



GreenRoofScore

**A tool for evaluating performance of greenroof
ecosystem services**



- **French association created in 2002**
- **Brings together actors of greenroof and green facades and promotes the domain**



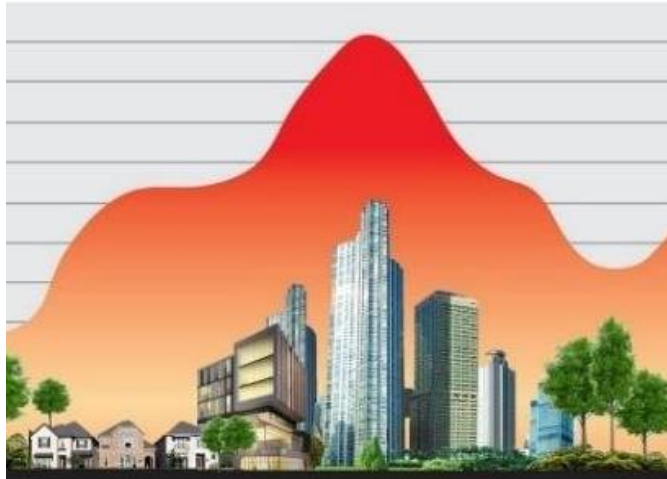
- **75 members in 5 sections:**
- Waterproofing and landscape companies
- Systems or component suppliers Contractors, architects, landscape designers, technical inspectors, technical experts
- R&D organizations and universities
- Professional organizations

- **Interacts with:**
- Public authorities
- Private and public actors
- Associations, research organizations
- International actors

- **Activities:**
- Represents green infrastructure industry
- Promotes greenroofs and green facades
- Federates businesses and organizations
- Market reporting
- Ensures market quality through publication of Guidelines and recommendations
- Provides training and skill-building

Green Roof Score

Context



Challenges of dense cities :

- Heat waves + mineralization => urban heat island
- Non-permeable surfaces + rainfall peaks => floods, pollution
- Increased infrastructure=> erosion of biodiversity
- Heat + pollution + lack of biodiversity
=> deterioration of health and well-being



Aggravated by:

- Climate change
- Growing urbanicity:
75% in 2022

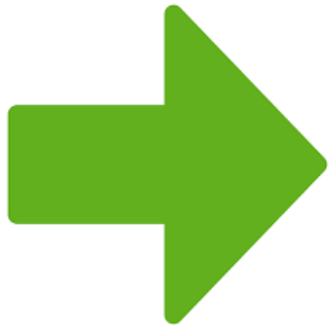
75% of
Europe pop.
urban



Green Roof Score

Context

Greening buildings is good, but...
How to ensure that
green building projects address the challenges
and provide ecosystem services?



**Create a tool to measure the performance
of green building projects on delivering
ecosystem services**

Green Roof Score

Description

Green Roof Score (GRS) is a tool to assess performance on **four selected ecosystem services (EcoS)**:

- 1. Urban heat island reduction**
- 2. Water management**
- 3. Biodiversification**
- 4. Support for health and well-being**

- Each service includes multiple scored indicators to earn points, with “bonus” points for key indicators
- GRS is developed by expert collaboration over 3 years
- V1.0 Edition for greenroof projects



Green Roof Score

Actors and outputs



Green Roof Score

Actors



Certification institutions

=> Integrate components of the GRS indicators into their reference or **analysis grids**



Contractors in design, installation and maintenance

=> Use GRS indicator check-lists **during design, construction and maintenance**



Local and regional authorities and policy makers

=> Use GRS to develop goals, recommendations or **policies for greening**



Manufacturers

=> Integration in **innovative solutions** that meet challenges of today's cities

Green Roof Score

EcoS indicators

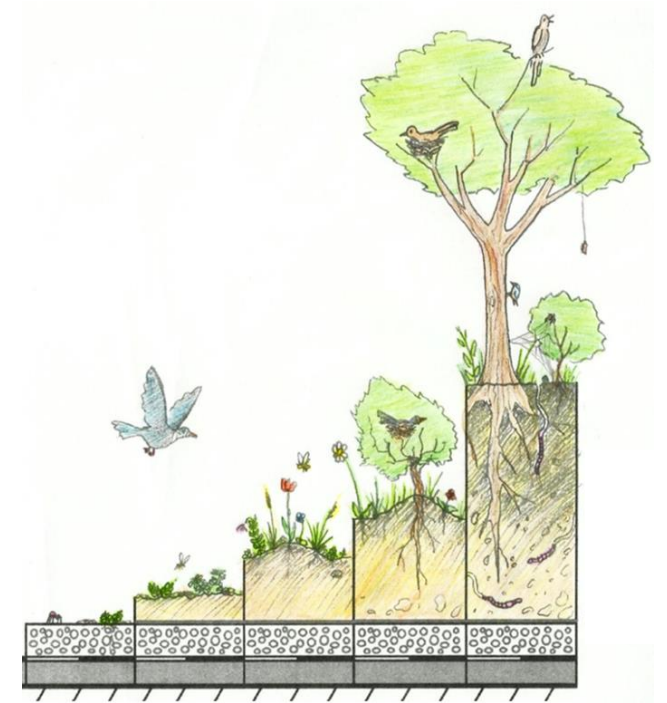
Scope and requirements

Each EcoS and indicator include :

- **Rationale** : explains overall goal and desired benefits
- **Objective** : describes specific method for achieving goal
- **Intent** : purpose
- **Performances** : defines level of results to achieve objective (expressed in points)
- **Assessment methods** : method to determine compliance
- **Recommendations and advices** : additional recommendations to further advance

Scope and requirements :

- Maximum score : 80
- Minimum surface : 50m² or 30% of the vegetable area / no maximum size
- New building or renovation
- Compliance with French Standards for the design and construction of Green Roofs (**RP TTV**)
- Conducted by member of Adivet or qualified professional



Green Roof Score

Surface

Intent

- Valorize the vegetated surface covered or the proportion of vegetated to overall surface

