



# GREEN ROOFS

PART OF SCOTLAND'S SUSTAINABLE FUTURE



# WHAT IS A GREEN ROOF?



Green roofs have been around for a long time. Until the nineteenth century, sod or turf roofs were prevalent for rural houses across Scandinavia. In the Highlands and Islands of Scotland, grass roofed houses, often related to crofts, were common. Iron Age wheelhouses built 1500 years ago are thought to have had green roofs.

Modern green roofs were first developed in Germany in the 1960s and today it is estimated that 10% of all German roofs have been greened. They consist of a waterproofing layer, root protection blanket and drainage layer along with the growing medium and plants.



Green roofs types are described as Intensive or Extensive, or a combination of the two. An Intensive roof has a greater depth of growing medium and can support a wide range of plants. An Extensive roof has a thin layer of growing medium that support a more specialised range of plants, such as succulents. The categorisation also relates to the amount of maintenance that the roof requires.

Green roofs can also be described as living roofs and can include collections of rocks, logs and/or rubble to provide additional habitat for wildlife. The essential element is that green roofs are designed to support living matter.

# GREEN ROOF BENEFITS



Knowledge and awareness of green roofs in Scotland is growing, and the number of buildings in Scotland with green roofs is increasing. Green roofs have become an important sustainable technology because they provide multiple benefits for the natural and built environment.

Green roofs make an important contribution to: reduce flooding; climate change adaptation and mitigation; support biodiversity; improve air quality and noise reduction. Green roofs further contribute to a healthy environment by increasing the opportunities for contact with nature, which has been lost in many urban environments.



WATER  
RETENTION

ENERGY  
EFFICIENCY

URBAN  
HEAT  
ISLAND  
EFFECT

**BENEFITS**

WHOLE-LIFE  
COSTS

HABITAT  
CREATION

AMENITY,  
HEALTH AND  
WELLBEING

AIR  
POLLUTION



## WATER RETENTION

Effective rainwater management, in particular urban water management, is a key challenge for Scotland. Many urban drainage systems are under severe pressure, especially during intense rainfall events, and the costs of maintaining and upgrading rainwater drainage systems are a burden. Green roofs have the ability to ameliorate the impact of rainwater run-off, which helps to reduce flood risk.

With accelerating urban growth, naturally draining soils are covered with sealed surfaces such as buildings, roads, car parks and pavements, decreasing percolation into the ground and increasing run-off. The ability of flood plains to mitigate flooding is reduced as they are developed and urban watercourses are locked away in drains and culverts reducing their ability to deal with flood waters. Research has shown that green roofs can contribute to flood mitigation, capturing between 40% and 90% of annual roof water run-off. It is best practice to encourage management of run-off as close as possible to where it lands and roofs are a first point of contact.

