-new-president>

A green roof is a specially prepared roof with plants growing in media.



Chicago Botanic Garden

**Vegetative roof**

**LIVING ROOF**

*Eco roof*

**Other Names**

*Planted rooftop*

**Garden roof**

*Vegetated roof*

# Maintenance

- When green roofs were first installed in the United States, many thought that no maintenance was needed.
- Over the years, those in the industry have noted that these roofs are low maintenance, not “no” maintenance (K. Laminack, with Moore Farms and Botanical Garden, personal communication, 6/25/16).

Kirk Laminack



Kathy Hollifield

# Challenges to Roofs in the South

Because of high heat, irrigation is necessary.

The high humidity in the south adds to the susceptibility of plants to diseases. Pythium can be a problem of southern green roofs, according to Green Roof Outfitters (M. Whitfield and C. Simmons, personal communication 6/14/2016).



Michael  
Whitfield



Chris  
Simmons

# Layers

Each green roof is constructed in layers.

A traditional green roof is constructed by laying down each layer over the entire roof at the same time.



<https://www.youtube.com/watch?v=sQ3veFk1C24>

If using modules, the waterproofing and insulation layers will be installed, and then modules containing the remaining layers will be placed on top.



<https://www.youtube.com/watch?v=jbSqqglpBUE>

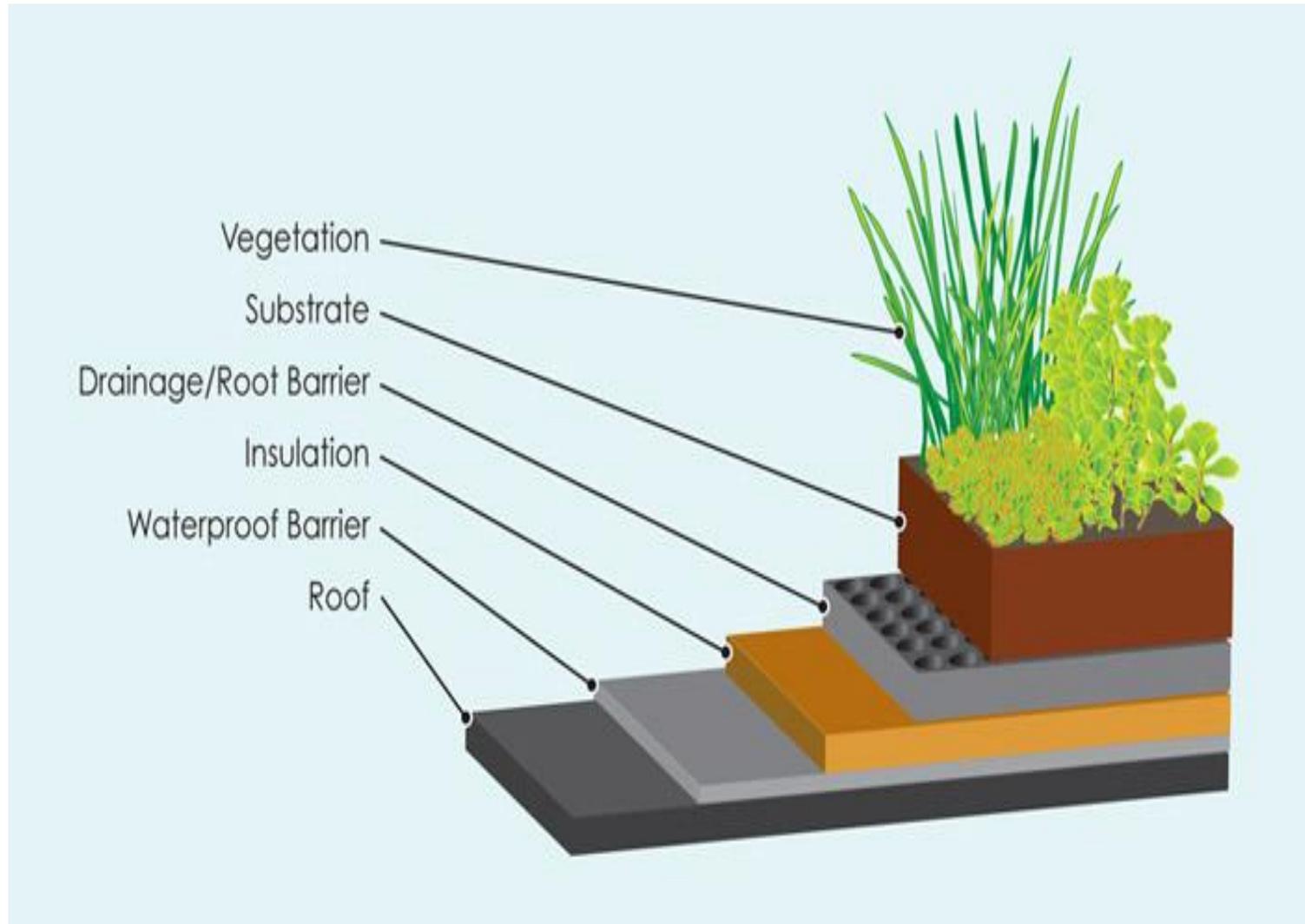
# Layers

The basic layers of a green roof are:

- The roof deck
- A waterproofing membrane
- Root barrier
- Drainage layer
- Insulation (per building code)
- Filter fabric
- Media
- Plants



Kirk Laminack



*Layers of a sustainable green roof.*

Image via Penn State University, Olivia Miller's Blog.  
<http://sites.psu.edu/millerdesignblog/2013/03/12/green-roofs/>

# Waterproof Membrane

It is essential to regularly check for leaks in the waterproofing membrane.

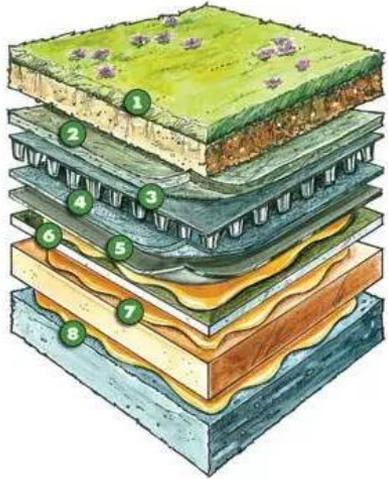


<http://www.doubledogremodel.com/building-a-seattle-green-roof/>

If there is a failure in the membrane, it may be easier to correct the problem if using a modular system such as GROWVista 2, the modular system available through Green Roof Outfitters (M. Whitfield and C. Simmons, personal communication 6/14/2016). Their modules are made of 100% recycled plastics.



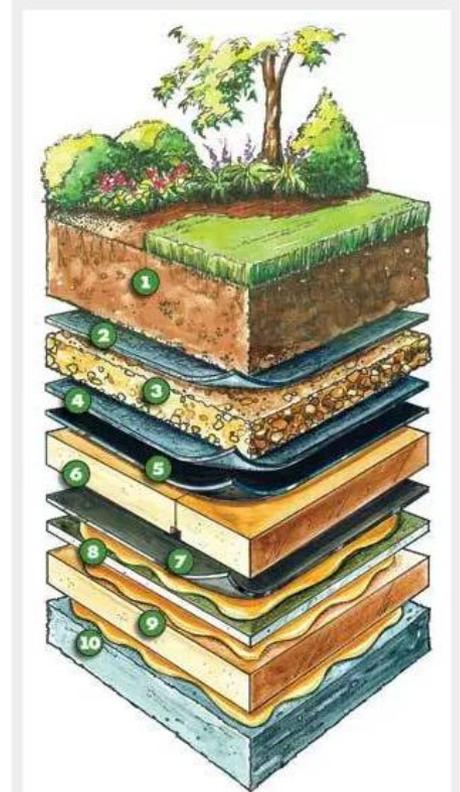
# Types of Green Roofs



Shallow Assembly (extensive) Diagram 1 Growth media 2 Moisture retention mat 3 Drainage board 4 Protection fabric 5 Membrane (adhered) 6 Dens Deck 7 Approved insulation 8 Substrate