Surface performance	Points
Bonus point for absolute value : vegetated area $\geq 500 \text{ m}^2$	1 pt
Bonus point for proportion of overall surface : vegetated area $\geq 60\%$ of possible surface that can be vegetated	1 pt










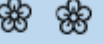



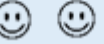

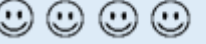
Note: “can be vegetated” = excludes technical areas but includes side gravel stripes

When multiple roofs: each roof evaluated separately



Green Roof Score version 1.0

Analysis and evaluation grid

	Level 1	Level 2	Level 3	Level 4
Combating the urban heat island	3 points 	4 to 6 points 	7 to 9 points 	10 points and more 
Water management	3 points 	4 to 6 points 	7 to 10 points 	11 points and more 
Biodiversity	4 points 	5 to 8 points 	9 to 12 points 	13 points and more 
Health/wellness	2 points 	3 to 4 points 	5 to 6 points 	7 points and more 



Results obtained by **EscoS**

4 levels :

- Level 1 = minimum standards
- Level 2 = good
- Level 3 = excellent
- Level 4 = exemplary

Notion of dominant when a project reaches level 3 or 4 in a given theme



Ecosystem service n°1 Rainwater management



Green Roof Score

Ecosystem service : Rainwater management

- Climate change is leading to **more frequent and intense rainfall peaks**.
- **The artificialization of soils** prevents absorption of rainwater, which then can flood sewage networks.
- **The greenroofs** can facilitate rainwater storage and controlled release to reduce flooding.



Principle

Use green roof complex to reduce the release of rainwater from the building.

Objective

Use green roof complex to store rainwater on the roof.

Green Roof Score

Rainwater management : indicators

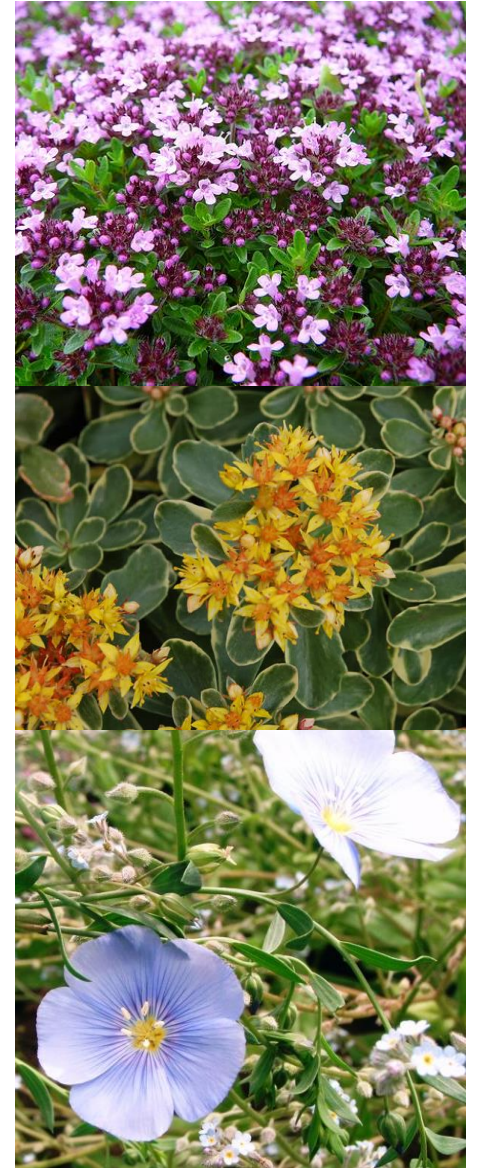
1 – Water retention capacity of the roof

2 – Rainwater discharge

3 – Rainwater flow discharge rate

4 - Water consumption on the roof

Maximum score for rainwater management is : 21/ 80



Green Roof Score

1. Rainwater retention capacity of the roof

Intention

- Retain water in all components including substrate, drain, plants and storage structure

Water retention performance	Points
$20 \text{ L/m}^2 \leq \text{retention} < 30 \text{ L/m}^2$	1 pt
$30 \text{ L/m}^2 \leq \text{retention} < 50 \text{ L/m}^2$	2 pts
$50 \text{ L/m}^2 \leq \text{retention} < 70 \text{ L/m}^2$	3 pts
$70 \text{ L/m}^2 \leq \text{retention} < 90 \text{ L/m}^2$	4 pts
Retention $\geq 90 \text{ L/m}^2$	5 pts

Evaluation method : Test report for all components according to the RP TTV test protocols

Green Roof Score

2. Rainwater discharge (in % for a time period > 1 year)

Rainwater discharge is the **quantity** of water (volume) hold by the substrate and consumed by the green roof that does not return to sewage network.

Intent

- Guarantee a % of local reference rainfall discharge.

Rainwater discharge Performance	Points
Rainwater discharge < 20 %	0 pt
20 % ≤ Rainwater discharge < 40 %	1 pt
40 % ≤ Rainwater discharge < 60 %	2 pts
60 % ≤ Rainwater discharge < 80 %	3 pts
Rainwater discharge ≥ 80 %	4 pts

Example : GR system (10 cm) + Sedum plants in Paris complies with the “Public Water Agencies” and “City of Paris Rainwater plan”
→ RW Discharge = 60% of the reference 16 mm’s rainfall

Green Roof Score

2. Rainwater discharge...



<https://faveur.cerema.fr/public/home>

Evaluation method

- Rainwater discharge can be calculated by **Faveur** = digital tool from french public research approved by Adivet
- Adivet tool criterion for approval :
 - Created by an independent scientific organization (engineering firm, University or public research department, etc.)
 - Minimum one year of daily weather data available
 - Data must be provided for every project

Green Roof Score

3. Rainwater flow discharge rate

The **rainwater flow** discharged from the roof during and after a rainfall event (**expressed in liters per second per hectare**) to evaluate contribution (runoff) to stormwater management.

