Interreg
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MultiRoofs

Joint Strategy Report

How public authorities can affect how rooftops get utilised

Deliverable 1.2.5

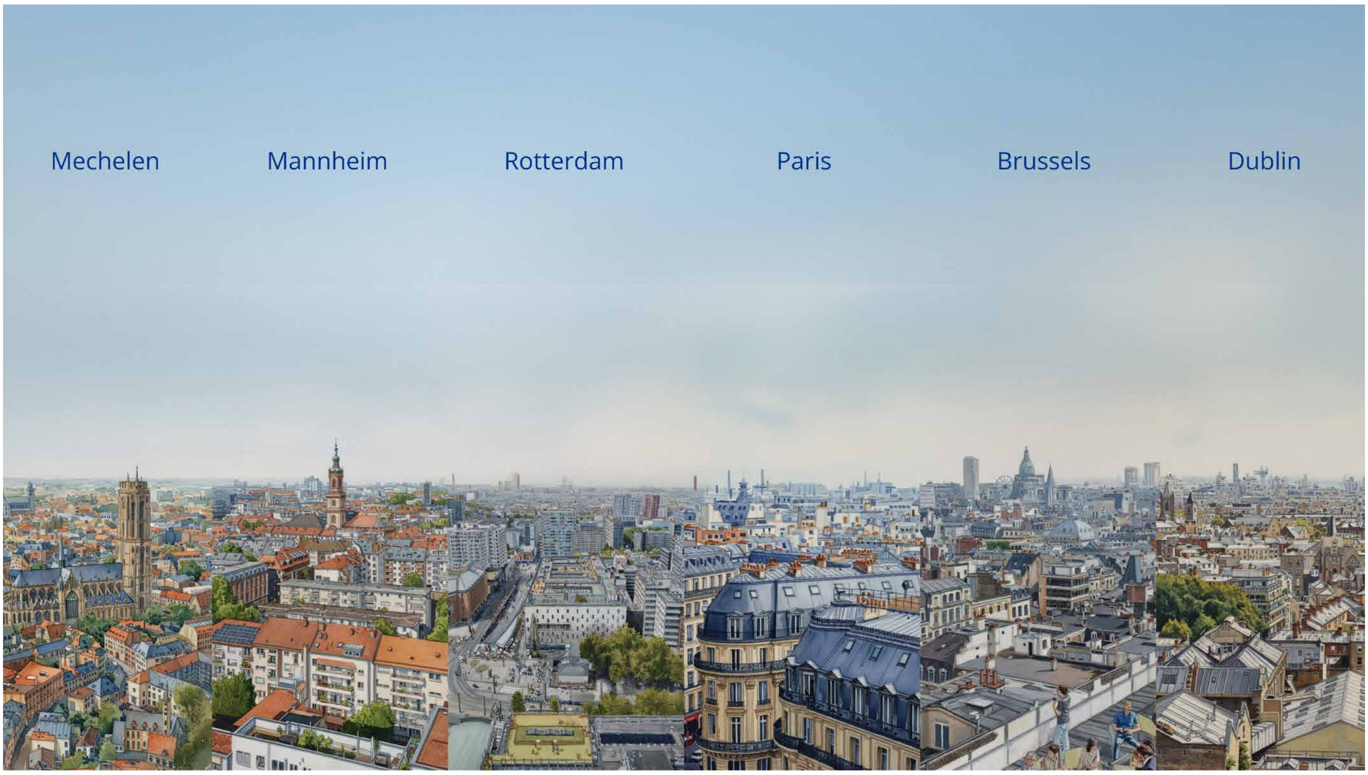

Table of Contents

Table of Contents

Table of Contents

1. Executive Summary

1. Executive Summary

Cities across Europe are facing growing and overlapping challenges: **rising temperatures**, **heavier rainfall**, **pressure on public space**, **increasing energy demands** and **shortages of green and social facilities**. At the same time, a vast amount of unused space already exists above our heads. Rooftops cover enormous areas within city boundaries, yet most of them remain underused. The MultiRoofs project brings together six European cities and regions to explore how public authorities can unlock this potential and use rooftops as active contributors to **climate resilience**, **energy transition**, **biodiversity restoration** and **community wellbeing**.

This report lays the foundation for a shared strategy. It introduces a common method that helps cities understand what is needed in different districts, what is technically possible on different buildings and what building owners are likely to want or accept. A key part of this work is the creation of shared definitions—of rooftop functions, building types, owner categories and district types—so that different cities can compare options and collaborate more effectively. These typologies support consistent decision-making even in very different local contexts.

