

Download Edition

# The Green Roof



## pocket guide

Published by The Green Roof Forum

# Look up!

A sustainable and innovative design opportunity exists right above our heads - **green roofs**.

This guide provides a brief introduction to green roofs, answers key questions, and gives sources of further information. Developers, planners and architects are encouraged to realise the economic, social and environmental potential of growing plants on roof tops.

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## What is a green roof?

A green or living roof is essentially the growing of plants on our roof tops. The insulating properties of soil and plants have been utilised by humans for thousands of years, cooling buildings in Africa and helping to retain heat in traditional buildings of North Europe and Scandinavia. Traditional urban roof gardens have largely been restricted to growing plants in containers and planters or spreading top soil across the roof. In recent times the development of multi layered systems which re-create growing conditions across the roof has opened up a variety of planting options. Green roofs can be anything from a thin growing layer of sedums and mosses to plants, shrubs, water features and even golf courses.



Green roofs can provide valuable green space in the built environment.  
West One roof terraces, Sheffield

There are three recognised approaches to roof greening emerging in this expanding industry: (Intensive, Semi-Extensive, Extensive)

**Intensive:** Consists of a thick layer of soil (100mm+) in which a variety of plants, vegetables, shrubs and trees can be grown. Such roof gardens are often accessible and can even be used for recreational facilities and public spaces. They provide a valuable habitat for wildlife but require frequent maintenance, comparable to that in a normal

garden, and place significant weight on the building structure.



Exhibition Hall  
Basel Switzerland

**Extensive:** Generally a shallow layer (25-100mm) of substrate planted with low-growing, stress-tolerant grasses, mosses and alpine species (e.g. Sedum). These light-weight systems require little or no maintenance, and do not impose any significant weight on the building structure.

There are generally considered to be three different approaches to Extensive Roof greening:

#### a) Sedum Roofs

These are usually pre-grown sedum mats based on 20mm of substrate or systems of greater substrate depth (standard depth = 70mm) in which sedums can be seeded or planted.



Offices, Basel Switzerland

#### b) Meadow Roofs

These roofs are based on 70-100mm substrate depth. They involve the use of seeded or planted low, drought-tolerant grasses, perennials and alpine species. These can be native or ornamental species.



Herb and Sedum Semi-extensive roof on a private dwelling. (© Bauder)

### c) 'Brown' or Biodiversity' Roofs

Such roofs are designed to recreate natural and often local habitats rich in birds, plants and insects. This is often done by using the by-products of the development process such as rubble and subsoil which are left to colonise naturally

overtime or seeded with wildflowers.

#### **Semi-Extensive:**

Of slightly greater depth than extensive systems (100-200mm), allowing for a greater diversity of plants to be grown and local habitats recreated. Based on the same principles as extensive roofs they are light weight and generally low maintenance.



Chicago City Hall illustrates the greater planting potential with greater substrate depth. (© Dr Nigel Dunnett)

## Do green roofs cost more?

The initial cost of a green roof is higher than for a standard roof; however this is offset by the full lifecycle costs:

### Increased Life Expectancy

Roof membranes protected from UV and weather damage by green roofs have a life expectancy two to three times greater than conventional roofs. The roof membrane underlying the Derry and Toms green roof in Kensington, London is in excellent condition over 60 years after its installation.

### Energy Savings

The insulation offered by green roofs considerably lowers heating and cooling bills. Studies in Canada found that the average daily energy demand to condition the space of a building under a green roof over the spring and summer was 75% less than under a conventional roof. German studies estimate that even light weight green roofs can offer electricity savings of around £5.20 m<sup>2</sup> p.a.

*“An industrial plant in Germany used for storing and cooling cider recovered the cost of the green roof it had installed within two to three years through the savings in heat and cooling costs, and the reduction in industrial equipment associated with these activities.”*

### Meeting Building Standards

By improving the energy performance of buildings, green roofs help to meet standards such as the Code for Sustainable Homes and BREAM. For example a green roof can score an extra 6.92% on an EcoHomes score. The construction industry is now required by the government to

embrace sustainable design techniques to meet the revision to Part L building regulations which requires at least a 25% improvement in the energy efficiency of buildings. Green roofs offer a unique design opportunity to meet such standards.