Intent

Guarantee a rainwater flow out of the building roofs

Rainwater flow discharge Performance	Points
Roof without any outlet flowrate system	0 pts
Discharge rate ≤ 50 L/s/ha	2 pts
Discharge rate ≤ 10 L/s/ha	4 pts
Bonus point : Discharge rate is operated by automatic controlled system	1 pt

Evaluation method

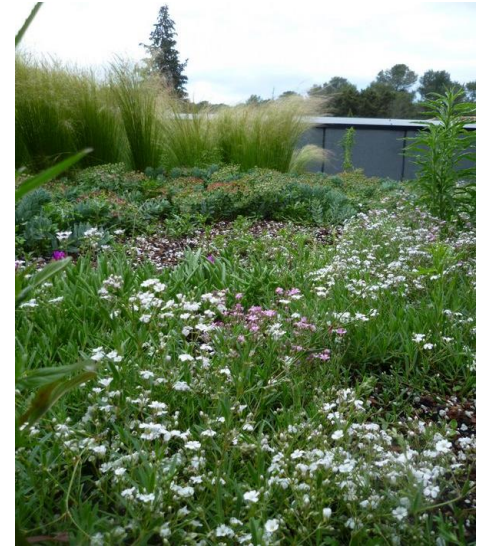
- **Report of calculation** by :
- The plumbing company, an engineering firm, and University or public research organization
- The supplier of the system based on the DTU 43.1

Green Roof Score

4. Water consumption on the roof

Intent

Presence of **suitable irrigation system** to achieve water management objectives and maximize water efficiency.



Performance of the irrigation system	Points
System designed according to study of water needs	1 pt
System designed according to study of water needs and an annual maintenance contract	2 pts
System designed according to above criteria AND with smart devices such as rain sensors or alert devices	3 pts
Bonus points : Reuse of rainwater for irrigation	3 pts

Evaluation Method

Review of:

- Assessment of water needs
- Irrigation schedule
- Maintenance contract



Ecosystem service n°2

Urban heat island reduction



Green Roof Score

Ecosystem service : Urban heat island

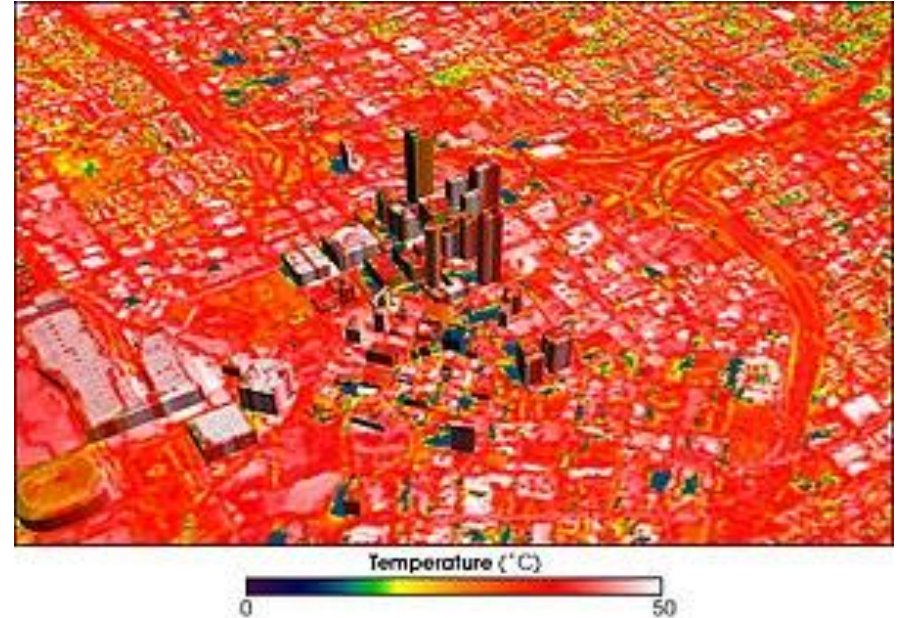
“**Urban heat island** is a local climate phenomenon characterized by higher city temperatures relative to the surrounding countryside or a regional average. It is caused by the accumulation of phenomena related to urban morphology, highly mineralized surfaces and anthropogenic heat inputs.”

- Cerema

Greening buildings make a significant contribution to addressing urban heat islands by:

- **Shading** => less heat by absorption of radiant energy
- **Substrate evaporation**
- **Plant transpiration**

=> More comfortable climate; reduction in air-conditioning use



Principle

Use greening to contribute to a “cool island”, by evapotranspiration

Objective

Maximize evapotranspiration while maintaining smart water use

Green Roof Score

Urban heat island : Indicators

1 - Type of vegetation (evapotranspiration performance level)

The choice of plants influences cooling performance

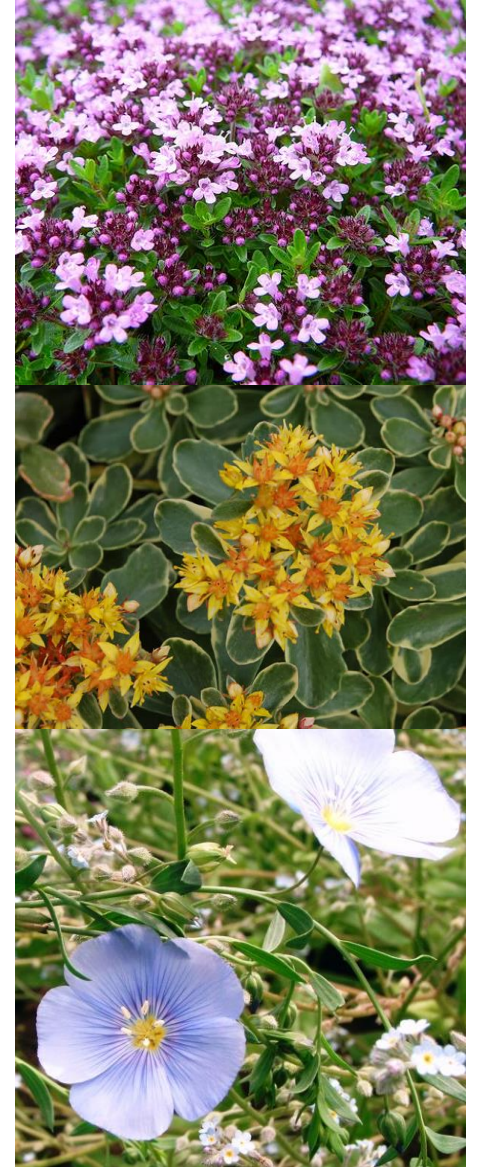
2 - Water retention capacity of substrate

