

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 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 the traditional earth sheltered huts of the Viking era. Recent times have seen the development of new technologies for rooftop planting, which have opened up a variety of planting options. Green roofs can now be anything from a layer of sedum and mosses to plants, shrubs, water features and even golf courses!



Sedum based roof at Dartford Football Stadium.

There are now three recognised approaches to green roofs emerging in this expanding industry, which are often referred to as **Intensive**, **Semi-Extensive**, **Extensive**. These terms refer to the amount of maintenance the roof requires.

Intensive: Consists of a thick layer of growing medium (50-100mm+) in which a variety of plants, vegetables, shrubs and trees can be grown. Such roof gardens are often accessible and can even be used as recreational facilities and public spaces. They require frequent maintenance, comparable to that in a normal garden, and do place significant weight on the building structure.



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

Extensive: Generally a shallow layer (25-100mm) of substrate planted with low growing, stress-tolerant grasses, mosses and alpine species known as a sedum. These light-weight systems require little or no maintenance, and impose relatively little weight on the building structure. There are three different approaches to Extensive Roof greening:



• Sedum roof at Gallie Craig Coffee Shop, Drummore.



• Wildflower roof. Photo provided by Nigel Dunnett.

a) Sedum Roofs

They are created from pre-grown sedum mats, or from cuttings or plug plants. The substrate layer can be between 20mm-100mm. Sometimes no substrate is present if a sedum mat is used.

b) Meadow Roofs

These roofs are based on a minimum of 70-100mm substrate depth. They are usually created with seed mixes of native wildflower and grasses that are typical of dry habitats.

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 crushed brick and subsoil which are left to colonise naturally overtime or seeded with wildflowers.



• An extensive green roof at Schiphol Airport in Amsterdam is used as a sound abatement measure.



• Moorgate Crofts ,Rotherham - The semi extensive roof illustrates the greater planting potential with greater substrate depth. (© Dr Nigel Dunnett).

Semi-Extensive:

Of slightly greater depth than extensive systems (100-250mm), 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. Native and non native perennials and grasses can be used.

◆ The cost of a green roof

The initial cost of a green roof is higher than for a standard roof; however this can be offset by the following benefits:

Increased Life Expectancy

Roof membranes protected from climatic extremes, UV light and mechanical damage by green roofs have a life expectancy two to three times greater than that of a conventional roof, saving the client the cost of re waterproofing during the expected life time of an average building.

Energy Savings

The insulation offered by green roofs considerably lowers cooling bills. German studies estimate that even light weight green roofs can offer electricity savings of around £5.20m² per annum whilst The National Research Council for Canada recorded that a green roof on a 122m² test facility reduced the average daily energy demand to aircondition the building by over 75%.

Green Roofs help cool buildings in two main ways. The roof surface does not heat up to the same extent and that heat is not transferred into the building. Secondly water evaporating from the plants on the green roof cools the roof itself.

Green roofs also help reduce the 'Urban Heat Island Effect'. Urban areas can be up to 7°C warmer than the surrounding countryside due to the large areas of asphalt and other dark materials they contain. These surfaces have a low albedo (reflectivity) and absorb heat unlike plants which reflect it. The vegetation on a green roof creates an 'oasis effect' offering shade that cools and humidifies surrounding air reducing these temperature highs.

Meeting Building Standards

By improving the energy performance of buildings, green roofs help to meet standards such as the Code for Sustainable Homes and BREEAM. 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 planning requirements to positively contribute to sustainability and enhance local biodiversity. This provides a solution to environmental policy issues, which 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. It is estimated that green roofs can absorb 75% of precipitation so that immediate discharge is reduced to 25% of normal levels (Johnston and Newton 1993).

With over 75% of rainwater becoming runoff in urban areas green roofs help reduce the pressure on the already strained sewer system reducing the chance of localised flooding.

The Environment of Canada study in Toronto found that greening 6% of available roof space at a cost of \$45.5 (CND), could retain as much storm water as a storage tank costing \$60 million – saving \$14.5million (£6.3 million).