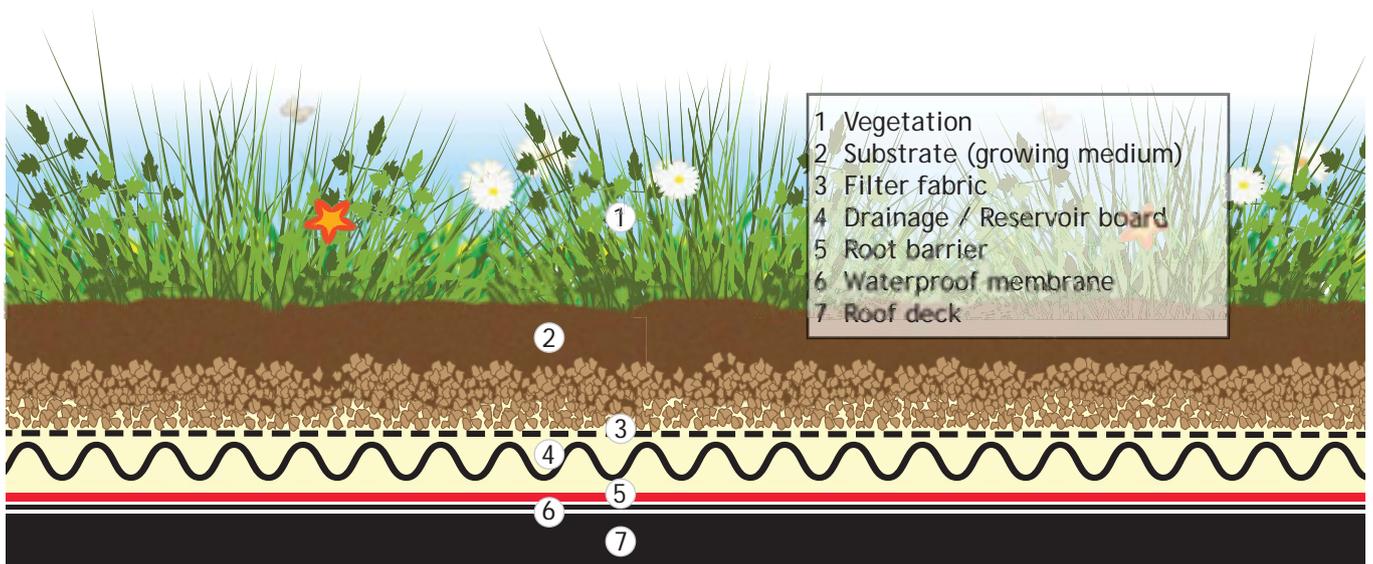
Sustainable Drainage Systems (SUDS) aim to address urban drainage problems

by mimicking natural drainage patterns. Green roofs are currently an underused element in SUDS schemes but make can an excellent addition, dealing with rainfall at source, reducing run-off and removing pollutants.

## URBAN HEAT ISLAND EFFECT

In cities, summer heat can be excessive and unpleasant. Increased temperature creates a greater demand for energy to run air conditioning and is also considered a health risk. While this might not be considered a frequent problem currently in Scottish cities, there is increasing concern over predicted temperature rises in the future as a result of climate change.

The temperature in cities has been shown to be as much as 6 C higher than surrounding countryside. The natural cooling effect of evaporation of water from plants and soil lowers the temperature of surrounding air. Hard surfaces tend to absorb incoming solar radiation during the day, then release or reflect heat at night, raising air temperatures. Covering roof space with green surfaces will reduce the heat island effect.



## HABITAT CREATION

Habitat loss is one of the most significant causes of loss of biodiversity. Habitat created on green roofs can mitigate the loss of some habitat types. Green roofs are particularly valuable in urban environments, increasing the extent and diversity of green space and utilising features which are traditionally of low habitat value - roofs. There is significant potential for green roofs to become an important component in the network of green spaces in urban environments. The bigger these green networks are, the greater the benefits for people and nature. The benefits of green roofs in respect of mitigating local temperature and reducing pollution in air and water can also contribute to the protection of urban biodiversity.