3 - Water storage structure(s) to irrigate vegetation

4 - Presence of a back-up irrigation system

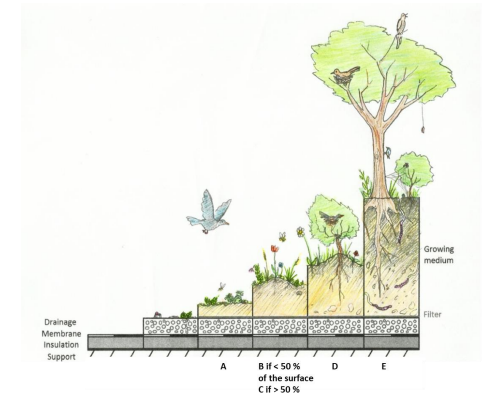
Achieving cooling performance also depends on storing and retaining water on the roof so that vegetation leads to evaporation

Maximum score for the reduction of urban heat island is : 18/ 80



Green Roof Score

1. Type of vegetation



		Points
A	Vegetation predominantly of succulent perennials mainly Sedum and mosses	1 pt
B	Shallow vegetation with occasional perennials herbaceous plants, perennial bulbous plants and grasses on <u>less than 50%</u> of the total vegetated area	2 pts
C	Succulents and dominant herbaceous and perennials plants, perennial bulbous plants and grasses on an area <u>greater than 50%</u> of the total vegetated area	3 pts
D	Vegetation dominated by herbaceous perennials, perennials with bulbs and grasses with occasional patches of woody and/or shrubby perennials (height less than 1.5 m) over an area greater than 20% of total vegetated area	4 pts
E	Meets criteria for previous strata AND significant presence of trees and shrubs (height greater than 1.5 m at maturity) on more than 20% of total vegetated area	5 pts

Valuation method

- List of plants indicating the proportion for each category Sedum, herbaceous, shrubs etc.

Green Roof Score



2 – Water retention capacity of the substrate

Intent

- **Maximize the water capacity** MWC of the substrate to retain and hold it over a long period for plant hydration and transpiration.

MWC (liters/m²) retained by the substrate after saturation for 24 hours and draining for 2 hours, proven by analyses by independent laboratory as described in RP TTV.

3 - Water storage structure(s) for irrigation of vegetation

Intent

- Adding component under substrate for storing water on the roof or on the ground and irrigating the vegetation
- Water must be accessible and available to meet plant needs

Green Roof Score

Urban heat island : Indicators

Substrate water capacity performance	Points	Extra water storage structure performance
$20 \text{ L/m}^2 \leq \text{MWC} < 30 \text{ L/m}^2$ very thin (6 cm), light, draining granular substrate suitable for extensive, constrained succulent vegetation	1 pt	$4 \text{ L/m}^2 \leq \text{retention} < 15 \text{ L/m}^2$
$30 \text{ L/m}^2 \leq \text{MWC} < 45 \text{ L/m}^2$ medium-thick (approx. 10 cm) hydro-retaining substrate suitable for extensive to semi-intensive xerophytic perennials and grasses	2 pts	$15 \text{ L/m}^2 \leq \text{retention} < 30 \text{ L/m}^2$
$45 \text{ L/m}^2 \leq \text{MWC} < 60 \text{ L/m}^2$ semi-intensive vegetation with few constraints	3 pts	$30 \text{ L/m}^2 \leq \text{retention} < 50 \text{ L/m}^2$
$60 \text{ L/m}^2 \leq \text{MWC} < 90 \text{ L/m}^2$ thick, hydro-retaining substrate suitable for a broad, diversified plant range with few constraints	4 pts	Retention $\geq 50 \text{ L/m}^2$
$\text{MWC} \geq 90 \text{ L/m}^2$ semi-intensive to intensive, fine-grained, highly water-retaining substrate composed of semi-shrubby to shrubby species with few constraints	5 pts	-

- Submit test report for MWC of the substrate
- Test performed by an independent laboratory

Valuation method

- Demonstrate storage capacity of additional water retention structure
- Demonstrate how stored water can be made available to plants

Green Roof Score

4. Presence of a supporting irrigation system



Intent

- Presence of irrigation system to achieve cooling objectives

Irrigation system performance	Points
No irrigation system	0 pts
Functional irrigation system	2 pts
Bonus point : Use of rainwater recovered in irrigation	1 pt

Valuation method

- Documents / draws show an adapted installation to the water holding capacity of the system

Indicator with recommendations for

- Mandatory watering point at 30m minimum from any point of the green roof
- Watering during the installation period, over a 3-week drought, semi-intensive/intensive, geographical location



Ecosystem service n°3

Biodiversification



Green Roof Score

Ecosystem service 3 : Biodiversity



The erosion of biodiversity, especially in cities, is a major issue. The greening of buildings can help to welcome biodiversity in a dense urban setting.