### **Gaining Planning Permission**

Green roofs offer an innovative way of meeting requirements to positively contribute to sustainability and enhance local biodiversity. Green roofs can provide a solution to environmental policy issues, which can cost a developer time and money by complicating and slowing down the process of gaining planning permission.

### **Reduced Drainage and Water Storage Requirements**

Green Roofs retain water and lower run-off which dramatically reduces the drainage infrastructure and water storage requirements on site.

The table below shows the drainage requirements of a 4500m<sup>2</sup> car park if green roofed or traditionally surfaced:  
(CRM rainwater consultants, © Zinco)

<i>Traditional Roofing Approach</i>	<i>Green Roof Approach</i>
27 No. 150mm diameter outlets	1 No. 150mm diameter outlet
162m above ground pipe work	6m above ground pipework
400m underground pipework	3m underground pipework
On site water retention required	No additional water storage required

## **Reduced Cost of Removing Waste Materials**

Instead of paying to remove the by-products of the construction process, unwanted aggregates can be screened and used on the roof as the substrate in which plants can be grown. The use of secondary aggregates on a roof of 1000m<sup>2</sup> can potentially save the developer £10,000 on substrate costs ([www.livingroofs.org](http://www.livingroofs.org)).

## **Increased Property Value**

Green roofs increase the attractiveness of a property to occupants- through reducing energy costs, demonstrating social responsibility and in many cases providing recreational space.

The cost of a green roof is site-specific, and varies according to:

- design and type of green roof
- loading implications on the structure
- professional consultancy fees
- pitch, edging and roof details (guttering, skylights etc.)
- roof area (economy of scale)
- time of year and type of planting
- building height
- maintenance, irrigation and access requirements



The installation of an extensive green roof is generally considered to double the cost of waterproofing and insulating a roof, prices can vary from £20-70 per m<sup>2</sup> exclusive of insulation and waterproofing. The lowest costing green roofs use secondary aggregates from the construction process which are sown with seed mixes or allowed to colonise naturally.

Innovative research at The University of Sheffield is helping to reduce the costs of green roofs, through the creation of natural rooftop environments. These roofs use locally-derived substrate materials and planting to create locally distinctive habitats. As a result such roofs require less infrastructure and minimal maintenance.



University of Sheffield research roofs

### **Green roofs often make economic sense:**

On standard inverted roofs, ballast or paving is used to weigh down the insulation which lies above the waterproof membrane. Instead of ballast or paving, a green roof can be installed to perform this role for as little as an additional £8m<sup>2</sup> (Livingroofs).

**Please note** costs can be reduced by contacting and consulting a green roof manufacturer at early stages of the design process.

## What are the maintenance requirements?

The maintenance requirements of green roofs are site and circumstance specific. Correctly planted, extensive green roofs are specially designed to be self maintaining and therefore require the following minimal upkeep:

- Annual removal of unwanted weeds and saplings
- Annual clearing of drainage outlets (requirement on all roofs)
- In severe drought it is recommended that the plants receive a small amount of irrigation via for instance a perforated pipe (this is largely unnecessary in the UK's climate)

It is advisable to include a maintenance deal of 2 years in the contract with the green roof manufacturer to ensure the initial establishment and upkeep of the plants.



Extensive green roofs are self maintaining and do not need to be mowed. (© Bauder)

## What are the structural implications of the extra loading?

Green roof systems can be installed over all types of roof membrane provided they are appropriately designed and able to take the weight of the green roof proposed. On new buildings any type of green roof can easily be factored into the structural design at little extra cost.