<https://theanarchist.wordpress.com/2008/10/06/how-to-build-a-green-wall-or-green-roof/>

- Extensive
  - Media up to 6" deep
- Intensive
  - Media over 6" deep
- Semi-Intensive
  - Media depth between that of extensive and intensive



Deep Assembly (Intensive) Diagram 1 Growth media 2 Protection fabric 3 Drainage gravel 4 Protection fabric 5 Root barrier 6 Extruded polystyrene 7 Membrane (adhered) 8 DensDeck 9 Approved insulation 10 Substrate

<https://theanarchist.wordpress.com/2008/10/06/how-to-build-a-green-wall-or-green-roof/>

Cantor, Steven L. (2008) Green Roofs In Sustainable Landscape Design. W.W. Norton & Company, Inc., New York, N.Y.

GSA. 3.0 Cost Benefit Analysis, GSA Green Roof Benefits and Challenges. [www.gsa.gov/portal/mediad/167839/filename/cost\\_benefit\\_analysis.action](http://www.gsa.gov/portal/mediad/167839/filename/cost_benefit_analysis.action)

GSA. System Overview. <https://sftool.gov/explore/green-building/section/76/green-roof/system-overview>

Philadelphia Water Stormwater Plan Review, 4.3 Green Roofs, <http://www.pwdplanreview.org/manual/chapter-4/4.3-green-roofs>

Upstate Forever. (7/9/16) Green Roofs. [www.upstateforever.org/pdfs/other/caw\\_LIDFact\\_GreenRoofs.pdf](http://www.upstateforever.org/pdfs/other/caw_LIDFact_GreenRoofs.pdf)

# Green Roof Benefits

- Reduce impermeable surfaces
- Increase biodiversity
- Reduce water runoff
- Improve storm water management
- Improve air quality
- Increase life of roof
- Block out noise
- Insulate from summer heat and winter cold (Cantor 2008)

# Green Roof Disadvantages

- Increased weight on roof
  - Platform, media, plants
  - Consultations with engineer/architect

(M. Whitfield and C. Simmons, with Green Roof Outfitters, personal communication 6/14/2016)
- Consult local building codes
- Initial cost



# Incentives

Many states and cities across the country offer tax incentives for adding green roofs to structures to help manage storm water; South Carolina does not.

Michael Whitfield and Chris Simmons, with Green Roof Outfitters, see this as one reason why there are so few green roofs in South Carolina (M. Whitfield and C. Simmons, personal communication 6/14/2016).

# Incentives

Below are a few of the incentives available in other states.

Location	Incentive
Austin, TX	credits
Baltimore, MD	credits are earned to use against storm water management fee
Chicago, IL	green roof fee credit
Cincinnati, OH	green roof loans; storm water management fee credit
Indianapolis, IN	monthly storm water user fee credit
Nashville, TN	green roof rebate
New York, NY	storm water retrofit program construction grant
Portland, OR	\$5/ft <sup>2</sup> incentive
Seattle, WA	storm water management bill credit
Washington, DC	green roof rebate program; storm water fee discount

# Toronto

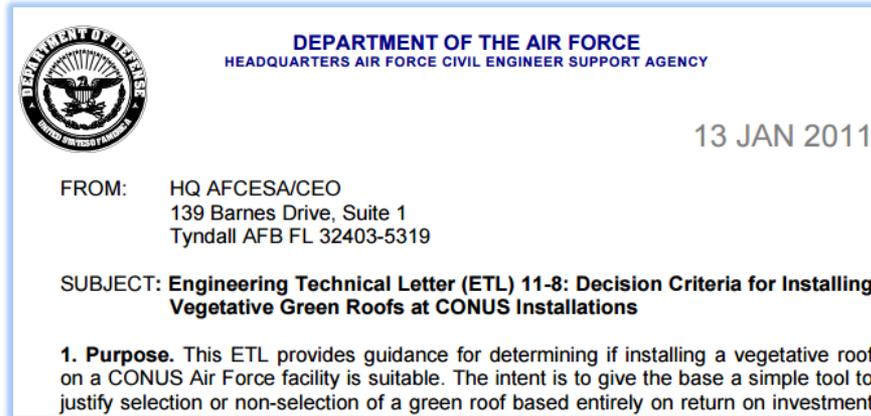
Toronto, Canada has a bylaw that requires green roofs on new construction.

