

## Southern Green Roofs

What images come to your mind when you hear the term Green Roof? Some people see images of a roof with green shingles, a metal roof painted green (D. Moran, with Greenville Technical College, personal communication, 6/16/2016), a sod roof, a roof with solar panels, grass growing on a roof, an old roof with moss growing on it (C. Hawkins, with Greenville Technical College, personal communication, 6/16/2016 ) or Carrabbas Italian Grill restaurant. Does the term “environmentally friendly” come to mind (A. Morgan, with Greenville Technical College, personal communication, 6/16/2016)? A green roof is a specially prepared roof with plants growing in media. There are other names that refer to the same thing such as eco roof, vegetative roof (Miller 2016), vegetated roof (Philadelphia), living roof, garden roof, and planted rooftop, to name a few. If the roof is not green all year, it will more likely be called a vegetative roof or a living roof. A roof may also be called “green” if the roof contains solar panels and no plants.

When green roofs were first installed in the United States, many thought that no maintenance was needed. There would be no need to weed, water, or monitor for nutritional deficiencies and diseases. One green roof design and consulting firm still recommends no permanent irrigation for these low maintenance gardens (Green). This may be more appropriate in cooler environments. 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). Weeds find their way onto green roofs, so they need to be weeded regularly. These roofs,

especially in the south, get very dry because of high heat. Incorporating some kind of irrigation helps them to succeed. 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).

One of the components of a green roof is a waterproof membrane. It is essential to regularly check for leaks in the waterproofing membrane. 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). Michael Whitfield and Chris Simmons, of Green Roof Outfitters in Charleston, SC, manufacture and sell the GROWVista 2 green roof modular system (M. Whitfield and C. Simmons, personal communication 6/14/2016). They are continuously revising the design of their modules to accommodate the needs of southern green roofs (M. Whitfield and C. Simmons, personal communication 6/14/2016). Their current design allows for water collection, so that plants do not dry out so quickly. It also allows for an irrigation system to be incorporated into the roof (M. Whitfield and C. Simmons, personal communication 6/14/2016).

There are two types of green roofs. They are extensive and intensive (Cantor 2008). Extensive roofs are generally considered to contain media depths up to 6", and intensive media depths over 6" (Cantor 2008; GSA Cost; Cutlip 2006; Philadelphia; GSA System; Upstate). Some include a third category called semi-intensive, in which the depth of the media is in between the extensive and intensive roof media depths

(Cantor 2008). These figures vary across literature, as one source notes that intensive roof depth begins at 12" deep (Upstate). Roofs that contain a combination of extensive and intensive green roofs generally are more appealing as they can accommodate a higher variety of plant species. In turn, they attract a higher variety of animal species. Extensive green roofs dry out faster than intensive roofs. There may be more weed pressure in intensive roofs due to deeper media and media that does not dry out as quickly.

Growing media for green roofs is made of a mixture to ensure that it is light weight, drains well and holds moisture. The media can include "crushed expanded shale, pumice, lava (scoria), terra cotta, calcined clay, expanded slate, or brick" (Cantor 2008).

Green roofs vary in slope. Flat roofs are more energy efficient, but a small slope is best (10-20% pitch) for proper drainage (Cutlip 2006). Anything with a greater slope will require more anchors to keep the plants from sliding (Cutlip 2006).

The benefits of green roofs are many. For example, they reduce the amount of impermeable surfaces, increase biodiversity, reduce roof water runoff, improve storm water management, improve air quality, increase life expectancy of the roof and block out noise. They can also clean the air and reduce energy consumption by insulating the structure from summer heat and winter cold (Cantor 2008). The addition of a green roof is also a way to recycle, increase greenspace, increase aesthetics and provide job opportunities. Green Roof Outfitters, which produces a modular system, uses 100% recycled plastics in their products (M. Whitfield and C. Simmons, with Green Roof Outfitters, personal communication 6/14/2016).

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). Below is a list of 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

(<http://www.vegetalid.us/green-roof-technical-resources/green-roof-and-stormwater-management-incentives.html>)

Toronto, Canada has a bylaw that requires green roofs on new construction. “The Bylaw requires green roofs on new commercial, institutional and residential development with a minimum Gross Floor Area of 2,000m<sup>2</sup> as of January 31, 2010. Starting April 30, 2012, the Bylaw will require compliance with the Bylaw for new industrial development” (City).

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>

The United States Air Force has published guidelines to instruct users toward the decision to, or not to, install a vegetative roof to save energy (HQ 2011). These criteria apply to installations in the continental United States (CONUS). 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 2011).

