CREATING A GREEN ROOF

HAZARD

HEAT

RAINFALL AND FLOODS

IMPLEMENTATION STEP

CONSTRUCTION

RENOVATION

AREA OF ACTION

ENVELOPE

OUTDOORS

COST

€ € €

low medium high

LEVEL OF SKILL

high

Green roofing is emerging as an effective way of making buildings more resilient to climate change, by protecting buildings from temperature variations, particularly during heat waves, and regulating rainwater run-off during heavy rainfall. There are three types of green roof, depending on the thickness of the substrate: extensive, semi-intensive and intensive.

IMPACTS

Greening a roof has several benefits:

- **Improves thermal comfort** for building occupants through natural regulation of building temperature and humidity (up to 40% reduction in temperature variations).
- **Reduces energy consumption** by up to 98% in the summer for air-conditioning needs.
- **Protects the roof's waterproofing membrane**, which is no longer exposed to UV rays, temperature differences and bad weather (longer lifespan of 30 to 50 years).
- **Retains rainwater** by absorbing part of rainfall (up to 50% annually) and freeing up networks to promote good drainage.

INSTALLATION GUIDE

The choice of roof model depends on the slope of the roof, the load the roof can support, the type of plants desired, accessibility and uses of the roof, plant maintenance and the budget. The table below details the characteristics of the different extensive, semi-intensive and intensive roofs:

TYPE OF ROOF	EXTENSIVE	SEMI-INTENSIVE	INTENSIVE
SUBSTRATE THICKNESS	4 to 12 cm	12 to 30 cm	> 30 cm
TYPE OF VEGETATION	Succulents, bulbs, moss, non-woody herbaceous plants (8 to 12 cm), etc.	Shrubs, herbaceous perennials, woody perennials, grasses, etc.	Trees, shrubs, perennials, etc.
LOAD	100 kg/m^2	150 to 350 kg/m^2	> 600 kg/m^2
MAXIMUM GRADIENT	20%	5%	5%
MAINTENANCE	Low (1 to 2 times a year)	Medium (3 to 4 times a year)	High (similar to a garden)

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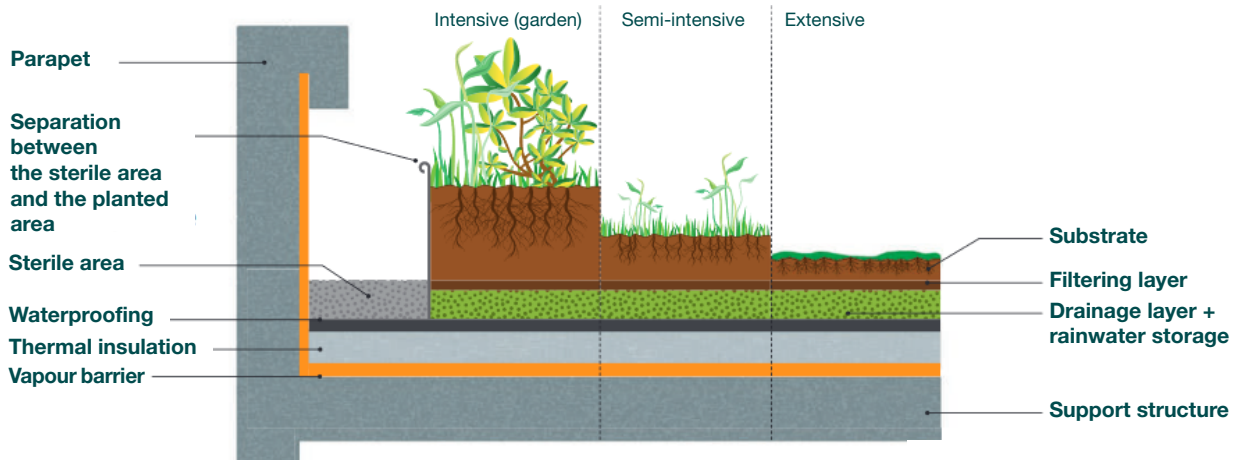
COMPONENTS OF A GREEN ROOF



Source : Adopta (2019)

Note that so-called “sterile” areas, at least 40 cm wide, must be created around the edges of the planted areas to maintain watertightness.

WEAK POINTS AND STRONG POINTS

⊕ Green roofs are particularly interesting because **roofs cover a large area of** the urban space (10% on average), with little competition for their use, apart from photovoltaic panels. Photovoltaic installations and green roofs are not in competition with each other if they are considered together from the design stage. On the contrary, they can work in synergy, such as the increase in photovoltaic yield through cooling from evapotranspiration.

⊕ As part of the French Energy and Climate Law, **some commercial buildings are required to plant one-third of their roof surface**, or to cover them with photovoltaic panels.

⊕ For unsuitable roofs, you can use materials or light-coloured, reflective coatings to ensure thermal comfort in summer.

⊕ Green roofs can **support biodiversity** by providing shelter and food for urban wildlife, while contributing to ecological connectivity in the form of patches. Because of the specific nature of the environment, particular care must be taken when selecting the plant palette.