The percentage coverage requirements are:

Gross Floor Area * (Size of Building)	Coverage of Available Roof Space (Size of Green Roof)
2,000-4,999 m <sup>2</sup>	20%
5,000-9,999 m <sup>2</sup>	30%
10,000-14,999 m <sup>2</sup>	40%
15,000-19,999 m <sup>2</sup>	50%
20,000 m <sup>2</sup> or greater	60%

\* Note: Residential buildings less than 6 storeys or 20m in height are exempt from being required to have a green roof.  
<http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=3a7a036318061410VgnVCM10000071d60f89RCRD#thresholds>

# United States Air Force



[https://www.wbdg.org/ccb/AF/AFETL/etl\\_11\\_8.pdf](https://www.wbdg.org/ccb/AF/AFETL/etl_11_8.pdf)

- The United States Air Force published guidelines to instruct users toward the decision to, or not to, install a green roof to save energy (HQ 2011).
- These criteria apply to installations in the Continental United States (CONUS) and their guidelines include a list of bases and each is given a score based on the energy benefits and irrigation demand of a green roof (HQ 2011).
- The highest score (best) possible is 13 and both Charleston AFB and Shaw AFB in South Carolina scored 10, which is considered “fair” in this publication (HQ 201).

# Online Green Roof Energy Calculator

## Green Roof Energy Calculator

GREEN BUILDING RESEARCH LABORATORY

GBRL Home

Facilities

Results and Resources

Faculty & Staff

Ne

### Green Roof Energy Calculator (v. 2.0)

This calculator was developed through a collaboration involving researchers and staff at Port University of Toronto, and Green Roofs for Healthy Cities. The effort was funded by the US G with additional financial and in-kind support from University of Toronto, Portland State Unive Environment Canada.

The green roof energy calculator allows you to compare the annual energy performance of a vegetative **green roof** to the same building with either a **dark roof** or a **white roof**. At the simulations are available for new construction (ASHRAE 90.1-2004) and old construction (pre office and residential buildings driven by typical precipitation and weather data. Representat schedule is optional. [Read more about how the Calculator works.](#)

#### Estimate Annual Green Roof Performance

Would you prefer to use **US Customary** or SI units?

- US Units  
 SI Units

#### Building Information

What State/Province is your building located in?

Rhode Island  
South Carolina  
South Dakota  
Tennessee

What city is your building located in?

Select a City  
Select a City  
Charleston

What is the total area of your **roof**?

Which **Type** is your building?

#### Green Roof Information

One drawback to this site for someone wanting to add a green roof in South Carolina is the fact that Charleston is the only city included in the list (Green).

# Recommended plants

- Plants with Crassulacean Acid Metabolism, CAM, such as *Sedum*, *Allium*, *Euphorbia* and *Delosperma* (Live)
- The Whole Building Design Guide (WBDG) recommends using *Potentilla*, *Carex*, *Phlox*, *Delosperma*, *Crassula*, *Portulaca* and *Aloe* (Miller 2016).
- Plants from these families: Portulacaceae, Crassulaceae and Euphorbiaceae (Li).



<https://www.nyu.edu/about/news-publications/news/2012/05/04/nyu-garden-shop-plant-of-the-week-may-3-2012.html>



<http://www.greenroofplants.com/catalog/plant-catalog/viewplant/?plantid=204>

Li, W.C. (2014). A comprehensive study of green roof performance from environmental perspective. International Journal of Sustainable Built Environment 3, 127-134.