A foundational aspect of the report is the role of data. Partners analysed what information is required to map rooftops reliably, what formats and identifiers differ across cities and how to overcome these differences. This resulted in a common data approach built on European interoperability standards.

All of this work feeds directly into the development of the digital twin tool. This tool brings together geographic data, technical assessments and policy needs into a single visual model. It helps local authorities see the physical potential of rooftops, compare different functional combinations and understand where interventions could have the greatest impact. While the tool does not make decisions for cities, it gives them a clearer, shared basis for discussions with colleagues, building owners and stakeholders.

The report also explores how to prioritise rooftop actions. Through a structured process, cities examined how different challenges—such as heat, flooding, mobility or housing—play out in different districts, and how these priorities align with the motivations of building owners. This strategic prioritisation framework helps local authorities decide where to begin, which combinations of rooftop functions are most valuable and what incentives may be needed to convince owners to participate. Finally, the report looks ahead to the next steps. In the upcoming pilot phase, six cities will test the digital twin tool using their own datasets, engage with local property owners and trial incentive approaches. These pilots will deliver practical evidence on what works, what doesn't and how the strategy can be refined for broader European use. For long-term scaling, the project will develop a training programme and a communication strategy so that other public authorities can adopt the MultiRoofs approach.

Altogether, this report provides a shared starting point for transforming rooftops from overlooked spaces into **strategic assets for European cities**. It shows how data, design, governance and stakeholder engagement can come together in a practical method, supported by a digital twin tool, to help cities act on climate and spatial challenges in a coordinated and future-proof way.

2. Introduction

2. Introduction

Why?

Cities lack space while their population and needs are growing. Underused rooftops can contribute significantly to tackling existing and rising urban challenges.

Mission

MultiRoofs transforms urban rooftops into accessible, biodiverse and inclusive spaces that make cities more liveable and resilient.

Vision

MultiRoofs sees roofscapes as drivers of collective urban transformation, powered by open data, digital tools and community engagement.

Cities across Europe are facing **growing pressures**: they are getting hotter, wetter, denser, and busier. At the same time, the need for **clean energy**, **green spaces**, **water storage**, **affordable housing** and **healthier neighbourhoods** is increasing. Yet the amount of free space at street level is limited. **Rooftops**, however, cover enormous surface areas and are often unused. This report explores how public authorities can **unlock this hidden potential** and turn rooftops into **valuable spaces** that benefit people, neighbourhoods and the environment.

The MultiRoofs project starts from a simple idea: if we treat rooftops as part of the city's **shared infrastructure**—just like streets, parks or public squares—we can use them to **deliver multiple functions at once**. Rooftops can help cool overheated districts, store and reuse rainwater, generate renewable energy, support biodiversity, provide safe spaces for play and meeting, or even add new usable floor space. Some of these functions work especially well together. For example, vegetation and water buffering cool the environment and make solar panels perform better, and greener rooftops improve health and relaxation. When combined carefully, these **"stacked functions"**

2. Introduction

create more value than if each function were installed separately.

This report explains how public authorities can **activate rooftops in a consistent and scalable way**. It introduces a **shared framework** that helps cities understand what is needed in different neighbourhoods, what is technically possible on different kinds of roofs and buildings, and what building owners are likely to want or accept. It also outlines how a **digital tool** can support **transparent decision-making**—by providing clear visuals, simple outputs and guidance that is easy to share with colleagues, owners and citizens. The tool addresses the following complementary questions:

· **what is needed** (what urban challenges are faced)?
· **what can be done** (what capacity is available)?
· **what is desired** (what scenarios gain support)?

The tool is not the goal in itself. The real goal is to enable **better, faster and more confident public decisions** about rooftop use.

The report builds on the series of **"strategy sprints"** carried out during the project. Earlier sprints established a **shared language** for rooftop uses, urban districts, building types and owner types. They also explored the **data needed to map rooftops accurately** and fairly across different cities. This introduction offers a roadmap for understanding how these pieces fit together and how they support the steps that follow.