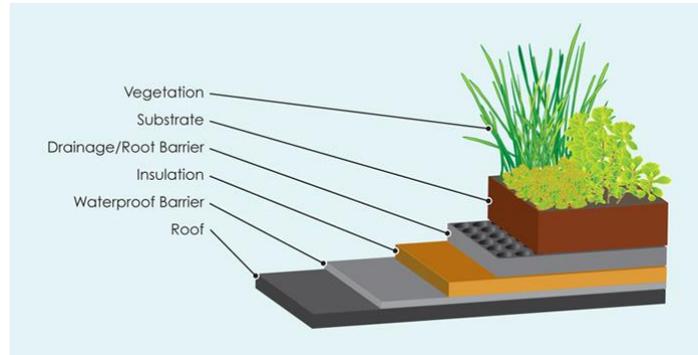
For anyone wanting to see how they would benefit from having a green roof, there is an online green roof energy calculator. This site lets visitors “compare the annual energy performance of a building with a vegetative green roof to the same building” with a conventional roof. Visitors to this site choose the state and city, area of the roof, and media depth, among other factors. 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).

There are disadvantages to having a green roof. The weight of the green roof platform, substrate, plants and water can be too heavy for many roofs. Before installing a green roof, an engineer and/or architect should be contacted to find out how much weight the existing roof can handle (M. Whitfield and C. Simmons, personal communication 6/14/2016). Then, these professionals will advise as to the best way to prepare the roof structure for the extra weight. This can be quite costly and must be considered before committing to the project.

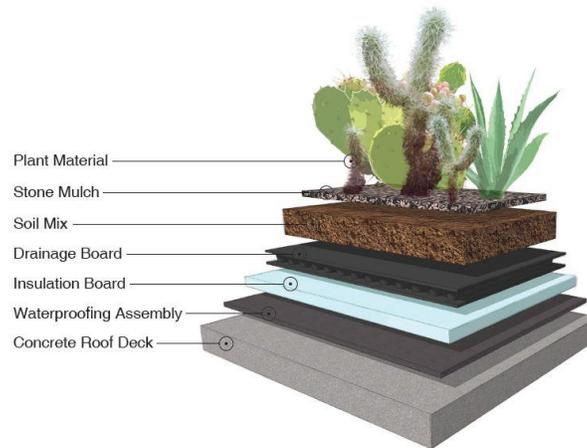
A lot of planning is involved before a green roof can be installed. When considering adding a green roof, it is a smart building owner who checks with the local city/town to verify that green roofs are allowed and to find out if there are any restrictions. After making sure to have a roof that can withstand the weight, accurate measurements must be taken. The installer must do site visits to see if there is enough room for the trucks to bring all of the equipment and supplies to the site. There will also be permits to obtain and even a crane may be required to move supplies to the roof.

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. If using modules, the waterproofing and insulation layers will be installed, and then modules containing the remaining layers will be placed on top. Regardless of which type is used, all include the basic layers. These layers are the roof deck, a waterproofing membrane, root barrier, drainage layer, insulation (per building code) (K. Laminack, with Moore Farms and Botanical Garden, personal communication, 6/25/16), filter fabric, media and plants. Drainage layers can be “simple geocomposite drain layers, reservoir sheets, and granular mineral medium” (GSA system). It is common to also have a gravel ballast around the perimeter of the green roof, around skylights chimneys, etc. (Upstate). The gravel area is the vegetative free zone (VFZ).

Below are a few examples of the layers in a green roof.



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/>



<https://swfsc.noaa.gov/textblock.aspx?id=18479>

### A module from Green Roof Outfitters



<http://greenroofoutfitters.com/green-roof-system/modular-options/intensive-green-roof-system/>

When planning a green roof, Vegetal I.D. suggests considering the following factors before beginning installation (Vegetalid):

- climate
- decking
- desired vegetation and aesthetic appearance
- safe working load
- roof pitch
- roof location and exposure
- rooftop accessibility
- building standards

The guidelines for green roofs, Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V., (FLL) Guideline for the Planning, Execution and Upkeep of Green Roof Sites, Release 2002, is a document produced in Germany (Philippi; Cantor 2008). These guidelines are free to anyone, unlike the American guidelines (ASTM), which cost \$50 (ASTM). One analysis recommends that the ASTM “include the need for more collaborative research and development in efforts to advance existing and new guidelines across ecoregions” (Dvorak 2011).