Performance	Points
Bonus point : the project is accompanied by an ecologist	1 pt

Principle

Improve the biodiversity of a green roof

Objectives

- Determine if GR hosts a diversity of organisms including plants and fauna.
 - Evaluate if GR ecosystem interacts with surrounding spaces
 - Determine if GR contributes to an inhabitable space for diverse species

Green Roof Score

Ecosystem service : Biodiversification

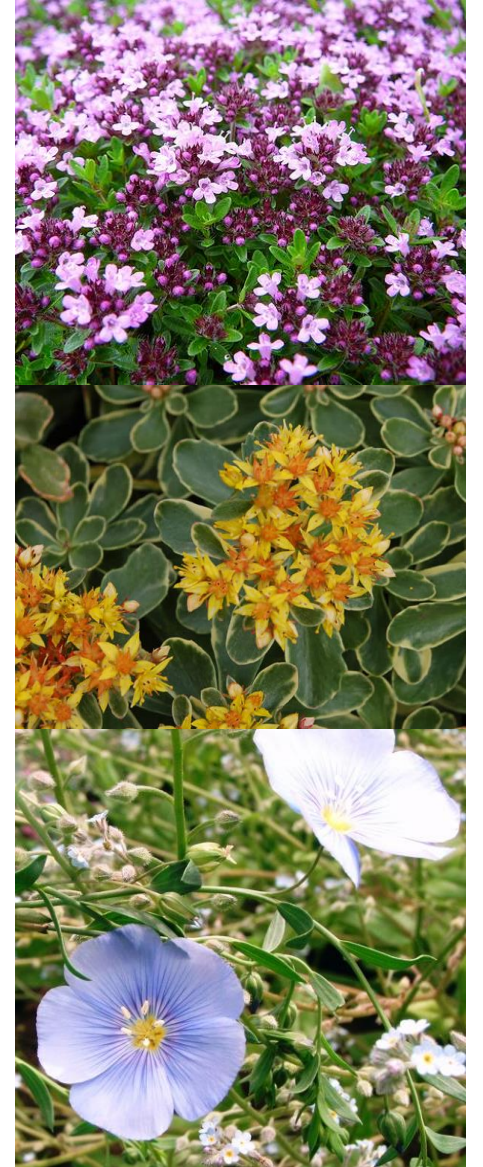
1 – Biotope coefficient per Surface (CBS-TTV)

2 – Substrate

3 – Diversity of plants

4 - Fauna

Maximum score for the ecoservice biodiversity is : 28/ 80



Green Roof Score

1. Biotope coefficient per surface (CBS-TTV)

Intent

Considers:

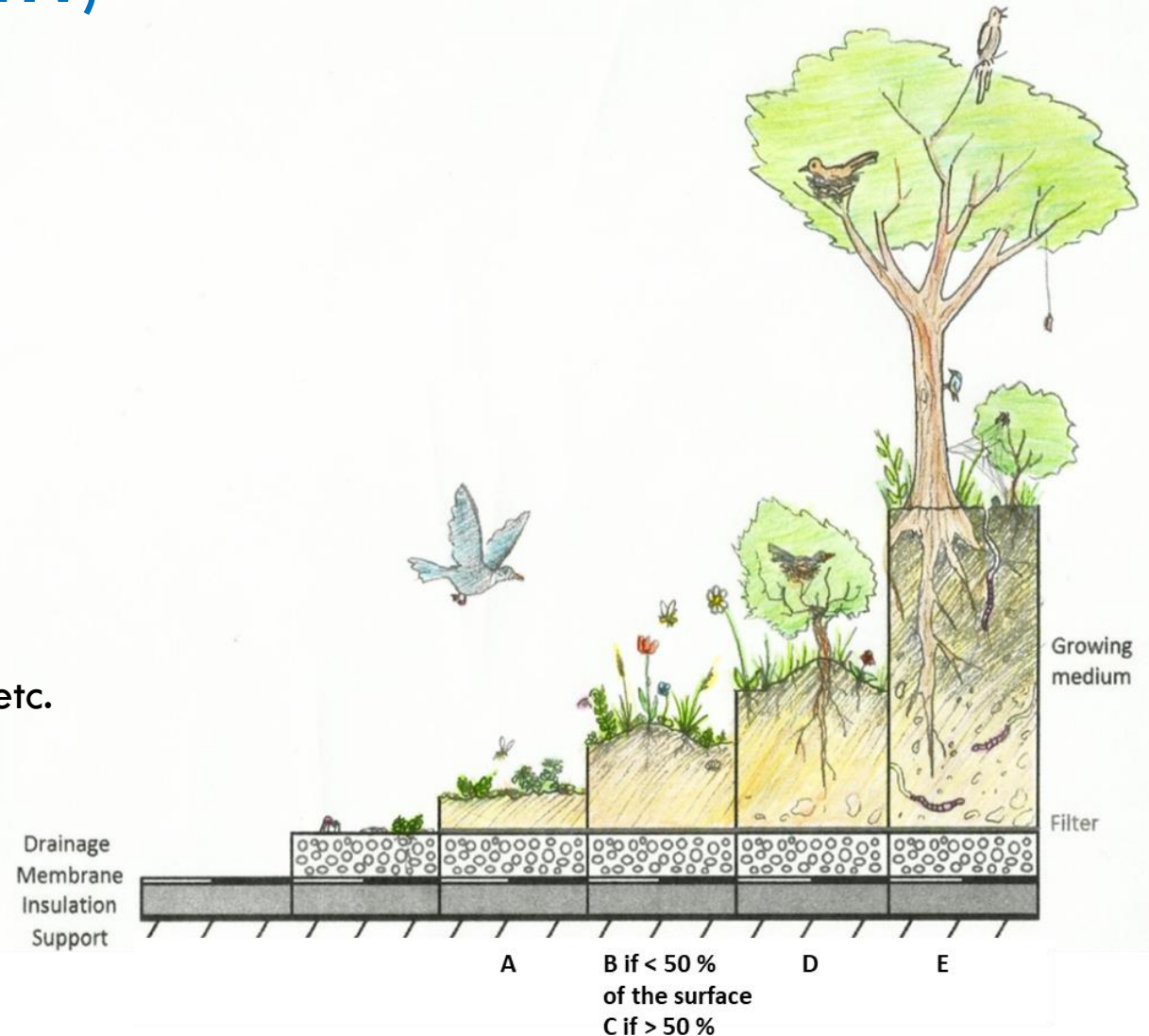
- Type of vegetation
- Thickness of substrate