Rooftops matter now more than ever. With climate change intensifying and cities needing to provide more services within the same limited space, rooftops offer an opportunity to act **faster, more efficiently** and with fewer trade-offs than many alternative interventions that often battle for space on ground level. Vegetation and water systems can reduce heat and flood risks. Solar panels and insulation improve the energy performance of buildings. Safe access to rooftops can create much-needed **community spaces**. And where suitable, rooftops can even support new housing or facilities. Because they make use of existing buildings, rooftop interventions often have shorter timelines and **fewer spatial conflicts** compared to new ground-level developments.

2. Introduction

This report is designed for **public authorities** who want to make better use of this overlooked part of the city. It offers **methods, examples and shared definitions** that allow cities to compare options, design incentives, collaborate across departments and engage with owners in a clear and consistent way. It also prepares the ground for the **pilot projects in six cities**, where the approach will be tested, improved and turned into practical guidance for wider use across Europe.

Who should read?

Urban planners and programme managers, asset and portfolio owners, data/GIS teams, policy officers for climate, energy, water, biodiversity, housing and urban development.

Decisions this informs now:

Where to act first (districts, owners), which rooftop functions to combine, how to package incentives, and how to compare options transparently.

What's in this version vs. the final one?

This version sets the method and pilot plan. The final version will add city-tested policy recommendations, stakeholder-specific next steps, and a consolidated monitoring and evaluation framework with pilot results.

3. Data driven rooftop mapping and utilization (SP1)

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3.1. Introduction

This section lays the **data-driven foundation for MultiRoofs**: what interoperable data is required, how it will be **assessed and transformed**, and how it underpins the development of the digital twin solution. It links directly to D1.2.2 (Strategy Sprint 1 report), D1.1.1–D1.1.6 (LA data inventories) and D1.1.7 (transnational interoperability assessment), providing a **clear set of inputs to the actual development of the tool**. For example, it helps to define a standardised solution architecture that will help LAs across North-West Europe to reliably adopt the tool, despite differing **technical, organizational and regulatory environments**.

3.1.1. Defining what the tool should do

Key findings D.1.2.2 – Report on Strategy Sprint 1
The goal of MultiRoofs is to provide a modular, interoperable approach to activating multifunctional rooftops, recognising that spatial, technical and policy complexities mean **data should inform, not decide**. Over six months, as pilot cities and regions sourced public data, the consortium developed both a suite of tools and a **collaborative scenario design process** that connects diverse stakeholders.

The main target group that will use the tool consists of **policymakers**—such as program and project managers, policy officers, and urban planners.

The method is framed around **three complementary functions**:
- Urban Challenges (what is needed);
- Capacities (what can be done);
- Scenarios (what is desired);

And aligns these with three data families: **Geospatial, Expert and Collaborative**:
- **Geospatial** data provides the objective backbone for calculating rooftop capacities by combining a 3D city model with 2D GIS layers to assess geometry, context and constraints. Where 3D models are absent, aerial LiDAR is commissioned and TU

3. Data driven rooftop mapping and utilization (SP1)

Delft's open-source Roofer reconstructs LoD2.2 geometries; additional synthetic attributes are derived via custom analyses.

- **Expert** data captures locally specific "Needs" through an Urban Challenges Mapping spreadsheet curated with planners, politicians and specialists, translating ambitions (e.g., climate adaptation, energy performance) into weighted targets to guide scenario-making.
- **Collaborative** data expresses the "Wants" during interactive sessions, where users set ambitions, draw activation zones and prioritise roofs; these preferences are collected live and embedded directly in scenario outputs (reports, visuals, quantitative summaries).

Interoperability is achieved by standardising on CityJSON as the sole mandatory 3D format, in line with Minimal Interoperability Mechanisms (OASC MIMs), and documenting workflows to convert existing models and merge them with 2D inputs in common GIS formats. This ensures cities with limited data can start with a minimal layer set, while richer contexts can add precision through additional attributes. The resulting data-rich 3D digital twin supports analysis and visualisation and can be stored locally or within municipal infrastructures, enabling flexible deployment and scaling across different governance and technical environments.

Key challenges include uneven availability and quality of 3D and 2D datasets across municipalities, the need to keep the digital twin current in dynamic cities, and the technically demanding translation from relative challenge scores to precise square metres of rooftop programmes. The report anticipates future refinements, and continued development to embed the **challenge framework directly in the tool**. Overall, the deliverable demonstrates that a standards-based, human-centred, and collaboratively governed process can robustly support multifunctional rooftop activation across diverse European contexts.