The table below shows the drainage requirements of a 4500m² car park if green roofed or traditionally surfaced: (CRM rainwater consultants, © Zinco)

| Traditional Roofing Approach | Green Roof Approach |
|----------------------------------|--------------------------------------|
| 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. The use of secondary aggregates on a roof of 1000m² can potentially save the developer £10,000 on substrate costs (www.livingroofs.org).



• The Cube Sheffield, which used recycled crushed brick as substrate.

The use of recycled materials also reduces the need for waste disposal to landfill.

Increased Property Value

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

Factors effecting the cost of a green roof

The cost of constructing 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 (craneage requirements)
- Maintenance, irrigation and access requirements

At the upper end of the scale the installation of an extensive green roof using a sedum system is generally considered to double the cost of waterproofing and insulating a roof. Green roofs that use recycled aggregates from the construction process and those sown with seed mixes or allowed to colonise naturally can be a less expensive option.

Innovative research at The University of Sheffield in conjunction with the GRID project is helping to reduce the costs and maintenance of green roofs, through research into the use of waste/recycled materials as substrates and different methods of planting.



• Well established 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 a modest additional cost.

◆ 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 only the following minimal upkeep:

- **Annual removal of unwanted weeds and saplings.**
- **Annual clearing of drainage outlets (requirement on all traditional roofs).**
- **In severe drought it is recommended that the plants receive a small amount of irrigation. This could be provided by a pre installed leaky pipe irrigation.**

It is advisable to include a maintenance deal of 2 years in the contract with the green roof supplier 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. The superimposed load resulting from a landscaped roof must also be based on its saturated weight.

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

As demonstrated above, modern, specially designed, light-weight extensive green roof systems weighing between 60-150kgm² 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 Standard's Institution, proper 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 soil and vegetation on it?

In actual fact the substrate, vegetation and various other components protect the roof surface from harmful UV radiation in sunlight and other weather extremes, increasing its lifespan 2-3 fold and thereby saving money in the long term.

IMAGE

▶ What guarantees do green roof manufacturers offer?

The major green roof manufacturers offer 15-25 year guarantees on waterproofing if installed by an approved contractor. Some may offer warranties for the plant element.

▶ 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° generally have specific design requirements in order to retain the water and substrate across the roof surface.

On roofs of up to 35° 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.

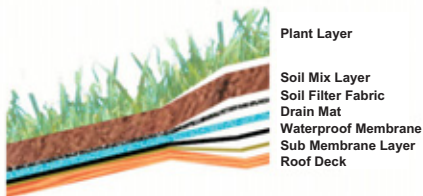
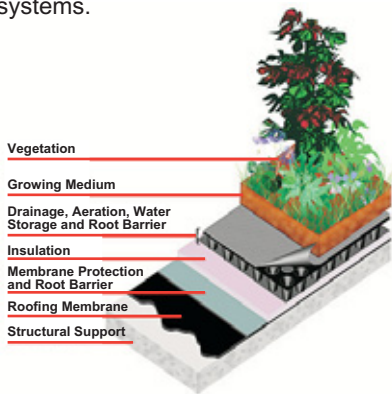


• Norfolk Park Community Primary School, Sheffield.

What are the components of a typical green roof system?

The requirements that all plants need to grow include water, light and a suitable growing medium. This can be created 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 the roof. They also protect the roof surface from plant roots and mechanical damage. A variety of systems can be used which provide a stable roof-top environment for plant growth.

The diagrams below show the build up of the more typical green roof systems.



▶ What are the planting options?

To maximise the potential of the rooftop these techniques must be used according to the sites requirements.

Sedum Mats or Pre-Grown Vegetation Blankets



- ✓ Instant established and neat vegetation carpet.
- ✗ High Cost
- ✗ Low Bio diversity potential

Plug Planting - Planted at densities of 15m²



- ✓ Can influence plant selection and design
- ✓ Lower cost than mats
- ✗ May take time to establish

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

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. One of the major catalysts for a shift in thinking towards green roofs has been the global attention on the issue of climate change and sustainability.