Varied plants and strata and great thickness of substrate contribute to establishing a complete ecosystem

Evaluation Method

Documentation of:

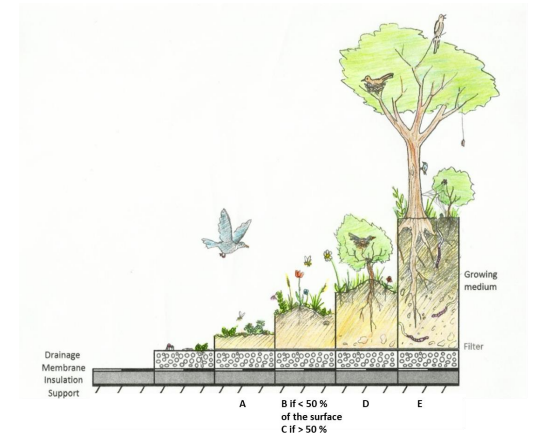
- Proportions of plant types : sedum, herbaceous, shrub etc.
- Substrate thickness



Green Roof Score

1. Biotope coefficient per surface (CBS-TTV)

Type of vegetation



	Plant Strata
A	Vegetation predominantly of succulent perennials mainly succulents and mosses
B	Shallow vegetation with occasional perennials herbaceous plants on <u>less than 50%</u> of the total vegetated area
C	Succulents and dominant herbaceous and perennials plants on more <u>than 50%</u> of the total vegetated area
D	Vegetation dominated by herbaceous perennials with occasional patches of woody and/or shrubby perennials (height less than 1.5 m) over an area greater than 20% of total vegetated area
E	Meets criteria for previous strata AND significant presence of trees and shrubs (greater than 1.5 m at maturity) on more than 20% of total vegetated area

Valuation method:

- List of plants indicating proportion in each category: Sedum, herbaceous, shrubs

Green Roof Score

Extensive

1. Biotope coefficient per surface (CBS-TTV)

+ =

Type of vegetation on Extensive Greenroof	Greenroof BCS	Thickness of substrate (cm)	Plant strata	Green Roof Score points
Very low thickness and dominant sedums	0.2	$X \leq 6$	A	1
Low thickness and dominant sedums	0.25	$6 < X \leq 8$	A	2
Low thickness, sedum base and significant presence of herbaceous perennials	0.3	$6 < X \leq 8$	B	2
Medium thickness and dominant sedums	0.35	$8 < X \leq 10$	A	3
Medium thickness, sedum base and significant presence of herbaceous perennials	0.4	$8 < X \leq 10$	B	3
High thickness and dominant sedums	0.4	$10 < X \leq 12$	A	3
High thickness, sedum base and significant presence of herbaceous perennials	0.45	$10 < X \leq 12$	B	4
High thickness, sedum base and dominant herbaceous perennials	0.5	$10 < X \leq 12$	C	4

Green Roof Score

Semi-intensive

1. Biotope coefficient per surface (CBS-TTV)

+ =

Type of végétation on semi intensive Greenroof	Greenroof BCS	Thickness of substrate (cm)	Plant strata class at plantation	Green Roof Score points
Medium-thickness with predominantly sedums	0,5	$12 < X \leq 20$	A	4
Medium thickness, sedum base and significant presence of herbaceous perennials	0,55	$12 < X \leq 20$	B	5
Medium-thickness sedum-based and dominated by herbaceous perennials	0,6	$12 < X \leq 20$	C	6
Medium thickness dominated by herbaceous perennials and presence of woody perennials	0,65	$12 < X \leq 20$	D	6
Thick with a predominance of sedums	0,6	$20 < X \leq 30$	A	6
Thick with a sedum base and a predominance of herbaceous perennials	0,65	$20 < X \leq 30$	C	7
thick dominated by herbaceous perennials and woody perennials	0,7	$20 < X \leq 30$	D	8

Green Roof Score

Intensive

1. Biotope coefficient per surface (CBS-TTV)

+

=

Type de vegetation on intensive* Greenroof	Greenroof BCS	Thickness of substrate (cm)	Plant strata class at plantation	Green Roof Score points
Medium to heavy thickness, with predominantly herbaceous vegetation	0,7	$30 < X \leq 80$	C	7
Medium to heavy thickness, predominantly herbaceous with shrubs	0,75	$30 < X \leq 80$	D	8
Medium to heavy thickness, dominated by grasses and shrubs, with the presence of trees	0,8	$30 < X \leq 80$	E	9
Thick and dominated by herbaceous plants and shrubs	0,85	$X > 80$	D	9
Thick and dominated by grasses and shrubs, with trees	0,9	$X > 80$	E	10
Open ground	1			

* Also called roof gardens

Green Roof Score

1a. « wild roof » or « brown roof »

Intention

- No vegetation installed by man, settled spontaneously on the substrate in place
- Substrate thickness between 10 cm and 30 cm
- Consulted by ecologist or a specialized consultant=> additional points as per green roof BCS table
- Includes wildlife refuges
- Can represent some or all surfaces to be vegetated

Note that particular attention must be paid to maintenance and ecological monitoring of this type of project

Year 0, + 5 months and + 2 years



Green Roof Score

1a. « wild roof » or « brown roof »