## AIR POLLUTION

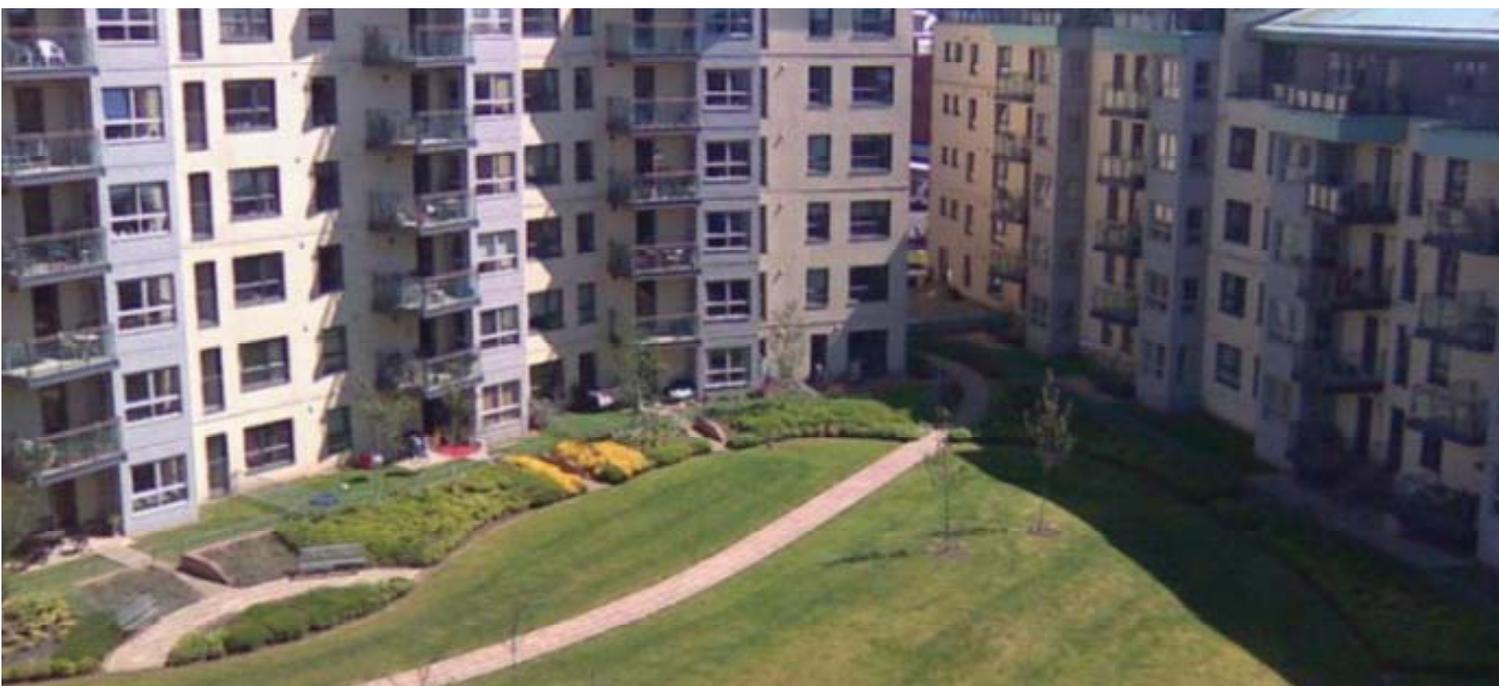
Urban air quality is a significant health concern. The UK Government's Environmental Audit Committee suggested in 2010 that up to 50,000 people a year in the UK may be dying prematurely due to air pollution. Various studies have been undertaken to quantify

the extent to which trees and shrubs are able to reduce levels of air pollution, and this also applies to green roofs. The plants on a green roof can trap and filter pollutants which threaten human health.

## AMENITY, HEALTH AND WELL-BEING

The high cost of land in cities exerts pressures on landowners and developers. Whether local authorities, private companies or individuals, there is pressure to construct built rather than green spaces. Green roofs can ameliorate this situation by providing a visual, and potentially accessible, green space in areas where development of such space is constrained. It is possible to meet development needs and increase green space in our cities by building green roofs.

It is widely accepted by health professionals that contact with nature and access to green space can improve people's mental and physical health and can speed recovery from illness. There is now a considerable evidence base which demonstrates that contact with nature and access to green space is good for our physical and mental health. The term



used to describe this is Biophilia. Recent research indicates where development of such space is constrained, or where mobility is limited, for example hospital grounds and sheltered housing, negative effects occur such as slower recovery times and higher incidences of crime.

## WHOLE LIFE COSTS

A green roof costs more to install than most other flat roof systems, while the cost of installing a green roof can vary in relation to the depth of the growing medium and the species of plants. However, there are economic benefits as the whole life cost of the roof can be lower. In particular, the life expectancy of the waterproofing layer is increased substantially due to the protection of the membrane from ultraviolet light and other environmental exposures. It is claimed that in some cases this could be as much as 100%.