Under the Kyoto Protocol greenhouse gases emissions must be reduced to 12.5% below 1990 levels by 2008-2012.

The increased insulation and building energy efficiency (both domestic and commercial) afforded by green roofs could substantially reduce our requirement for energy, and therefore, our production of greenhouse gases. Increased greening also has the effect of absorbing carbon dioxide and producing oxygen, helping to redress the atmospheric imbalance.

Environmental and economic problems caused by sewage and storm water overflow, the urban 'heat island effect' and air pollution, have persuaded many foreign local authorities to introduce policies and incentives to encourage green roof implementation. In Germany, for instance, direct financial support is offered for roof greening (ranging between 25-100% of the cost) and 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).





• The proposed layout of Longely Hub courtesy of Kerry Bentley.

Given the competitive lifecycle costing of green roofs, and their many benefits, it is astonishing that they are not a more common feature in the UK. Although there are no public policies in that relate directly to green roofs; policies encompassing urban renewal, construction, open space, nature conservation and drainage all have relevance. Local Councils in South Yorkshire have now reached

a turning point with policy makers realizing the role green roofs could play in sustainable urban drainage schemes, promotion of biodiversity and building performance.

➡ Why green roofs for South Yorkshire?

Regeneration and development across South Yorkshire offers a great opportunity to employ 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.

Green roofs in Sheffield include:

West One roof terraces
Moorgate Crofts
Sheffield University Humanities Building
Doncaster Marina
Heeley City Farm
Sheffield Cathedral
West One
Sheffield Plaza
The Cube
Norfolk Community Primary School



• Sheffield Plaza.

Only in London have there been a significant number of green roof developments, the most high-profile of which include Canary Wharf and Beddington Zero Emissions Development (BedZED).

In Depford Creek is a new type of green roof designed to protect a rare inhabitant of brownfield sites, the Black Redstart has emerged. Known as 'brown' or 'biodiversity roofs' they have been championed by the independent organisation 'Living Roofs' who helped initiate the Black Redstart Action Plan for London in association with the London Biodiversity Partnership. This has been a key driving force in green roof implementation in the area, showing that economic regeneration does not have to lead to a loss of biodiversity. Green roofs can now be found on the Laban Dance Centre, the Creekside Centre and London Zoo's Komodo Dragon House (Photos below), with a further 100,000m² of such rubble based roofs planned for London over the coming years.



• **Laban Dance centre London. This is a rubble biodiversity roof built to encourage Black Redstarts.**



• **London Zoo's Komodo Dragon House.**

▶ Are there any regional examples?

West One (Sheffield)

Client:

Devonshire Green Holdings Ltd (a subsidiary of City Estates).

Architect:

Donaldson Edwards Partnership - Landscape.
Carey Jones Architects - Building Architecture.

Main Contractor:

MJ Gleeson Group.

Type of Roof:

Residential, Retail and Leisure with undercroft parking.

Size of Roof:

Roof terraces approximately - 1800m².
Above car parks (plaza and circulation areas) - 2200m².

Details of Green Roof Element:

Intensive system - Typical vegetation, grass, trees and shrubs with decorative paving. Decking built off concrete slabs.

Green Roof Contractor:

English Landscapes.

Reason for Green Roof:

The roof garden provides essential recreational space for residents dramatically improving the aesthetics of the building and the environmental credentials of the developer.



Sheffield University Humanities Research Institute

Client:

Sheffield University.

Architect:

Bond Bryan Architects.

Main Contractor:

William Birch & Sons.

Type of Roof:

Research Facility - Office/Seminar.

Size of Roof:

Intensive roof garden 450m².

Details of Green Roof Element:

Intensive roof garden built on a concrete roof. Substrate depth approx 450mm.