✓ Gravel Surface	90 - 150 kg/m <sup>2</sup>
✓ Paving Slabs	160 - 220 kg/m <sup>2</sup>
✓ Vehicle Surface	From 500 kg/m <sup>2</sup>
✓ Extensive green roof	60 - 150 kg/m <sup>2</sup>
✓ Intensive green roof	200 - 500 kg/m <sup>2</sup>

Modern, specially designed, light-weight extensive green roof systems weighing between 60-150kg m<sup>2</sup> fall within the loading capacity of modern building regulations.

The extra soil depth, water-holding capacity and plant growth of intensive green roofs is more likely to have structural implications.

## What access to the roof is needed?

According to the British Standards Institution, access has to be provided to the roof area of all new-builds, and inspections must be carried out twice a year. Installing a green roof does not change this, but if there is no edge protection on the building, Health and Safety regulations require anyone within 2m of the edge to wear a safety harness. Brackets or fall nets under the green roof can provide attachment points.

## Is a roof more likely to spring a leak with all this soil and vegetation on it?

In actual fact the substrate, vegetation and various other components protect the roof surface from harmful UV and other weather extremes, increasing its lifespan 2-3 fold and thereby saving money in the long term. The life span of a standard roof's waterproof membrane is 20-30 years, whereas the condition of waterproofing underlying green roofs of over 60 years has been found to be in excellent condition e.g. Derry & Toms Kensington roof garden.



These green roofs on a water filtration factory in Switzerland are over 90 years old

## What guarantees do green roof manufacturers offer?

The major green roof manufacturers offer 15-25 year guarantees depending on the type of waterproofing installed. Warranties do not cover the living layer of plants.

## Can a green roof be grown on any pitch of roof?

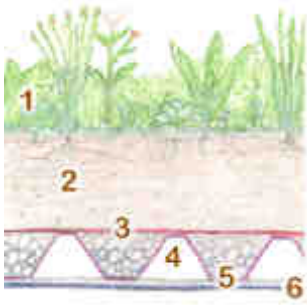
Green roofs can be grown on any pitch of roof even vertical walls; however roofs of greater than  $9.5^\circ$  generally have specific design requirements in order to retain the water and substrate across the roof surface. On roofs of up to  $35^\circ$  this can be achieved with the installation of a series of cross batons or grids which have to be more closely spaced the steeper the roof. Minimum falls of 1:60 are recommended to allow free draining.



Semi-extensive roof on private dwelling, Switzerland.

## What are the components of a typical green roof system?

In order for plants to grow on our roof tops, natural environmental conditions have to be re-created. This can easily be done by the installation of a series of functioning layers which, while retaining the necessary water to support the plants, allow excess water to drain off and protect the roof surface from plant roots and mechanical damage. A variety of systems are supplied by manufacturers which provide a stable roof-top environment for plant growth. A typical system includes the following:



**1. Vegetation layer:**

Low growing, stress tolerant alpine and herb species

**2. Lightweight Soil:**

50-100mm in depth

**3. Filter Mat**

**4. Drainage Layer:**

Aggregate or plastic cups

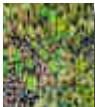
**5. Root Barrier**

**6. Waterproof Membrane**

Cross section of a modern extensive green roof by Peter Wilkinson

## What are the planting options?

The potential of the rooftop is best maximised by integrating these techniques to suit the site and requirements



### Sedum Mats Pre-Grown Vegetation Blankets

- + Instant established and neat vegetation carpet.
- High Cost
- Low Bio diversity



### Plug Planting - Planted at densities of 15m<sup>2</sup>

- + Can influence plant selection and design
- May take time to establish
- Low Bio diversity
- + Lower cost than mats



### Sowing Seeds or Cuttings

- + Selection and sowing of desired seeds
- + Cost effective
- Takes 1-3 years to establish vegetation cover
- Sowing can only take place in spring or autumn



### Natural Colonisation

- + High Bio Diversity
- + Minimal Cost
- Takes time to establish
- Aesthetically not to everyone's taste

Please note that green roofs do not have to be covered with a uniform layer of substrate or planted using a particular technique. The most attractive and thriving rooftops combine soil depths and plants to create an adaptable habitat rich in fauna and flora.



