I/ General description and characterization of the NBS type

I.1 Definition and different variants existing

Definition

A semi-intensive green roof system is characterized by small herbaceous plants, ground covers, grasses and small shrubs, requiring moderate maintenance and occasional irrigation. A typical growing medium depth for a semi-intensive green roof is 15 to 30 cm. This system is able to retain more storm water than an extensive system and provides the potential to host a richer ecology. Though higher in maintenance, this green roof system also provides the potential for a formal and intensive garden effect. In addition, few references identify a third category of green roofs: simple-intensive (semi-intensive) (FLL, 2008) which are vegetated with lawns and ground covering plants. These roofs require frequent maintenance including cutting, watering, and fertilization.

Semi-intensive green roof, Carnegie Mellon Hamerschlag Hall
© GREEN ROOF SERVICE LLC

Different variants existing

It is difficult to identify a variants of semi-intensive green roof. According to our expertize, we estimated that there is two kinds of semi-intensive green roof that can be identified like intensive green roof. We founded that they are depended on biodiversity and wide range of different shrubs and habitats:

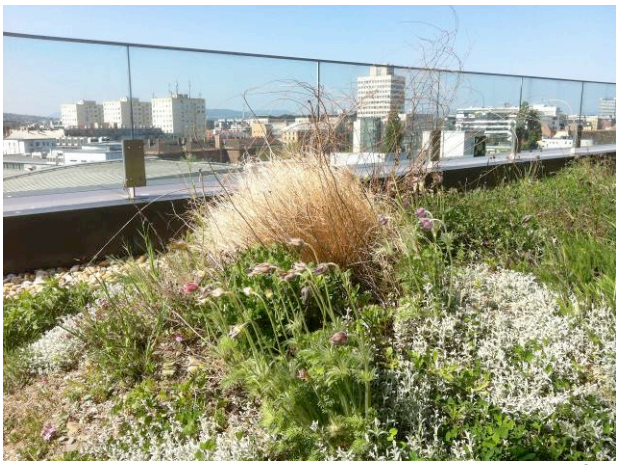
=> Maintain biodiversity

The philosophy of a semi-intensive green roof relies on the fact that the plant material that is destroyed during the construction phase will be restored at the top of the building and will reduce the adverse effects of urbanization and deforestation (Osmundson, 1999). The characteristics of a good crop is used for this kind of roof is resistant to exposure to direct sunlight.

It is important to note given the location of the plant growth will have a shorter distance to the sun than usual roof. Also, avoid plants that have roots growing down. The contribution of the semi-intensive green roof to the urban environment is manifold.

Those roofs with small or lager shrubs, soil forms the basic constituent of the substrate, in order to support plant growth.

Semi-intensive green roof, Swarthmore College, PA, USA
© greenroofservice.com



Plants development in semi-intensive green roof, Vienna, Austria
© Florian Kraus, Green4cities

Plants development in semi-intensive green roof, Vienna, Austria
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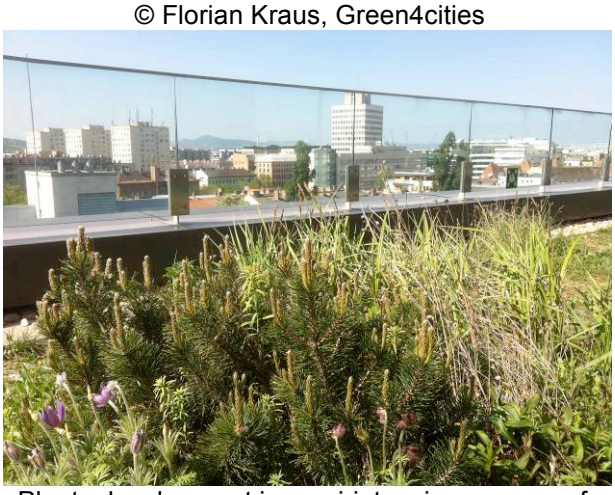
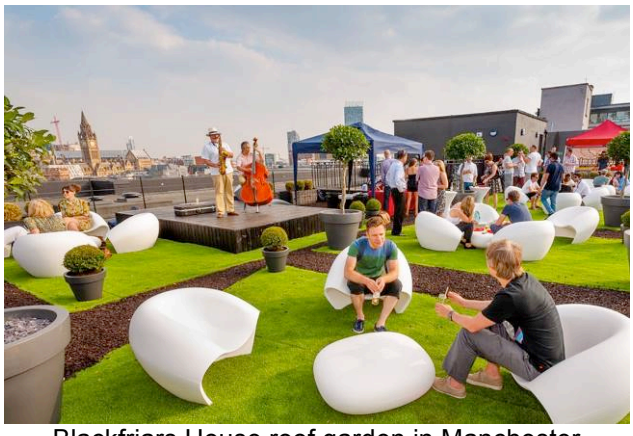


Plants development in semi-intensive green roof, Vienna, Austria
© Florian Kraus, Green4cities

=> An ideal habitat

Semi-intensive green roof are designed specifically for recreation, although the inclusion of vegetation in planters (such as on terraces or balconies) is often used to enhance their visual attractiveness. They are those that have no substrate and no intentionally vegetated part to their construction. Because of this, they have limited SUDS (sustainable urban drainage systems) or climate change adaptation benefit (Authority, 2008). Roof terraces, where there is adequate space available, are well suited for sports such as ball games.