Green Roof Contractor:

Malden Roofing. Green Roof system provided by Bauder Ltd

Reason for Green Roof:

To provide a usable garden space for social use and environmentally efficient roof construction. The Humanities Building needed to expand so there was a need to make use of limited space to accommodate the new conference room, digital suite and seminar room. Rather than a cumbersome extension to the building the design is recessed into the ground and built in organic form.



Moorgate Crofts Business Centre (Rotherham)

Client:

Rotherham Investment & Development Office (RIDO),
Rotherham Metropolitan Borough Council (RMBC).

Architect:

Rotherham Construction Partnership, Rotherham Metropolitan
Borough Council.

Main Contractor:

Hall Construction, Hull.

Type of Roof:

Commercial-Business Centre.

Size of Roof:

770m² rooftop garden-semi extensive-: 415m²; plus 170m²
paving; upper 185m² paved).

Details of Green Roof Element:

Lower roof 200mm semi-extensive substrate planted with
drought tolerant perennials, ornamental grasses, bulbs and
alpines. Upper 50mm substrate and sedum mat.

Green Roof Contractor:

M&j Roofing/English Landscapes.

Reason for Green Roof:

Seen as a valuable addition to the building's sustainable design,
which includes geothermal heating and cooling and the use
of recycled building materials.



Commercial Case Study UK: Adnams Brewery Distribution Centre (Suffolk)

Client:

Adnams Plc.

Architect:

Aukett Fizroy Robinson

Main Contractor:

Haymills Construction Ltd.

Type of Development:

Commercial - used by Suffolk Brewery Arms as a distribution and logistics centre.

Size of Roof:

6,000m²

Details of Green Roof Element:

The building is covered in an extensive sedum system grown locally in Cheltenham.

Green Roof Contractor:

Greenfix SkyGardens Ltd.

Reason for Green Roof:

In order to deliver the clients aspirations for 'Britains Greenest Warehouse', the architects incorporated several sustainable design features to minimise environmental impact and respond to Adams exemplary commitment to sustainability.



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.



They offer a great opportunity to install a DIY green roof and utilise 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. If you are considering building a green roof make sure you refer to the National Building specifications and the new CIRA guidelines.



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

Green roof manufactures, suppliers & consultants in the UK:

Green Roof Manufacturers, Suppliers & Consultants in the UK:

www.alumasc-exteriors.co.uk

Alumasc, Zinco

www.bauder.co.uk

Erisco Bauder

www.greenroof.co.uk

Blackdown Horticultural Consultants

www.greenfix.co.uk

Greenfix

www.evergreenroofgardens.co.uk

Evergreen roof gardens-roof garden design and landscaping

www.kalzip.co.uk

Corus, Kalzip

www.ruberoid.co.uk

Ruberoid

www.safeguardchem.com

Safeguard

www.sarnafil.co.uk

Sarnafil Ltd

www.thegreenroofconsultancy.co.uk

Green Roof Consultancy

www.flordepot.co.uk

FlorDepot

- The Green Roof Forum, which includes founder members from Groundwork Sheffield, the University of Sheffield and Sheffield City Council, is working together to transform the city's roofs into ecologically valuable habitats and public spaces.
- The Forum helped to secure 2 years of funding to start the GRID (Green Roof Infrastructure Development) Project. The project aims to deliver a long term strategy to increase the uptake of green roof technology across South Yorkshire's build environment by:
 - Creating a central demonstration and research centre which will display various green roof systems in different settings together with regionally specific data on their performance. A network of demonstration roofs will allow developers and interested parties to see how green roofs establish and function in different settings.
 - Publications, educational leaflets and practical demonstrations to increase awareness of this technology and provide developers, architects and planners with appropriate technical guidance and advice.



- A practical demonstration on Fargate helped engage the public and increase awareness of Green Roof technology.



• Incorporating green roofs.

▶ 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

Green Roof Centre

www.thegreenroofcentre.co.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.

University Of Sheffield Landscape Department

www.shef.ac.uk/lanscape/greenroof/index.htm

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