The company, Live Roof, recommends that plants with Crassulacean Acid Metabolism, CAM, be selected for use on green roofs (Live). CAM plants conserve water by opening their stomata at night. Some of the plants that Live Roof recommends for green roofs are *Sedum*, *Allium*, *Euphorbia* and *Delosperma* (Live). The Whole Building Design Guide (WBDG) recommends using *Potentilla*, *Carex*, *Phlox*, *Delosperma*, *Crassula*, *Portulaca* and *Aloe* (Miller 2016). One Hong Kong study recommends plants from these families: Portulacaceae, Crassulaceae and Euphorbiaceae (Li).

Green roof installers commonly recommend planting extensive roofs with sedums as they generally do better in shallow media, and a majority of green roofs are

located in climates cooler than the southeastern United States. Other plants, such as “small grasses, herbs and flowering herbaceous plants” are also recommended for extensive roofs (Extensive).

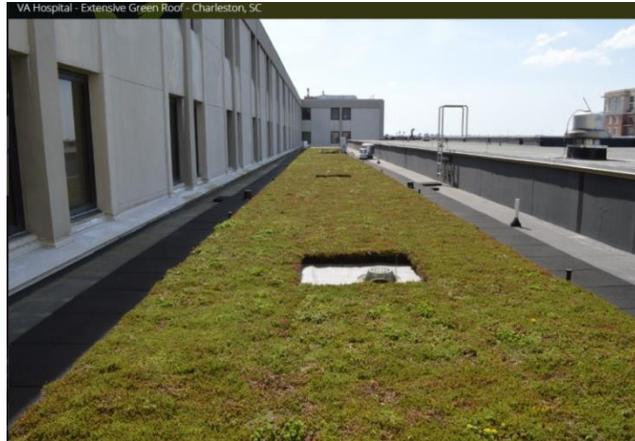
Various companies sell plants for green roofs. On Green Grid Roofs’ website, listed are several links to show products that they sell. For example, they sell “pre-selected plant mix options” and it also shows “recommended plant lists” (Greengrid). Neither of these sections offered choices for the southeast area of the United States (Greengrid).

American Hydrotech, a green roof installer, does not recommend sedums for southern green roofs. They are not a viable option. They do, however, suggest that other “succulents, natives, grasses and perennials” can be used (American).

Green Roof Plants actually has a Southeast Blend in their plant selection list (Green Roof Plants). This is encouraging, since it is not always easy to find plants for the southern green roof. Since the site mentions that their Southeast Blend tolerates shade, one wonders how well this mix will tolerate the high humidity, full sun, and high temperatures in South Carolina.

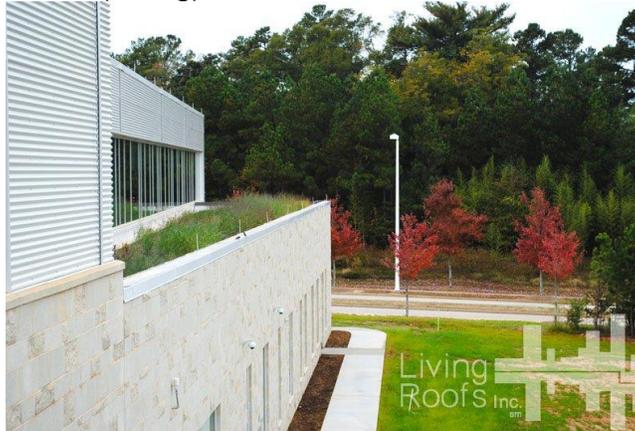
The factors that make a green roof successful are variable, depending on the point of view. Jeff Baker and Zack Roach, with Clemson Landscape Services, both agree that one of the factors that make a site successful is plant survival (J. Baker and Z. Roach, personal communication, 7/1/16). An architect or designer may agree that a successful site is one that adds visual interest and is aesthetically pleasing. Below are examples of successful green roofs.

Green Roof Outfitters considers the green roof on the VA hospital in Charleston, SC successful because the roof of chives and sedums is outside the End of Life wing at the hospital (M. Whitfield and C. Simmons, personal communication 6/14/2016).



<http://greenroofoutfitters.com/about/featured-projects/#!>

The green roof at Bon Secours St. Francis Health System Millennium Cancer Treatment Center in Greenville, SC is a semi-intensive roof with “ornamental and native grasses” (Living). This site is considered successful because patients can look out at this roof while undergoing treatment (Living).



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

The green roof at S.E.W. Eurodrive, in Lyman, SC is “accessible to employees” and includes “tables, chairs, and walkways” (Living).



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

The green roof at the J.L. McMillan Federal Building in Florence, SC, is one of the largest green roofs in South Carolina.