3. Data driven rooftop mapping and utilization (SP1)

3.1.2. Identifying and assessing the underlying data

Key findings D.1.1.1 – D1.1.6 – Building and geographical data inventory
This section summarizes the principal findings from the data inventory and assessment across the six LAs. It highlights the current data landscape, common strengths and gaps, interoperability and governance issues that will affect MultiRoofs' ability to produce the results mentioned in the section above, and pragmatic next steps to reach a Minimum Viable Product (MVP) and scale thereafter.

Unique findings by Local Authority

3. Data driven rooftop mapping and utilization (SP1)

Theme	Rotterdam	Brussels	Dublin (Local Council Areas)
Data	City-wide LoD2.2; high-density LiDAR (~30 pts/m²); ≤5 cm orthophotos; streetview private; roofprints not separate	LoD2.2 (GeoPackage); roof/ground via queries; 5 cm orthophotos (ECW); 2021 LiDAR by tiles; no oblique; usage at block level; limited EPC	LoD2.2 localised to Smart Districts; OSM footprints; local point clouds/orthos for pilots; identifiers behind paywalls (Eircode/ GeoBuilding Intel); construction/energy aggregated (small areas); heritage per LA; no streetview
Interoperability	Uses CityJSON; BAG IDs enable linking; mixed heritage sources need mapping; LiDAR density varies	No shared building ID across 3D/2D/ cadastre; ECW limits some tooling; CityJSON export via FME; manual LiDAR download; no single API	Fragmented across four LAs/Smart Districts; varied formats and coverage; paywalled IDs complicate linkage
Ownership / Privacy	Building-owner data private; streetview private	Cadastral/ownership and construction year contain GDPR-sensitive fields; sharing needs agreements/ anonymisation	Several datasets private or purchasable; access depends on agreements and stakeholder interest
Governance/ Access	Formal DUB process with GLO contracts; potential multi-month timelines; emerging municipal data broker; dependency on national DSO regulation digitisation	Paradigm platform with continuous updates; cartography team supports anonymisation/ conversions	Multi-stakeholder coordination required; Codema aims for regional harmonisation; prototypes to unlock cooperation/ procurement
Technical capacity	Strong geodata/ GIS/analytics; prior RoofScape experience	Internal capability to curate/transform/ validate; can produce one-off CityJSON export	No city-wide LoD2.2; roofprints absent; limited building-level attributes; stakeholder alignment challenges
Gaps and risks	Roofprints absent; regulation dataset not assessed; LiDAR density variability	Limited building-level usage/EPC; tiled LiDAR overhead; ID linkage missing	No city-wide LoD2.2; roofprints absent; limited building-level attributes; stakeholder alignment challenges

Table 1a: Building and geographical data inventory in participating LA's (part a)

3. Data driven rooftop mapping and utilization (SP1)

Theme	Île-de-France	Mechelen	Mannheim
Data	Strong baselines: footprints (cadastre), LiDAR HD (10 pts/m²), orthophotos (5–6 cm), BAN addresses, ADEME EPC; solar potential; roofprints and 100 pts/m² LiDAR expected 2026; LoD2.2 not yet available	Footprints/indicative roofprints via Digitaal Vlaanderen; orthophoto 15 cm public; true ortho, oblique photo (8cm) + LiDAR is purchased; VMM flood/heat/drought layers; heritage via DV; no EPC; CRS EPSG:31370	City-wide LoD2.2 (2019 base); manual/local updates; internal 3D Tiles only; CityGML conversions needed; LiDAR (2022), orthophotos (2023), inner-city streetview; heritage WMS; no EPC; roofprints absent
Interoperability	Broad APIs and consistent national registries support linking	Two building IDs (GBG/gebouwregister) not linked; address/building URIs link via gebouweenheid; roofprint eaves imperfect	CityGML hard to use; conversion to CityJSON/other formats required; building-level heritage combination tricky; limited data accessibility
Ownership / Privacy	Ownership public only for legal entities; some BDNB fields not open	Cadastre attributes (usage, owner, construction year) private; parcel-based with multi-building ambiguity; internal municipal datasets private	3D building data licensed (not open); ownership data internal with legitimate interest and case-by-case checks
Governance/ Access	IDF High Resolution project timing risk; internal mobilisation and coordination challenges; language interface already supported	OSLO alignment pending for some internal datasets	Manual/single-resource update model; shift towards Urban Digital Twin integration; planner adoption limited (2D dominates)
Technical capacity	Internal expertise present; mobilisation is the constraint	Limited 3D processing expertise; requires consortium support and step-by-step guidance	Technical capability present; broader organisational uptake limited
Gaps and risks	LoD2.2 and roofprints pending; dependency on HR project timelines	EPC absent; ID mismatches; CRS handling required	Irregular updates; conversion/export barriers; lack of open access; roofprints absent; EPC missing