Live Roof. Resources for Architects and Engineers. <http://liveroof.com/architecture-and-engineering/>

Miller, Charlie. (3/14/2016). Extensive Vegetative Roofs, Whole Building Design Guide. National Institute of Building Sciences.

# Guidelines

- International

- Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V., (FLL) Guideline for the Planning, Execution and Upkeep of Green Roof Sites (Philippi; Cantor 2008)
- Free

- United States

- American guidelines (ASTM)
- \$50 (ASTM)

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ASTM E2777 - 14 ⓘ

Standard Guide for Vegetative (Green) Roof Systems

Active Standard ASTM E2777 | Developed by Subcommittee: [D08.24](#)

Book of Standards Volume: [04.04](#)

Format	Pages	Price	
PDF	14	\$50.00	<a href="#">ADD TO CART</a>
Hardcopy ( <a href="#">shipping and handling</a> )	14	\$50.00	<a href="#">ADD TO CART</a>

ASTM International. Standard Guide for Vegetative (Green) Roof Systems. <https://www.astm.org/Standards/E2777.htm>  
Cantor, Steven L. (2008) Green Roofs In Sustainable Landscape Design. W.W. Norton & Company, Inc., New York, N.Y.  
Philippi, Peter M. Introduction to the German FLL-Guideline for the Planning, Execution and Upkeep of Green-Roof Site. <https://www.epa.gov/sites/production/files/documents/IntroductiontotheGermanFLL2.pdf>

# Recommended Plants for the Southeast?

- Many companies sell plant mixes and have a recommended plant list. However, many do not offer either of those for the southeast (Greengrid).

## Recommended Plant Lists

Lower Mid-Western [\[PDF\]](#)  
Northern California [\[PDF\]](#)  
Southern California [\[PDF\]](#)  
Mid-Atlantic [\[PDF\]](#)  
Northeast [\[PDF\]](#)  
Upper Mid-Western [\[PDF\]](#)  
Mountain Region [\[PDF\]](#)  
Pacific Northwest [\[PDF\]](#)

## Pre-Selected Plant Mix Options

Northeast Standard Sedum Mix [\[PDF\]](#)  
Midwest Standard Sedum Mix [\[PDF\]](#)  
Midwest Quick-Cover Sedum Mat [\[PDF\]](#)  
Mid-Atlantic Standard Sedum Mat Mix by Sempergreen [\[PDF\]](#)  
Mountain Standard Sedum Mix [\[PDF\]](#)  
Northeast and West Coast Sedum Mat Mixes by Etera

- Tuff Stuff [\[PDF\]](#)
- Color Max [\[PDF\]](#)
- Sun/Shade [\[PDF\]](#)
- Sweet Tea [\[PDF\]](#)
- All Seasons [\[PDF\]](#)

# Factors of a Successful Green Roof

The factors that make a green roof successful are variable, depending on the point of view.



Jeff Baker and Zack Roach, with Clemson Landscape Services, both agree that one of the factors that make a site successful is plant survival (J. Baker and Z. Roach, personal communication, 7/1/16).

An architect or designer may agree that a successful site is one that adds visual interest and is aesthetically pleasing.

# Successful Green Roofs

VA hospital  
Charleston, SC



# Bon Secours St. Francis Health System Millennium Cancer Treatment Center Greenville, SC



<http://www.livingroofsinc.com/portfolio/commercial/bon-secours-st-francis-health-system-millennium-cancer-center/>

# S.E.W. Eurodrive Lyman, SC



Living  
Roofs Inc.  
SM

<http://www.livingroofsinc.com/portfolio/commercial/s-e-w-eurodrive/>

# J.L. McMillan Federal Building Florence, SC



<http://www.greenroofs.com/projects/pview.php?id=1603>

# Furman Office Building Greenville, SC



<http://www.greenroofs.com/projects/pview.php?id=56>

# USC Darla Moore School of Business Columbia, SC



# Taco Boy Restaurant Charleston, SC



<http://www.livingroofsinc.com/portfolio/commercial/taco-boy-restaurant/>

# 21<sup>st</sup> space wing headquarters building Peterson Air Force Base, CO



<http://www.greenroofs.com/projects/pview.php?id=1243>

# Duke University Ocean Conservation Center Beaufort, NC



<http://www.livingroofsinc.com/portfolio/university/duke-university-ocean-conservation-center/>