The Orchid Hotel, Beijing, China
© Tripadvisor (link)



Blackfriars House roof garden in Manchester
© Jamie Boulger

I.2 Urban challenges and sub-challenges related + impacts		
Main challenges and sub-challenges targeted by the NBS	01| Climate issues > 01-2 Climate adaptation 02| Urban water management and quality > 02-1 Urban water management > 02-2 Flood management 07| Public health and well-being > 07-2 Quality of life	- The plants reduce solar radiation reaching the roof surface then its temperature. It contribute to urban heat island mitigation. - It has been established that semi-intensive green roof reduce temperature and solar irradiance, provide up to 50% reduction in the heat flux into building (Onmura et al., 2001). Thus resulting in significant building energy saving. - Semi-intensive green roof contribute to the Urban Heat Effect mitigation (Osmundson, 1999), protect and secure the longevity of the roof structure, grade rainstorm water distribution (Nektarios et al., 2011) - In the summer months, the semi-intensive systems with grass retained 99% of the load of Pb, Zn, and Cu and 98% of Cd in the water. In winter months the semi-intensive roof with vegetation retained 68% Cu, 92% Zn, 88% Cd 94% Pb in the water (Steusloff, 1998). - Semi-Intensive green roofs produce an aesthetic improvement, especially important for surrounding buildings. - They increase water-holding capacity, and provide sufficient anchorage to the plants (FLL, 2008)
Co-benefits and challenges foreseen	04| Biodiversity and urban space > 04-1 Biodiversity > 04-2 Urban space development and regeneration > 04-3 Urban space management 5 | Soil management > 5.1 | Soil management and quality 06| Resource efficiency > 06-1 Food, energy & water 7 | Public health and well-being > 07-1 Acoustics	- Semi-intensive act as habitats for native plants species in urban landscape (Madre et al., 2014) - The green roof substrate is able to support vegetation. In addition, it can store carbon(Bouzouidja et al., 2018). In addition, it can store carbon. - The U values for a semi-intensive green roof with 40 cm soil substrate were 0.45 $W/m^2/K^1$ and 0.61 $W/m^2/K^1$ for a typical roof (Wong et al., 2003). – Adaptive semi-intensive green roof systems are also related to the thermal performance of buildings that is expected to improve in proportion to the increase of the substrate depth (Wong et al., 2003). - A straightforward effect is the decreased sound propagation through the roof system to the inside of the building (Kang et al., 2009).

Possible negative effects	07| Public Health and well-being 07-3 Health 10I People security 10.3 Other: bad structural designs 04| Urban space management	- Potential challenges can include structural considerations, issues associated with installing a green roof on a historic building, knowledge of applicable codes, and issues associated with roof construction and maintenance (GSA, 2011). - Green roofs occasionally fail to perform at the level for which they were designed. Potential failures include leaks, plant loss, inadequate drainage, soil erosion and slope instability (GSA, 2011).

II/ More detailed information on the NBS entity

II.1 Description and implication at different spatial scales	
Scale at which the NBS is implemented	Buildings and sometimes only partially
Impacted scales	At building scale and depending on the number of green roofs existing. At neighbourhood or city scale, the impact of green roofs is less relevant. It is depending of green roof area coverage
II.2 Temporal perspective (including management issues)	
Expected time for the NBS to become fully effective after its implementation	- Build up green roof. Depends on the selected plants and/or tree: · shallow-root plants like sedum, mosses, herbs, and grasses: 1 year · flowering plants, taller grasses, small and larger shrubs: 1 to 2 years
Life time	30-50 years
Sustainability and life cycle	- Green roofs require significant interventions to be removed and most of the materials can be reused. - Plants and substrate can be composting or recycling in most of the cases.
Management aspects (kind of interventions + intensity)	- Does partially require irrigation - Nutrients - Range from weekly checks during summer on roof terrace garden - The aesthetical approach prevails on simple-intensive green roofs. Maximal maintenance, 8 to over 15 min/m^2/year (Catalano et al., 2018)
II.3 Stakeholders involved/ social aspects	
Stakeholders involved in the decision process	- Private owners, or co-owners of buildings - Municipality in case of public buildings - Experienced engineers, - Building surveyors, - Property managers
Technical stakeholders & networks	- Landscape architect, planer, designers, - Structural engineers, - Architects - Specialized green spaces management firms and gardeners.
Social aspects	-Need to find an agreement with all the co-owner of a building => importance of the participatory process. -Need to inform about the real impacts, to reassure about widespread prejudices (risk to keep humidity across the roof, fear to introduce insects in the building, etc.)