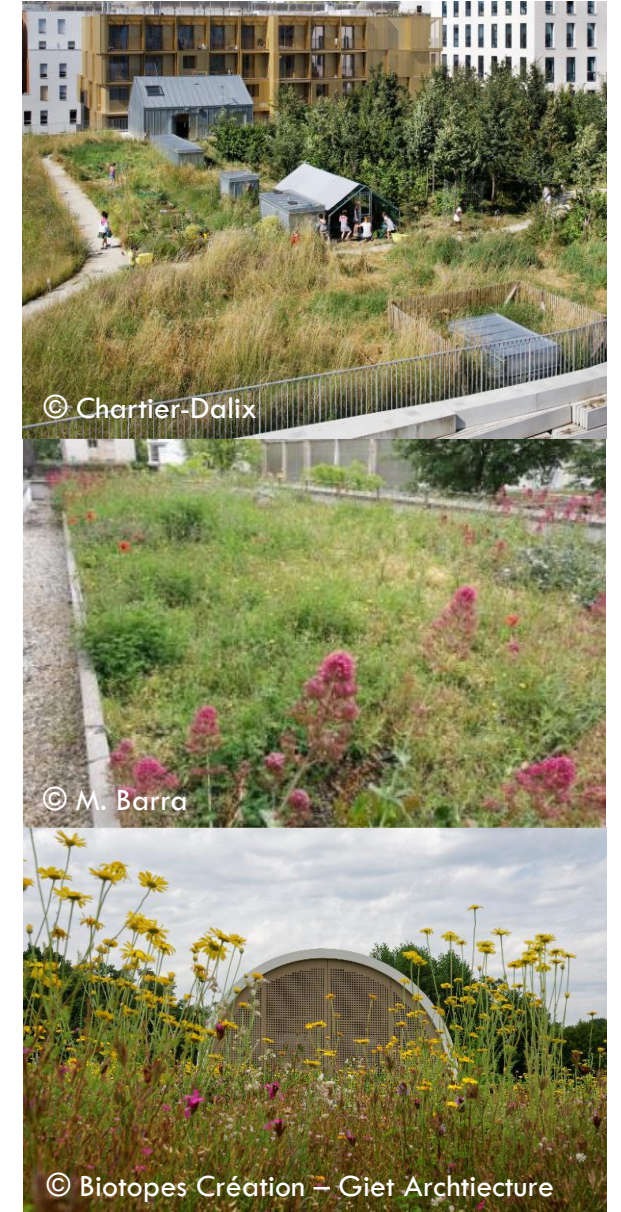
Performance of the wild roof	Points
Thickness of 10 to 12 cm: favorable to spontaneous ground cover	3 pts
Thickness of 12 to 20 cm: favorable to spontaneous herbaceous cover	5 pts
Thickness of 20 to 30 cm: favorable to spontaneous herbaceous cover; and potentially including shrubs (species to be controlled)	7 pts

Method of evaluation

- Documentation of substrate thickness and ecologist council

Recommendation

- Leave bare areas so that spontaneous plant species can settle => growth of heritage species e.g. emergence of wild orchids in interstices



Green Roof Score

2a. Substrate nature and thickness

Intent

- Variation of thickness and media (humidity, microbial life, etc.) to increase diversity

Performance of the substrate	Points
1 single thickness on the entire greenroof	0 pts
Multiple zones with different thicknesses	3 pts
Multiple zones with different types of substrates	3 pts
Both of two previous criteria (thicknesses and type)	5 pts

Evaluation method

- Drawings indicating different zones with variations in substrate thickness
- Determination of percentage of each zone vs total surface



Green Roof Score

2b. Substrate organic matter (OM)



Intent

- Organics increase the soil life (nutrient restitution to plants)
- Organics are self-degrading and eventually decompose

Performance of the substrate (OM in % of dry matter weight)	Points
Extensive GR : OM < 5%	0 pts
Extensive GR : $5 \leq \text{OM} < 10\%$	1 pt
Semi-intensive GR : OM < 10%	0 pts
Semi-intensive GR : $10 \leq \text{OM} < 15\%$	1 pt
Substrate in compliance with NFU 44-551 Intensive Greenroofs / Roof gardens > 30 cm	2 pts

Measurement method

- Documentation of the OM content

Green Roof Score

3. Diversity of plants

Intent

- Diversifying plant species to increase biodiversity

Performance of plants diversity	Points
0 to 10 species	1 pt
10 to 20 species	3 pts
20 to 30 species	4 pts
> 30 species	5 pts

Evaluation method

- Documentation of plants species

Recommendations

- Plant species adapted to roofs (RPTTV)
- Consider distribution of different species so that relative abundance is balanced



Green Roof Score

4. Fauna

Intent

- Increase communities of fauna such as:
 - Arthropods (insects and spiders)
 - Mollusks (slugs and snails)
 - Lizzards
 - Birds
 - Chiropterans (bats)
- Not possible to define animal species that will settle on the roof => "fauna" criterion focuses on the installations that can be designed and built on the roof to host fauna

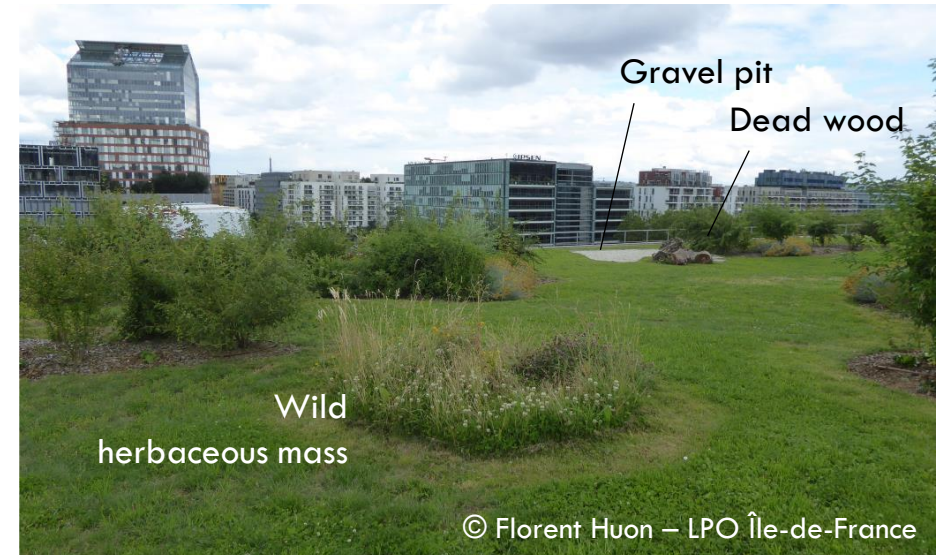
Considerations

- Installations target specific groups of species
- Indicator = number of installation per unit area
- Special attention to plants with respect to wildlife e.g. pollinators/flowering plants