# Chicago City Hall Chicago, IL



# Rockefeller Center New York, NY



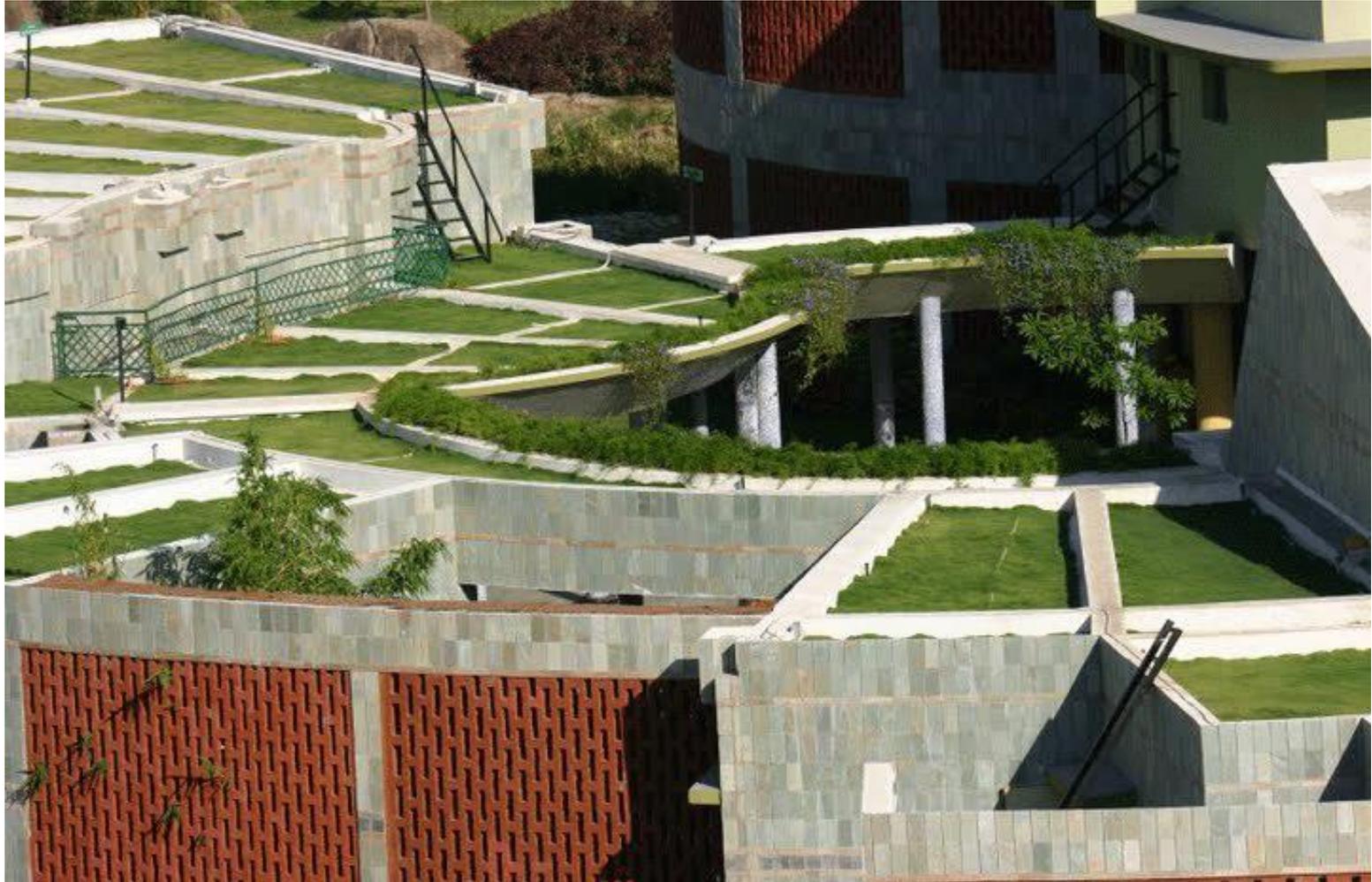
<http://www.powerhousegrowers.com/6-successful-sustainable-green-roof-projects/>