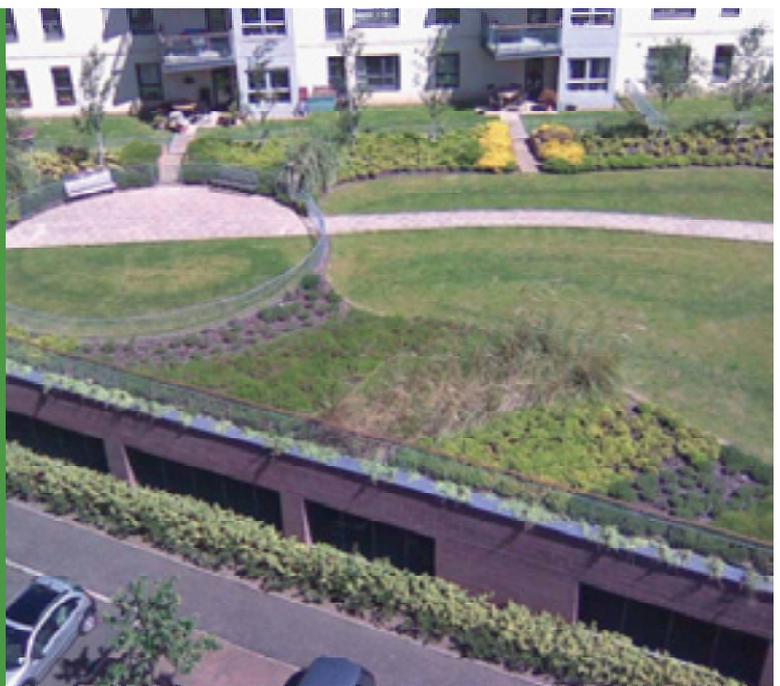
Around the world, city water rates are reduced pro rata in relation to the area of green roof covered, reflecting the reduced load on the sewer systems. A similar policy

could have significant impact for many cities in Scotland.

## ENERGY EFFICIENCY

Thermal insulation is a key consideration in building design, keeping them cool in the summer and warm in the winter. Effective insulation will result in significant cost savings by reducing heating and cooling requirements. Green roofs have been proven to consistently lower the heat transfer between the building and external environment. The plants and growing medium absorb sunlight and reflect heat as part of their natural processes. Green roofs have been shown to reduce the daily energy demand for air conditioning in the summer by over 75% through the process of evapotranspiration. In the winter, they remove direct contact of the membrane with winter winds, increasing overall thermal performance of the building. While green roofs do not perform like standard insulation, energy savings have been shown to amount to 2.5kWh/m<sup>2</sup>/yr. Green roofs can contribute to Building Standards efficiency requirements.

It's possible to meet development needs AND increase green space in our cities by building green roofs.



# GREEN ROOF F.A.Q.

## PLANTS AND PLANTING: WHAT IS POSSIBLE?

Conditions for plants vary on green roofs according to the depth and type of substrate, the location, elevation, exposure and slope. Most green roofs have a relatively thin layer for plants to grow in compared to soil depths on the ground because of the limitations of weight and the amount of materials required.

Thin growing media and good drainage mean that many green roofs tend to dry out, so plant species which can withstand dry conditions and/or recover well after drought are specified. Sedums are widely used, but coastal plants like Thrift or Kidney Vetch and a wide range of other species of grasses, perennial wildflowers and annuals also make good green roof plants.

Plants with large tap roots do not grow so well and can damage the roof structure. Woody shrubs like Heather are best avoided as they can build up dry material which is a fire risk.

There is significant opportunity for

creative design of plant communities with locally tailored mixes or planting to encourage wildlife. In many cases the precise conditions on a roof are not known in advance so a wide range of species are often used, with some thriving and others not; the mix of plants in time 'evolve' to the conditions.

In extreme drought, plants may die off and regenerate from seed set in previous years so the appearance of a roof may vary a lot, which should be regarded as one of the attractions.

Plants can be established as seed sown directly onto a roof or added as plugs, turf or 'blankets' of pre-grown plants.