Green Roof Score

4. Fauna



Performance in fauna equipments	Points
Wildlife refuges on the substrate (piles of wood, drilled logs, sand, light rocks, gravel, etc.) 1 unit per 100 to 150 m ²	1 pt
Various types of birdhouses, chiropteran nesting boxes and insect hotels 1 unit per 200 to 300 m ²	2 pts
Specific means of creating wildlife refuges with the intervention of an ecologist	3 pts
Bonus point : Ecological maintenance of the roof described in a maintenance booklet	1 pt

Evaluation method : Documentation of wildlife refuges and nesting boxes and relative size



Ecosystem service n°4

Support of health and well-being



Green Roof Score

Health/Well-being

- Scientific evidence of the role played by nature on our psyche:
 - Improved relaxation, calmness and tranquility
 - Increase in productivity
 - Reduction of absenteeism
- The evaluation process seeks to value the green infrastructures in its potential influence on health and well-being benefits according to concrete indicators



Principle

Use the vegetation of the building to improve the quality of life for communities

Objectives

Allow view of or access to vegetated spaces

Health and well-being benefits include:

- Physiological: air quality, acoustics
- Psychological: seeing nature, having access to it, recreational activities, social link, etc.

Green Roof Score

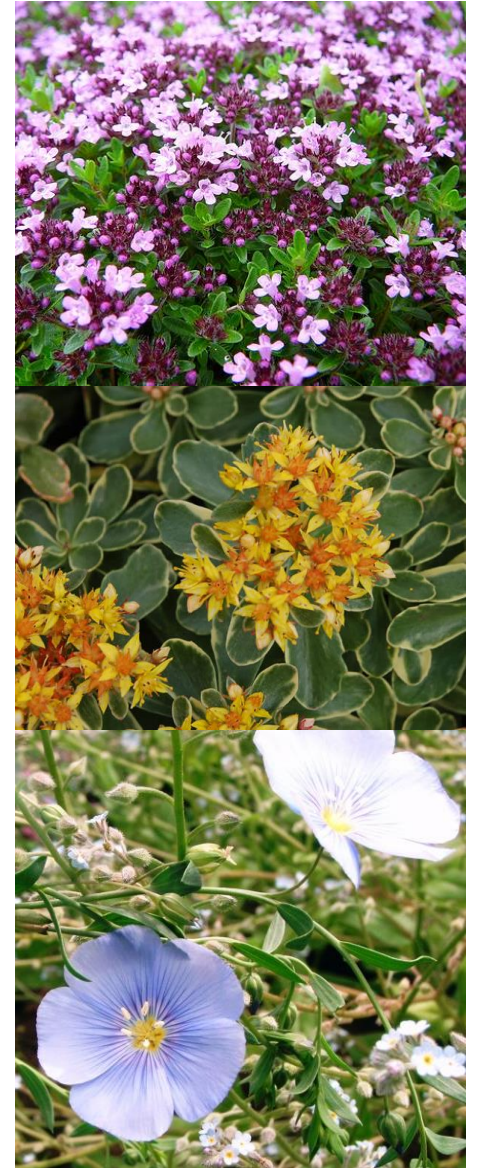
Ecosystem service 3 : Support Health and well-being

1 – Biophilic design / visibility

2 – Biophilic design / accessibility

3 – Accoustic

Maximum score for the ecoservice Health and well being is : 11 / 80



Green Roof Score

Health/Wellness : Indicators

1 - Biophilic design / Visibility

Intention

Ensure vegetation is visible from occupied spaces :

- In the building
- In the surrounding area



Performance in visibility

Vegetated elements have an overall visibility of at least 20%

Points

2 pts

Evaluation Method

Documentation or diagrams that demonstrate visibility

Green Roof Score

Health/Wellness : Indicators

2 - Biophilic design / Accessibility

Intent

To provide physical access to vegetated areas



Performance in Accessibility	Points
The greenroof is accessible to building users	1 pt
The greenroof is accessible and provides a place for rest and social interaction	2 pts
The greenroof hosts a food production space	3 pts

Note: One classification only (highest category reached)

Evaluation method

Documentation or diagrams that demonstrate above

Recommendations

Design vegetation for human interaction: eating, planting, weeding, watering, etc.

Green Roof Score

Health/Wellness : Indicators

Performance in Accessibility	Points
Bonus Point : Area for food production represents min. 10% of plantable area	2 pts
Bonus Point : Public programs about urban agriculture or dedicated areas for educational roof farming programs	2 pts

Evaluation method

Documentation of proportion used for food production

Documentation of education/outreach plan and program location



© Ecovegetal



© Cultures en Ville

Green Roof Score

Health/Wellness : Indicators

3 – Acoustics

Intent

Improve the acoustic quality of the occupied spaces:

Noise level reduction in occupied spaces depends on load-bearing element.



Performance in Acoustics	Points
Load-bearing element:	
- Concrete slab + vegetation	1 pt
- Wood load-bearing element + vegetation	1 pt
- Steel sheet + vegetation	2 pts

Evaluation method : Documentation of load-bearing elements and green roof location

Recommendations : The greater the thickness of the substrate, the better the sound absorption

Green Roof Score

Analysis and evaluation grid

For each of the 4 ecosystem services including various indicators, a **summary grid** is used for easy scoring and results summary to:

- Quickly evaluate the project
- Identify the strengths of the project
- Identify recommendations to improve the project

HAVE A GREAT READING OF THE FRENCH **GREEN ROOF SCORE** !!



Thank you for your attention



Lionel SINDT
lsindt@soprema.fr
Tel : 06 78 95 67 83



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