Table 1b: Building and geographical data inventory in participating LA's (part b)

3. Data driven rooftop mapping and utilization (SP1)

Cross-LA observations

- The LoD2.2 coverage varies from full availability on the city level (Rotterdam, Mannheim) to patchy/ local availability (Dublin, Mechelen), with Île-de-France and Brussels largely well served by national/regional infrastructures.
- The point cloud density and access differ (≥10 pts/m² recommended; Rotterdam, Mechelen and parts of Île-de-France meet or exceed this; some partners need purchases).
- Persistent identifiers are inconsistent: several partners lack a single building ID suitable for cross-dataset linking; where IDs are missing, geometry-based matching will be required. The context for each LA is:

o Rotterdam: BAG Pand ID provides a strong, persistent building ID (good).

o Brussels: no single shared building ID across 3D/2D/cadastre yet; geometry based linking needed until an ID strategy lands.

o Dublin: paywalled/partial identifiers; expect geometry + address matching in pilot areas.

o Île de France: national registries (BAN, RNB/BDNB) help, but alignments still needed during LoD2.2 reconstruction.

o Mechelen: two unlinked building ID systems (GBG vs Gebouwenregister URI); crosswalk (map identifier systems onto each other) and spatial reconciliation required.

o Mannheim: internal IDs exist but data access/conversion barriers mean an ID crosswalk may be needed for external use.

- Data is delivered in mixed formats (CityGML, GeoPackage, ECW, LAS/LAZ, proprietary 3D-tiles). Converting to a canonical schema (CityJSON v2.0) and standard CRS handling will be fundamental.
- Governance and privacy: ownership/cadastre datasets are frequently private or sensitive (GDPR) and need anonymisation or controlled access; formal agreements and roles (e.g. data brokers) are essential.
- Technical capacity: capability to run reconstruction (Roofer), ETL, and manage CityJSON varies — some partners require training or external processing support.

3. Data driven rooftop mapping and utilization (SP1)

3.1.3. Understanding transnational data interoperability

Key findings D.1.1.7 – Interoperability Assessment
The assessment concludes that transnational adoption of MultiRoofs is feasible, but partner datasets differ substantially in format, CRS, semantic detail, identifier policies and access conditions. A **two-stage methodology** is applied to investigate interoperability:

1. Local authorities submit a 1 km × 1 km samples to evaluate 3D building models and their convertibility;
2. Additional attributes are assessed for format, linkability, metadata, security and quality.

Partners fall into three cases:
- Case 1 cities (Rotterdam, Brussels, Mannheim) already have LoD2.2 models;
- Case 2 (Île-de-France, Mechelen) can reconstruct LoD2.2 using footprints and classified LiDAR;
- Case 3 (Dublin) has partial inputs and will start with small pilot areas. Key issues include inconsistent or missing building identifiers, CRS variations, variable LiDAR classification and density, mixed file formats (CityGML, GeoPackage, ECW, LAS/LAZ), and GDPR-sensitive ownership/cadastre data spread across departments.

3.1.4. Addressing data (interoperability) challenges

To address these, the assessment recommends aligning with **European interoperability frameworks** (EIF/EIF4SCC) and OASC's MIMs, using CityJSON v2.0 as the canonical 3D encoding (with a MultiRoofs extension for project-specific attributes), and establishing an **automated ETL pipeline** (GDAL/PDAL with Roofer where needed) to normalise CRSs, reconstruct LoD2.2 and **validate conformance**.

Organisational measures include DCAT-style minimally required metadata, ID crosswalks or generation of stable MultiRoofs IDs, and sharing agreements, anonymisation and access controls for sensitive datasets. With these technical and governance mechanisms in place, the tool can **operate reliably**

3.2. Implications of SP1 on the development of the tool

3.2.1. Principles and standards

We align to **European best practice** to ensure "minimal but sufficient" interoperability: the European Interoperability Framework (EIF) and EIF4SCC for layered guidance (technical/semantic/organizational/legal, OASC MIMs Plus (with emphasis on MIM7 Geospatial), and CityJSON v2.0 (OGC) as the canonical 3D encoding. **Geospatial metadata** is managed by adhering to ISO 19115 and DCAT-AP can be used for dataset discoverability. If applicable, OGC APIs (Features/Tiles) can provide standards-based access to 3D tiles.