## WHAT ABOUT THEIR WEIGHT?

Any landscape feature on a roof will have loading implications and the saturated weight of any such features must be used to calculate the structural load. Below is a list of weights of various landscape elements, including green roof systems. This has been calculated according to standards outlined in 'German National Standard DIN 1055 -

## Design Loading for Buildings'

- Gravel surface: 90-150 Kg/m<sup>2</sup>
- Paving slabs: 160-220 Kg/m<sup>2</sup>
- Vehicle surface: +550 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>

Interestingly, many roof systems are covered in paving slabs to ballast the insulation. An extensive green roof system would have a negligible effect on the structural load in these instances, while providing the range of other benefits. The structural report for a commercial building in London allowed for an extensive green roof with a substrate depth of up to 8cm to be applied on top of the paving slabs without any negative structural implications. However, unless other roof systems are structurally strengthened, a simple extensive sedum mat may well be the only option.

## DO THEY NEED MUCH MAINTENANCE?

All roofs require maintenance and green roofs are no different. Depending on the species of plants, a certain amount of 'gardening' is needed; with a sedum roof this can amount to very little, but with wild meadow flower roofs, or 'intensive' roofs with shrubs or trees, the pruning and weeding commitment is greater. Green roof warranties often have a component of maintenance inscribed to lessen the risk of failure.

## IS THERE AN INCREASED FIRE RISK?

If built in accordance with the regulations and guidelines green roofs do not present a fire risk. For example, on large roofs gravel paths are inserted as fire breaks to separate zones of planting. In some European countries, green roofs can lower fire insurance premiums.

## ARE THEY GUARANTEED AND INSURED?

Currently it is difficult to get guarantees for the green roof construction as a whole. Often, it is the waterproofing layer that is guaranteed as long as the build-up above is installed by a recognised contractor. Guarantees for the condition of the plants are more difficult to obtain as the factors affecting their performance vary and failure could depend on a wide range of factors that are outside the control of the installation contractor. However, if a maintenance programme and contract is in place then guarantees for the living and planting medium can be sought from that company.

Green roofs are very much a new area for UK Insurance companies and the industry is lagging behind its European partners, where insurance of green roofs is more common. Certain Insurance companies in the UK are beginning to promote green roofs due to their multiple benefits. With increasing demand, green roof insurance will become 'normal businesses' for UK insurance companies. In the meantime, those wishing to ensure green roofs have to shop around and make direct contact with companies.

## ARE THEY RECOGNISED BY THE NATIONAL HOUSE BUILDING COUNCIL?

Provided they have been constructed in accordance with the NHBC Standards (Chapter 7.1) then yes, green roofs are recognised by NHBC. In practice they are looking for the Green Roof system to be designed and supplied by the roof membrane manufacturer to ensure that one company takes responsibility for the green roof and waterproofing element. They also require that the system (including the waterproofing layer) is installed by the manufacturer's approved installers.

## WHAT IS HAPPENING IN THE REST OF THE WORLD?

Many European countries have very active associations promoting green roofs including Germany, Switzerland, the Netherlands, Italy, Austria, Hungary, Sweden and the UK. Copenhagen now has a mandatory policy to install green roofs. Beyond Europe, many US and Canadian cities now have mandatory policies, for example Toronto, Portland and Chicago. The City of Linz in Austria has been paying developers to install green roofs since 1983 and in Switzerland green roofs installation has been a federal law since the late 1990s. In the UK, their up-take has been slow but a number of cities have developed policies to encourage their use, notably in London and Sheffield.

## FURTHER INFORMATION

### THE SCOTTISH GREEN ROOF FORUM

*A voluntary partnership promoting the development of green roofs in Scotland*  
[www.sgrf.org](http://www.sgrf.org)

### LIVING ROOFS

*An independent organisation promoting green roofs and living roofs in the UK*  
[www.livingroofs.org](http://www.livingroofs.org)

### THE GREEN ROOF CENTRE

*The national centre for excellence on green roofs in Sheffield, UK*  
[www.thegreenroofcentre.co.uk](http://www.thegreenroofcentre.co.uk)

### THE GREEN ROOF CODE

*GRO's code of best practice relating to green roof design, specification, installation and maintenance.*  
[www.greenroofcode.co.uk](http://www.greenroofcode.co.uk)

### BUGLIFE

*Creating Green Roofs for Invertebrates: A Best Practice Guide*  
[www.buglife.org.uk](http://www.buglife.org.uk)



## PARTNERS