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

The Furman Office Building in Greenville, SC has a green roof. Initially, it was not successful. The roof was originally planted with “a pre-grown vegetation mat” like others installed in northern areas (greenroofs.com), but were not successful. Later, “new growing media” and plants were installed (greenroofs.com). Almost one year later, there was “almost 70% coverage” at the satisfaction of the customer (greenroofs.com).



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

The USC Darla Moore School of Business in Columbia, SC (Living).



<http://www.livingroofsinc.com/portfolio/university/usc-darla-moore-school-of-business/>

Taco Boy restaurant in Charleston, SC (Living).



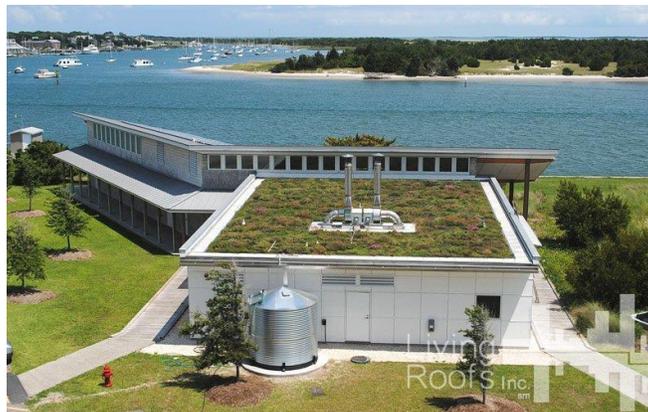
<http://www.livingroofsinc.com/portfolio/commercial/taco-boy-restaurant/>

There is a green roof on the 21<sup>st</sup> space wing headquarters building at Peterson Air Force Base, CO. This roof is “about 67 degrees cooler than the nearby 21<sup>st</sup> Mission Support group building” (Greenroofs).



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

Duke University Ocean Conservation Center green roof in Beaufort, NC. This roof did not undergo any “soil erosion or damage” after experiencing two hurricanes (Living).



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

Chicago City Hall, Chicago, IL “rooftop garden”



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

Rockefeller Center, New York, NY green roofs.



<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 green roof in Hyderabad, India (Powerhouse).



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

Ford Rouge Center green roof in Dearborn, MI (Powerhouse). This green roof covers ten acres (Powerhouse).



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

Moore Farms Botanical Garden, Lake City, SC. Southern green roof research is being conducted at this location (K. Laminack, Personal Communication, 6/25/16).



Kathy Hollifield



Kathy Hollifield



Kathy Hollifield



Kathy Hollifield

Lee Hall III Garden Roof at Clemson University, Clemson, SC.



Below are award winning green roofs from around the world.

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



<http://www.hydrotechusa.com/projects/901-cherry-avenue-gap>

2010 Green Roofs for Healthy Cities Award of Excellence  
Intensive Institutional Category  
American Society of Landscape Architects Headquarters  
Washington, DC



<http://www.hydrotechusa.com/projects/american-society-landscape-architects-headquarters-0>

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



<http://www.hydrotechusa.com/projects/lds-conference-center>

2015 Extensive Industrial/Commercial Green Roof Award  
Berry Architecture Office  
Red Deer, Alberta, Canada



<http://greenroofs.org/index.php/resources/awards-of-excellence/2015-award-winners/2-uncategorised/345-2015-extensive-industrial-commercial>

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



<http://greenroofs.org/index.php/resources/awards-of-excellence/2015-award-winners/2-uncategorised/352-2015-intensive-institutional>

Green Roof of the Year 2014  
Allianz Insurance Company  
Stuttgart, Germany



<http://www.greenrooftechology.com/green-roof-blog/green-roof-of-the-year-2014>

2006 Green Roofs for Healthy Cities Award of Excellence  
Intensive Institutional Category  
Mashantucket Pequot Museum & Research Center  
Mashantucket, CT



<http://www.hydrotechusa.com/projects/mashantucket-pequot-museum-research-center>

2014 Green Roofs for Healthy Cities  
Intensive Industrial/Commercial Green Roof Award  
Whole Foods Market  
Lynnfield, MA



<http://www.greenroofs.com/projects/pview.php?id=1612>

2006 Green Roofs for Healthy Cities Award of Excellence  
Extensive Institutional Category  
2006 AIA/COTE Top Ten Green Project  
Ballard Library  
Seattle, WA