3.2.2. Overview of required interoperable data

Two components form the core data basis: (1) 3D building models at LoD2.2 to capture roof geometry and location; and (2) **additional attributes that describe performance and constraints** (e.g., slope, area, irradiance, heritage, ownership, energy labels, flood/heat/noise zones). At minimum, footprints and classified aerial LiDAR (ground/ buildings classes; ≥10 points/m² preferred) or an existing 3D model are required to reconstruct LoD2.2. All data should carry clear identifiers, CRS, units, provenance, and licences to enable **consistent linking and reuse**.

3.2.3. Data sources and accessibility

Geospatial baselines are sourced from **national and municipal providers** (e.g., BAG footprints, CBS neighbourhoods, RVO energy labels, municipal WFS/WMS for heritage/flood/green corridors), complemented by **portfolio/client datasets** where available. Access should, where possible, be via **standards-based services** (OGC WFS/OGC APIs) or **structured formats** (CSV, SHP, GeoPackage). **ISO 19115 metadata** captures the data characteristics (e.g. LoD, EPSG code, etc.) and DCAT-AP describes the coverage, update cadence, licence, and contact points of a particular dataset. The approach anticipates heterogeneous realities and supports staged sourcing—starting with **open data** and expanding as **local capacity grows**.

3.2.4. Data interoperability and integration

Heterogeneous inputs are normalised into CityJSON (canonical schema) through an ETL pipeline leveraging GDAL and, where needed, Roofer for automated LoD2.2 reconstruction. CRS differences are handled through declared EPSG/WGS codes (INSPIRE metadata), and attributes are mapped using documented templates; a CityJSON Extension will capture MultiRoofs-specific fields. **Unique and persistent identifiers are enforced**; where absent, geometry-based linking methods are applied. Conformance checks validate schema, LoD, CRS, ID policy, and metadata, ensuring a consistent, comparable model across cities.

3.2.5. Governance and Privacy Considerations

Organizational and legal interoperability is addressed by defining ownership/stewardship, clear terms/licences, and a pragmatic privacy posture: MVP relies on open data; sensitive attributes are aggregated/offline or joined in place via connectors. DPIA triggers are assessed **when personal or restricted data is used**; access controls (OIDC/RBAC) are introduced accordingly. Please note that this will take place at a later stage (post-MVP).

3. Data driven rooftop mapping and utilization (SP1)

Where to find additional information?

D1.2.2 (Strategy Sprint 1 report)

D1.1.1–D1.1.6 (LA data inventories)

D1.1.7 (transnational interoperability assessment)

4. Typologies and Definitions (SP2)

4. Typologies and Definitions (SP2)

4.1. Introduction and methodology

This chapter establishes a shared language for **rooftop functions**, **urban districts**, **building types**, **building owners**, and **the roles of Local Authorities** (LAs). It ensures that MultiRoofs partners interpret data, tool outputs, and policy choices consistently across different contexts.

The process to come to this typologies and definitions combined bottom-up input from partner cities/regions with top-down harmonisation using **evidence-based data and European standards** (e.g., LUCAS land use, Urban Atlas). Through surveys, MIRO sessions, and iterative reviews, partners co-created definitions and principles that will guide the next steps of the project, including pilot actions and incentive design.

It builds on insights from **previous knowledge sessions** and **workshops** and its purpose is to create a structured foundation for rooftop strategies by defining urban district types, property types, and owner categories.

The process to come to the different frameworks and definitions followed three steps:

- **Framework Consolidation**: Apply the shared urban challenge framework and governance models developed earlier.
- **Typology Development**: Classify the different frameworks, linking them to rooftop potential.
- **Collaborative Design**: Use iterative sprints and the shared Miro board to validate definitions across partner cities/regions.

The typologies and principles below are the direct outcomes of Strategy Sprint 2 and provide the foundation for prioritisation and incentives & cost–benefit strategies (Ch.5 - Strategic Prioritization Framework (SP3). Each section summarises definitions, key principles for use in practice, and pointers to detailed annexes and examples. The typologies are transnational and interoperable by design, and should be adapted locally (policy, datasets, regulatory context) when applied in pilots and policy development.