## What are the benefits of a green roof?

### Economic

- May assist and speed up the process of gaining planning permission by alleviating environmental policy issues
- Insulates the building in winter and summer, reducing heating and cooling bills (In Germany studies estimate that electricity savings for a standard extensive green roof = £5.20 m<sup>2</sup> per)
- Extends the life expectancy of the roof membrane two or three fold by protecting it from harmful UV and weather damage
- Adds to the property value
- Reduces the drainage infrastructure and water storage requirements on site
- Can re-use aggregates that would otherwise have to be removed from new build sites
- Can score highly in environmental building rating schemes (e.g. A green roof can score an extra 6.92% onto a buildings EcoHome score)
- Supporting growth of new environmental industry

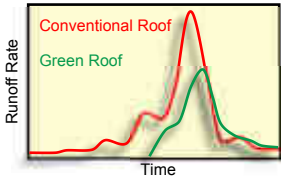
### Social

- Provides a public amenity of value to local residents and workers, and can even be used for recreational or sporting purposes
- Raises green credentials of occupier
- Many of the environmental benefits contribute towards improved human health
- Improves the view from surrounding buildings by providing an aesthetic green space

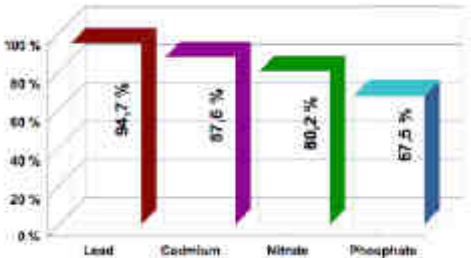
## Environmental

- Retains between 40-90% of water, thereby significantly reducing storm water run-off and flash flooding

The chart shows comparison of run-off from a conventional roof and extensive green roof



- Provides a habitat for wildlife including endangered invertebrates and birds
- Dampens noise levels entering and leaving the building by up to 18dB and reduces reflective noise by 3dB or more
- Filters dust and pollution from the air and water



Percentage of chemicals reaching the roof that are retained by an extensive green roof. (Kohler & Schmidt 2003)

- Insulates and cools the building reducing energy expenditure and carbon emissions
- Reduces the urban heat island effect by lowering temperatures around the building through evapotranspiration which in turn lowers smog production
- Contributes to reducing climate change

## What is the status of green roofs in the UK?

Across Europe, North America, Japan and other parts of the world, the potential for green roofs to improve the quality of urban environments has been widely recognised. Environmental and economic problems caused by sewage and storm water overflow, the urban 'heat island effect' and air pollution, have persuaded local authorities to introduce policies and incentives to encourage flourishing green roof industries. In Germany, for instance, where large cities offer direct financial support for roof greening (ranging between 25-100% of the cost) green roofs now represent 7% of all new roof constructions.



Built in 1986 Vienna's Hundertwasser-Haus demonstrates the potential of roof greening (© Hundertwasser Archive)

Given the competitive lifecycle costing of green roofs, and their many benefits, it is astonishing that they are not a more common feature of the UK's urban landscape. Only in London have there been a significant number of green roof developments, the most high-profile of which include Canary Wharf (Photo above ©Livingroofs) and Beddington Zero Emissions Development (BedZED). Green Roof examples across the rest of the country tend to be restricted to individual dwellings, environmental centres and one-off commercial developments such as Rolls Royce HQ, Chichester.



Emerging in London is a new type of green roof designed to protect a rare inhabitant of brownfield sites, the black redstart. Known as 'brown' or 'biodiversity roofs' they have been championed by the independent organisation 'Living Roofs' and can now be found on the Laban Dance Centre, the Creekside Centre and London Zoo's Komodo Dragon House (Photo Opposite © Sarnafil), with a further 100,000m<sup>2</sup> of such rubble-based roofs planned for London over the coming years. Green roof developments in South Yorkshire are sparse by comparison, but examples include the Moorgate Crofts Business Centre and West One roof terraces.