# GENO Haus Stuttgart, Germany



<http://www.powerhousegrowers.com/6-successful-sustainable-green-roof-projects/CII->

# Sohrabji Godrej Green Business Centre Hyderabad, India



# Ford Rouge Center Dearborn, MI



<http://www.powerhousegrowers.com/6-successful-sustainable-green-roof-projects/>

# Moore Farms Botanical Garden Lake City, SC



Kathy Hollifield

# Moore Farms Botanical Garden Lake City, SC



# Moore Farms Botanical Garden Lake City, SC



Kathy Hollifield

# Lee Hall III at Clemson University Clemson, SC



# Lee Hall III at Clemson University Clemson, SC



# Award Winning Green Roofs

2006 Green Roofs for  
Healthy Cities Award of  
Excellence

- Intensive  
Industrial/Commercial  
Category
- Manulife Insurance  
Building
- 601 Congress
- South Boston, MA



<http://www.hydrotechusa.com/projects/601-congress>

# 2003 Green Roofs for Healthy Cities Award of Excellence

- Extensive New Construction Category
- Gap Inc.
- 901 Cherry Avenue
- San Bruno, CA



# 2010 Green Roofs for Healthy Cities Award of Excellence

- Intensive Institutional Category
- American Society of Landscape Architects Headquarters
- Washington, DC



# 2008 Green Roofs for Healthy Cities award of Excellence

- Intensive Institutional Category
- Austin City Hall
- Austin, TX



<http://www.hydrotechusa.com/projects/austin-city-hall>

# 2014 Green Roofs for Healthy Cities Award of Excellence

- Extensive Institutional
- NOAA Southwest Fisheries Science Center
- San Diego, CA



<http://greenroofs.org/index.php/resources/awards-of-excellence/2014-award-winners/2-uncategorised/316-noaa-southwest-fisheries-science-center>

# 2003 Green Roofs for Healthy Cities Award of Excellence

- Extensive Institutional Category
- LDS Conference Center
- Salt Lake City, UT



# 2015 Extensive Industrial/Commercial Green Roof Award

- Berry Architecture Office
- Red Deer, Alberta, Canada



# 2015 Green Roofs for Healthy Cities Award of Excellence

- Extensive Institutional Green Roof Award
- The Krishna P. Singh Center for Nanotechnology
- University of Pennsylvania
- Philadelphia, PA



<http://greenroofs.org/index.php/resources/awards-of-excellence/2015-award-winners/2-uncategorised/346-2015-extensive-institutional>

# 2015 Green Roofs for Healthy Cities Award of Excellence

- Intensive Institutional Green Roof Award
- Helen Schuler Nature Center
- Lethbridge, AB, Canada



# Green Roof of the Year 2014

- Allianz Insurance Company
- Stuttgart, Germany



# 2006 Green Roofs for Healthy Cities Award of Excellence

- Intensive Institutional Category
- Mashantucket Pequot Museum & Research Center
- Mashantucket, CT



# 2014 Green Roofs for Healthy Cities

- Intensive Industrial/Commercial Green Roof Award
- Whole Foods Market
- Lynnfield, MA



# 2006 Green Roofs for Healthy Cities Award of Excellence

- Extensive Institutional Category
- 2006 AIA/COTE Top Ten Green Project
- Ballard Library
- Seattle, WA



2006 Excellence in Irrigation Honor Award from the American Society of Irrigation Consultants and the 2005 Green Roofs for Healthy Cities Awards of Excellence in the Intensive Industrial/Commercial category

- Millennium Park
- Chicago, IL



# South Carolina Green Roof Inventory

- Below is a list of green roofs in South Carolina, as shown on the Greenroofs.com projects database (Greenroofs).
- Users of this site, [www.greenroofs.com](http://www.greenroofs.com) can sort the database by project name, roof size, project year, location, roof size, designer and more (Greenroofs).