<http://www.hydrotechusa.com/projects/ballard-library>

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



<http://www.greenroofs.com/projects/pview.php?id=459>

Several things stand out with successful green roofs. The award-winning roofs discovered through this research are accessible to the public or to employees, capture and recycle rain water, clean the air, combat the heat island effect, and they enrich the lives of cancer patients. Chicago's City Hall green roof was built to clean the air and combat the heat island effect (Powerhouse). Rockefeller Center's Green Roofs are more than 75 years old and are used by employees (Powerhouse). GENO Haus's green roof in Stuttgart, Germany, is 47 years old and is open to the public (Powerhouse). CII-Sohrabji Godrej Green Business Center's green roof is used to recycle water, which has resulted in a decrease of 35% in "its municipal potable water utility consumption (Powerhouse). The Ford Rouge Center's green roof in Dearborn, MI is large, 10.4 acres and was installed to collect and filter rain water (Powerhouse). Other benefits of the Ford green roof are "improved building insulation" and creation of a wildlife habitat (Powerhouse). The green roof at the Bon Secours St. Francis Health System Millennium Cancer Treatment Center in Greenville, SC are located where patients can easily see them (Livingroofs).

Award winning green roofs can be observed by the public and employees, can serve as teaching labs, and even though some cost a lot of money, they can reclaim old, rundown areas and bring life back into those buildings. The Ballard Library green roof in Seattle, WA can be seen via an observation deck (American). The area used by this building has reduced its hardscape to 20% of the lot (American). The Mashantucket Pequot Museum & Research Center green roof in Mashantucket, CT is accessible to the pedestrians (American). The LDS Conference Center green roof in Salt Lake City, UT houses a large meadow (American). The green roof at Austin City Hall in Austin, TX contains gardens on more than one level and is easily visible to pedestrians (American). The Gap Inc.'s green roof was designed to use "native grasses and wildflowers" so as to blend in with the landscape (American). The green roof on the Allianz Insurance Company building in Stuttgart, Germany, utilizes an underground irrigation system which has not interfered with the lawn and shrubs for more than 30 years (Greenrooftechology.com). The Berry Architecture Office green roof in Red Deer, AB, Canada, is a building that was an old bowling alley (Greenroofs.org). The roof features a flowing stream (Greenroofs.org). Millennium Park's green roof in Chicago, IL covers below-ground parking lots, "a commuter rail line, and an opera hall" (Greenroofs.com).

Below is a list of green roofs in South Carolina, as shown on the Greenroofs.com projects database (Greenroofs). Their "International Greenroof & Greenwall Projects Database" contains "1,648 projects" equaling "35,564,920 ft<sup>2</sup>" of green roofs and green walls from across the world (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="#">A.J. 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>)

<http://www.greenroofs.com/projects/plist.php>

This database is not a complete list of green roofs in South Carolina. For example, the following projects are not listed.

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>

(J. Baker and Z. Roach, personal communication, 7/1/16; Living)

The following table compares qualities of award-winning green roofs from around the world with those in South Carolina.

Projects:	Lee Hall	Moore Farms	Bon Secours	Taco Boy	J.L. McMillan Federal Building	S.E.W. Eurodrive
Cost		\$20-25/ft <sup>2</sup>				
Public can view	X	X	X	X		X
Irrigation	X	X	X	X	X	
Southern Climate	X	X	X	X	X	X
Reclaimed space		X		X		
Educational	X	X				
Years Installed	2012	2011	2014	2009	2011	
High profile location		X		X		
Native plant species			X			

Extensive	X			X	X	X
Intensive		X				
Semi-Intensive			X			
Rainwater harvesting/ recycling		X		X		
Roof Size	30,000 ft <sup>2</sup>	6,000 ft <sup>2</sup>	1,700 ft <sup>2</sup>	2,500 ft <sup>2</sup>	28,500 ft <sup>2</sup>	3,000 ft <sup>2</sup>
Plants used	at least 9 varieties of sedum	grasses, perennials, succulents, bulbs, vegetables	native and ornamental grasses	deciduous and evergreen drought tolerant species	sedums, delosperma, talinum, allium	southeast extensive mix
Architect	McMillan Pazdan Smith	Joe Rogers	McMillan Pazdan Smith	Kevan Hoertdoerfer Architects	ALR Architecture, PC	McMillan Pazdan Smith
Pitch		4:12				
Slope					1%	
Traditional	X	X	X	X	X	X
Modular						

The 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). He did notice that cacti do well, but it is difficult to weed around them. He also mentioned that *Nepeta*, *Agave*, *Cuphea* and clump grasses, such as *Muhlenbergia*, have done well on the southern green roof (K. Laminack, Personal Communication, 6/25/16). Green roofs should be tailored to local climates. What is needed is for someone to think outside the sedum box to discover the varieties of plants that are best suited for southern green roofs.

## Works Cited

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