## Are there any regional examples?

### Norfolk Community Primary School

**Client and Architect:**

Sheffield City Council  
(Cath Basillio)

**Main Contractor:**

Kier Sheffield

**Type of Roof:**

Metal Deck



**Size of Roof:** 1684m<sup>2</sup>

**Details of Green Roof**

**Element:** 40mm vegetation support blanket overlain with 30mm Sedum Mats

**Green Roof Contractor**

Roof garden consultancy

**Reason for a Green Roof**

A planning requirement contributing towards reducing surface run-off and intrusive noise from rain and hail. A

Green roof was chosen for its water holding capacity as an innovative form of sustainable urban drainage design, with excess water runoff from the roof being harvested and utilised to supply the schools toilets.



## Moorgate Crofts Business Centre, Rotherham

**Client and Architect:** Rotherham City Council (Client-Investment and development office)

**Main contractor:** Hall Construction

**Type of Roof:** Concrete and metal

**Size of Roof:** 958m<sup>2</sup> (Extensive- 373m<sup>2</sup>, Semi-intensive- 415m<sup>2</sup> planted, 170m<sup>2</sup> paved)

### Details of Green Roof Element:

Extensive green roof- 50-85mm substrate overlaid with sedum mats

Semi-intensive roof- 200mm plug planted and landscaped with a selection of plants

### Green Roof Contractor:

Extensive- Alumasc, Zinco,

Semi-intensive- planting sub contracted to English Landscapes

### Reason for a Green Roof:

A green roof was seen as a valuable addition to the building's

sustainable design. Indeed the building was specifically built to maximize the opportunities offered by a green roof and access the views across the valley.



## Planning a green roof?

1. Decide the function the rooftop will have.

- Is it overlooked? Does it need to be aesthetically pleasing?
- Is it for people to access? Use as an amenity?
- Is it for biodiversity? Reduce run-off?
- Would you like the green roof to be used as a recreational space? wildlife haven? Or both?



2. Consider the condition of the existing roof, its structural capacity and the access to the roof. With new-builds these considerations can easily be factored in at the design stage.

3. What type of green roof is most appropriate for the building, budget and purposes you have in mind?

- Extensive: green roofs are lightweight, low maintenance, non access systems of low growing plants
- Intensive: heavy, high maintenance accessible systems that support a range of plants and can provide a valued amenity

4. Approach a green roof consultant, manufacturer or supplier to discuss, design considerations, technical details and establish cost.



- The major green roof companies are also roof membrane manufacturers and will therefore give quotes not only for the whole green roof system, but also the roof waterproofing and insulation necessary on the building.
- Manufacturers can recommend approved roofing contractors.
- Consultants can provide advice and guidance on planting and also install the green roof systems.

Please note the National Building Specifications (NBS) now includes standards for green roofs



This build in Germany supports an attractive meadow habitat  
© APP Dachgarten GmbH



Duff Street green roof Scotland, maximises the use of sedum mats over this barrelled roof ©Bauder

## Do It Yourself

Phone booths, kennels, bus shelters, sheds and garages are but a few examples of raised surfaces that are ideally suited to greening.



Photos are of the Groundwork Sheffield team installing green roofs on the city's bus shelters.



Garden Sheds and other outbuildings offer a great opportunity to install a green roof yourself and utilise such wasted space to provide habitat, roof protection and even grow herbs or vegetables to use in the kitchen. When building a green roof remember that the roof top design should recreate natural growing conditions wherever possible .

Further information about DIY green roofs is available in a separate fact sheet produced by The Green Roof Forum.