Project	Year	Location	Roof Size	
<a href="#">1630-2 Meeting Street, "The Refinery"</a>	2014	Charleston, SC, USA	2300 ft <sup>2</sup>	214 m <sup>2</sup>
<a href="#">Moore Farms Botanical Garden Research Roof (and Wall)</a>	2011	Lake City, SC, USA	6000 ft <sup>2</sup>	557 m <sup>2</sup>
<a href="#">Private Kiawah Island, SC Residence</a>	2011	Kiawah Island, SC, USA	1500 ft <sup>2</sup>	139 m <sup>2</sup>
<a href="#">Private Rock Hill, SC Residence</a>	2011	Rock Hill, SC, USA	348 ft <sup>2</sup>	32 m <sup>2</sup>
<a href="#">Private Lexington, SC Residence</a>	2011	Lexington, SC, USA	800 ft <sup>2</sup>	74 m <sup>2</sup>
<a href="#">J.L. McMillan Federal Building/ Courthouse</a>	2011	Florence, SC, USA	28500 ft <sup>2</sup>	2648 m <sup>2</sup>
<a href="#">AJ Whittenberg High School</a>	2010	Greenville, SC, USA	600 ft <sup>2</sup>	56 m <sup>2</sup>
<a href="#">Founders Federal Credit Union Corporate Office</a>	2010	Lancaster, SC, USA	1850 ft <sup>2</sup>	172 m <sup>2</sup>
<a href="#">Taco Boy</a>	2009	Charleston, SC, USA	2500 ft <sup>2</sup>	232 m <sup>2</sup>
<a href="#">Carolina First</a>	2008	Greenville, SC, USA	1938 ft <sup>2</sup>	180 m <sup>2</sup>
<a href="#">Circular Congregational Church - Lance Hall Addition</a>	2007	Charleston, SC, USA	700 ft <sup>2</sup>	65 m <sup>2</sup>
<a href="#">Charleston Residence (pool/guest house)</a>	2007	Charleston, SC, USA	800 ft <sup>2</sup>	74 m <sup>2</sup>
<a href="#">Furman Office Building</a>	2004	Greenville, SC, USA	4200 ft <sup>2</sup>	390 m <sup>2</sup>

Total Queried Roof Size: 52,036 ft<sup>2</sup> (4,834 m<sup>2</sup>)

This database is not a complete list of green roofs in South Carolina. For example, the following projects are not listed. (J. Baker and Z. Roach, personal communication, 7/1/16; Livingroofs)

Project	Year	Location	Roof Size
Lee Hall III	2012	Clemson University	30,000 ft <sup>2</sup>
S.E.W Eurodrive	2013	Lyman, SC	3,000 ft <sup>2</sup>
Bon Secours St. Francis Health System Millennium Cancer Treatment Center	2014	Greenville, SC	1,700 ft <sup>2</sup>

Livingroofs, Inc. <http://www.livingroofsinc.com/portfolio/commercial/s-e-w-eurodrive/>

Award winning green roofs are not located in the southeast, so they are not exposed to the hot, humid conditions experienced in South Carolina.

Green roof research is lacking in South Carolina.

This is shown in the lack of plant survival in the sedum mats that were installed on the green roof on Lee Hall III at Clemson University (J. Baker and Z. Roach, personal communication, 7/1/16).

Kirk Laminack, with Moore Farms and Botanical Garden in Lake City, SC, noticed that sedums do not do well on green roofs in South Carolina (K. Laminack, Personal Communication, 6/25/16).



# Recommendations

- Green roofs should be tailored to local climates.
- Someone should think outside the sedum box to discover the varieties of plants that are best suited for southern green roofs.