⊖ Installing a green roof on an existing building is **complex because of the additional load**, especially when the roof is intensive or semi-intensive.

⊖ Although they are better suited to existing buildings, the thin substrate of **extensive roofs** makes them **inaccessible to** building **users** and less beneficial for biodiversity and associated ecosystem services.

MALADAPTATION

Maladaptation can result from the following:

More fragile building structure

Designing a green roof is a complex process. If the choice of vegetation is not adapted to the structure of the building, it may be weakened, causing problems with rainwater infiltration. This poses a risk to users.

Ineffective co-benefits

Furthermore, neglecting the stage of choosing the plant palette can render the project ineffective, or even lead to harmful effects on biodiversity. If the plants chosen are not suited to the particular conditions of the roof (wind, slope, thin substrate, etc.), the expected added value in terms of adaptation to climate change will not be achieved.

Pressure on local biodiversity

If the roof is home to invasive exotic species, interspecific competition may arise, putting pressure on local biodiversity.

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MONITORING INDICATORS

ESSENTIAL RECOMMENDATIONS WORTH THINKING ABOUT

- USE LOCAL SPECIES AS MUCH AS POSSIBLE
- ADAPT THE PLANT PALETTE TO CURRENT AND FUTURE CLIMATES
- ADAPT THE PLANT PALETTE TO THE CONDITIONS ON THE ROOF (HEIGHT, WIND, SLOPE, ETC.)
- USE SEVERAL THICKNESSES AND TYPES OF SUBSTRATE
- ENSURE THE PRESENCE OF A RAINWATER HARVESTING SYSTEM TO IRRIGATE ROOF-TOP VEGETATION
- INSTALL WILDLIFE REFUGES (WOOD PILES, ROCK PILES, BIRD NESTING BOXES, ETC.)
- ENSURE THAT THE SUBSTRATE THICKNESS IS GREATER THAN 8 CM
- CALL ON THE SERVICES OF AN ECOLOGIST DURING THE DESIGN PHASE

MONITOR MY ACTIONS FOR CLIMATE CHANGE ADAPTATION

+/- : Quantitative indicator ★ : Qualitative indicator

INDICATORS OF MEANS		INTERPRETATION
+/-	Percentage of green roof area in relation to total roof area	As high as possible, taking into account the roof structure
★	Type of roof installed (extensive, semi-intensive or intensive)	If possible, aim for an intensive roof
+/-	Number of plant strata	To be maximised
+/-	Calculation of the CBS-TTV described in the GreenRoofScore according to substrate thickness and vegetation type (no unit)	To be maximised
+/-	Water consumption for irrigation (m^3)	To be minimised
+/-	Percentage of key recommendations followed (%)	To be maximised

INDICATORS OF RESULTS		INTERPRETATION
+/-	Comparison between the temperature (°C) on the green roof and on a control roof	Green roof temperature < Control temperature
+/-	Comparison between energy consumption (kWh) for heating and cooling before and after green roofing	Energy consumption (kWh) before > energy consumption (kWh) after
+/-	Ecosystem performance of the project calculated using the GreenRoofScore	Best possible score
+/-	Maximum water capacity (CEM) of the substrate (l/m^2) (calculation protocol in appendix G of the GreenRoofScore)	To be maximised
+/-	Water retention capacity of the roof	To be maximised
+/-	Capacity of the water harvesting system destined to water plants (l/m^2)	To be maximised according to capacity of the roof (structure, surface, etc.)
+/-	Rainfall abatement of roof (%)	To be maximised
+/-	Roof leakage rate ($l/s.m^2$) (see definitions)	To be minimised
+/-	Reduction of runoff downstream from roofs using the Cerema's "Faveur" tool	To be maximised

**The control situation is defined by the parameters set to isolate the influence of the adaptive action (similar conditions: weather, time of measurement, space, etc.).*

DEFINITION

- **Water retention capacity of the roof**: quantity of water (volume/m^2 of roof) retained by the substrate after saturation with water for 24 hours then drained for 2 hours.
- **Water harvesting system for watering plants**: device added to the substrate to store water on the roof or on the ground and irrigate vegetation.
- **Rainfall abatement of the roof**: quantity of rainwater captured by the substrate and consumed by the green roof (evaporation by the substrate and transpiration by the vegetation).
- **Roof leakage rate**: volume of rainwater discharged by the roof during a rainfall event.

TOOL

- GreenRoof Score: Standard developed by Adivet to assess the performance of green roofs in terms of ecosystem services.
- Faveur: Tool developed by Cerema to assess the water performance of green roof terraces.

FIND OUT MORE

Adivet (2023), *Règles professionnelles pour toitures terrasses végétalisées*

Adopta (2019), *La toiture végétalisée*

De Munck (2013), Modelling of urban vegetation and adaptation strategies for improved comfort and energy demand in the city

Adivet (2023), GreenRoofScore

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