## Where can I get further information?

Please visit either of the following sites for links to further information

### Groundwork Sheffield

[www.groundwork-sheffield.org.uk](http://www.groundwork-sheffield.org.uk)

- Download green roof publications including a guide to DIY green roofing
- Read about The Green Roof Forum and their initiative to green South Yorkshire's rooftops

### LivingRoofs

[www.livingroofs.co.uk](http://www.livingroofs.co.uk)

The UK's only not-for-profit independent green roof organisation

- Advice, research and promotion of green roof systems
- All you need to know about green roofs and their status across the UK

### Publications

- Green roofs, research advice note: British Council for Offices and Corporation of London (2003)
- Green Roofs Ecological Design and Construction: Leslie Hoffman (Foreword), William McDonough (Foreword), Earth Pledge (2005). Schiffer Publishing Ltd.
- Planting Green Roofs and Living Walls: N Dunnett and N Kingsbury (2004). Timber Press.
- English Nature Leaflet 'Living Roofs'
- Green Roofs, English Nature Research Report no. 498. (2003). English Nature

## **Green Roof Manufacturers, Suppliers & Consultants in the UK:**

[www.alumasc-exterior.co.uk](http://www.alumasc-exterior.co.uk)

Alumasc, Zinco

[www.bauder.co.uk](http://www.bauder.co.uk)

Erisco Bauder

[www.greenroof.co.uk](http://www.greenroof.co.uk)

Blackdown Horticultural Consultants

[www.greenfix.co.uk](http://www.greenfix.co.uk)

Greenfix

[www.evergreenroofgardens.co.uk](http://www.evergreenroofgardens.co.uk)

Evergreen roof gardens- roof garden design and landscaping

[www.kalzip.co.uk](http://www.kalzip.co.uk)

Corus, Kalzip

[www.ruberoid.co.uk](http://www.ruberoid.co.uk)

Ruberoid

[www.safeguardchem.com](http://www.safeguardchem.com)

Safeguard

[www.sarnafil.co.uk](http://www.sarnafil.co.uk)

Sarnafil Ltd

[www.thegreenroofconsultancy.co.uk](http://www.thegreenroofconsultancy.co.uk)

Green Roof Consultancy

[www.flordepot.co.uk](http://www.flordepot.co.uk)

FlorDepot

## Why green roofs for South Yorkshire?

Green roofs worldwide are proving to be an economically viable way of achieving sustainable buildings and greener environments for urban residents.

In the UK however, green roofs remain a fresh and innovative form of building practice yet to be fully recognised outside of London. The regeneration and developments across South Yorkshire offers a great opportunity to employ such sustainable and creative design. The area of drab, grey, impermeable rooftops in urban areas is vast: in Sheffield city centre, for instance, roofs account for over 35% of space. This unutilised space receives direct sunlight year round, and given the correct conditions, plants could thrive there. Such habitats up high could help to replace lost green areas and provide ideal safe havens for endangered plants, birds and invertebrates. By installing green roofs, building owners can also lower energy costs and provide surroundings that offer a natural and stimulating working and living environment. Green roofs



A sedum green roof on a lawn mower shed

©Altham Hadwood Centre  
[www.oak-beams.co.uk](http://www.oak-beams.co.uk)

have the potential to generate significant publicity and make a bold statement about the occupier and developer's environmental commitment.

The Green Roof Forum, which includes founder members from Groundwork Sheffield, the University of Sheffield and Sheffield City

Council, is working together to address this and transform the city's roofs into ecologically valuable habitats and public spaces. The Forum is launching a European funded initiative to bring about more green roofs in South Yorkshire, working closely with local authorities. The initiative will provide developers, architects and planners with appropriate technical advice and guidance. It will also provide access to demonstration roofs that people can visit and gain first-hand experience of how they look and function.

We need you! If you are working on a large scale green roof project or in your own back garden, the Green Roof Forum would love to hear from you.

Please email [info@groundwork.org.uk](mailto:info@groundwork.org.uk) or Tel: 01142636420



Humanities Research Institute, Sheffield



West One roof terraces, Sheffield

## **The Green Roof Pocket Guide**

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