II.4 Design / techniques/ strategy

Knowledge and how-know involved	- Decision between the types of use to which it is put: an occupied roof (to access the roof) or not occupied roof (inaccessible to the public). - From technical point of view, semi-intensive green roof can include inverted roof. Often a problem with this type of roof is that there is rainwater sitting underneath inverted roofs. - On a new building or existing one, that needs a structural engineer investigation. - Selection of plant adapted to: • the local climate • Sunlight orientation and overshadowing • Wind exposure - Set up the maintenance keeping plants in the right conditions. - Maintaining services in the right conditions. Care must be taken to keep roots and leaves out of the drainage system
Materials involved	- moisture barrier (roofing membrane) - thermal insulator - waterproofing membrane (root barrier) - drainage layer - filtering layer - growing medium (substrate) - shrubs most of the time

II.5 Legal aspects related

- Ownership and tenant. There is a clear difference between an owner (landlord) and a tenant (lessee). A landlord has exclusive rights to their property to use in any manner according to the planning constraints and permissions in each jurisdiction (and no third-party consent is generally required to create a green roof or wall). A tenant is bound by the terms of their lease, and a green roof or wall may be prohibited or a permissible use with consent. Consent is likely to be required from the landlord (1).
- Structural loads. Analysis by a structural engineer is required (1).
- Irrigation and drainage: Water supply is usually a simple tap, but if irrigation is needed, and a hydraulic engineer is required to review how it is to be serviced and drained and it is likely need irrigation licence (1).
- Access permit to the roof (1)

  Insurance. Insurance will be required by the party maintaining the garden or produce area, as well as insurance for visitors and public; also liability for work, health and safety legislation (1).

II.6 Funding Economical aspects

Range of cost	Calculating the average cost of green roofs can be difficult because there a number of variables, not just the size and accessibility of the site but the types of plants that are going to be grown on it. In the United Kingdom costs start by approximatively 75 €/m^2. In addition to the initial cost of designing and installing green roofs, there are also running costs, which need to be taken into consideration, such as maintenance and regular gardening. The cost of a semi-intensive green roof in Great Britain, starts around 120 €/m^2. Green roof components: · Substrate · Plants · Filter fabric · Drainage Board · Root barriers · Protection fabric Irrigation system Drainage system

Origin of the funds (public, private, public-private, other)	- Private: the ownership is a private one as business building, hotels, apartments - Public. The building ownership is a public owner like City councils, museums, schools, etc.

II.7 Possible combinations with other kinds of solutions (other environmental friendly solutions or conventional ones)

- Green roofs provide habitat to many bee species. For example, in New York City, U.S.A., a study of the bee diversity in urban gardens found a total of 54 species from 19 sites (Matteson et al., 2008). In Vancouver city, Canada, gardens and urban parks obtained a total of 56 bee species from 25 sites; species richness did not differ significantly among site types (Tommasi et al., 2004).

Implementation of beehive on a green roof
© 2018 Dusty Gedge's Roofs & Rambles

III/ Key elements and comparison with alternative solutions

III.1 Success and limiting factors

Success factors

- **Green Roof Goal**: It is essential to start project planning with the purpose of the green roof. Is it intended primarily to deliver environmental, cost-saving benefits? Is it expected to serve as a decorative landscape element? Is it for urban farming? To set the direction for any project, first define the purpose of the green roof, establish priorities for specific goals and align stakeholder expectations (Rugh, 2014).
- **Architectural Factors**: Roof structural load capacity is the most basic issue (Rowe et al., 2003)

Location: Regional climate determines what type of green roof and plants you can and should have (Rowe et al., 2003).

Limiting factors	- Take into account the new structural load when refurbishing a building: One important item to be considered is the increased structural load. The structural engineer must factor in the weight of completely saturated soil since the plantings and the soil will hold a significant amount of water (1).

City University of Hong Kong Hu Fa Kuang Sports Centre roof collapses site

Author: exploringlife-CC BY-SA 4.0

- **Lifetime of the roof membrane.** Green roofs tend to improve the life of the membrane because it is completely covered by plantings and is not exposed to the sun's harsh UV rays. However, the membrane may be exposed to plant roots, animals and insects, and fertilizer chemicals. It is important that a protective barrier be used over the waterproofing membrane.
- **Maintenance ongoing cost. Is also important to consider** that a green roof requires routine landscape maintenance, which can vary from occasional to regular and can add a significant ongoing cost. In addition, space should be allocated for storage of maintenance materials

III.2 Comparison with alternative solutions

Grey or conventional solutions counterpart

- White or cool roof: the green roof decreases the annual building needs for heating and cooling by 1.2% while the white roof contributes to decrease the needs just by 0.4%. This small difference is mainly attributed to the higher insulation capacity of the green roof and the lower calculated surface temperatures on it (Santamouris, 2014)

White or light-colored roofs

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- Gravel roof: The gravel in a ballasted roof helps absorb heat, preventing the sun from heating the roof materials below and making the roof more energy-efficient. In addition, gravel also protects against hail and from foot traffic during repair or maintenance work. The gravel is easy to move when conducting repairs or maintenance

	 Gravel roof © Anderson Roofing
Close NBS	- Other green roof types (extensive and intensive green roof) - Build or attached planter systems (including balconies)

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