4. Typologies and Definitions (SP2)

4.2. Rooftop Usage (functions)

4.2.1. Framework (7-colour system)

The consortium adopts a **seven-colour taxonomy** to classify rooftop functions from the document 'Concept Omgevingsprogramma MFD' (2022, by P2, Plaattaal and Superworld, commissioned by the municipality of Rotterdam):

- **Green — Nature & Biodiversity**. Vegetated roofs supporting habitat, corridors, micro-climate and air quality.
- **Blue — Water Retention & Management**. Passive/active storage, reuse, buffering and quality improvement of rainwater.
- **Yellow — Energy Transition**. Renewable energy and heat generation, storage and thermal comfort/insulation measures.
- **Red — Social & Community**. Outdoor social, cultural, educational and recreational uses (public or semi-public access).
- **Orange — Mobility**. Active travel connectors, last mile logistics, safety routes and special pads (e.g., drones/UAM where applicable).
- **Purple — Densification**. Built extensions for new habitable/usable space (housing, workspaces, facilities).
- **Grey — Utilities & Infrastructure**. Technical systems and urban services (HVAC, telecoms, flues, guardrails, signage).

Figure 1: 7-colour rooftop functions framework

4.2.2. Principles for application

The **seven-colour rooftop framework** provides a clear, shared way to describe rooftop functions while supporting practical implementation. Its core principle is **multifunctionality**: rooftops can deliver far more value when functions are combined. Green roofs cool buildings and enhance biodiversity, blue roofs improve water buffering, and both can strengthen the performance of solar energy systems. Social and mobility functions also benefit from greener and cooler environments. This approach encourages cities to **deliberately design for synergies** rather than single-purpose interventions.

To remain both accessible and operational, the framework works on two levels. The **public-facing level** uses the seven colours to communicate options simply to owners, residents and decision-makers. The **professional level** adds more detail—such as subcategories, quality criteria, and design guidance—so planners and engineers can adapt solutions to specific buildings and local conditions.

Although the colours remain consistent across cities, application must be **locally tailored**. Climate, policy, structural characteristics and community priorities differ, so cities can adjust **intensity, accessibility and design** requirements while keeping the shared classification intact.

Several strategic considerations guide implementation of rooftops strategies. First, **time-based programming** (chrono urbanism) helps maximise limited rooftop space by allowing different uses at different times—for instance, a school roof serving pupils by day and the wider community in the evening.

Second, cities can **focus effort where it matters most** by defining priority intervention zones based on local challenges such as heat, flooding, lack of green space or limited social facilities. The tool supports this by visualising potential combinations, while policy choices remain local.

Finally, rooftop transformations are most effective when **aligned with existing urban**

projects. Integrating rooftop upgrades with planned maintenance, renovations or district-level initiatives reduces costs, speeds delivery and increases overall impact. By applying these principles, cities can turn underused roofs into multifunctional assets that support climate **resilience, energy transition, biodiversity restoration and community wellbeing**.

4.3. Urban Districts

Urban districts help link rooftop opportunities to the characteristics of different parts of the city. The MultiRoofs framework uses **six simple, shared categories**:

- City Centre,
- Sub-centre,
- Residential,
- Industrial & Services,
- Green Areas
- Unused Zones

to make districts comparable across partners. Each district is defined by its spatial boundary, main land-use function and an indication of density. This gives cities a **common structure** while allowing them to use their own planning boundaries and datasets.

Districts vary in **building types**, **ownership patterns** and **challenges**. City centres are dense and often constrained by heritage; residential areas range from low-rise neighbourhoods to compact apartment zones; industrial districts have large roofs but may face structural limits; and green or unused areas play roles in ecological or transitional planning. **Matching rooftop functions to these contexts**—such as prioritising energy in industrial zones or social and green functions in residential areas—**improves impact**.

Cities may refine these categories with local sub-districts and optional parameters like dominant building types, owner profiles or specific planning rules. This keeps the framework consistent but adaptable to local needs. The district lens ultimately supports prioritisation, showing where rooftop capacity aligns with local challenges and where multifunctional rooftops can add the most value.

4.4. Building Types

Understanding building types is essential for assessing which rooftop functions are technically feasible and how multifunctional solutions can be applied across a city. Buildings differ widely in their **use, construction era, materials, roof forms and regulatory constraints**, and these characteristics strongly influence the opportunities and limits for rooftop transformation. The building typology provides a shared structure for analysing this diversity across partner cities.

The framework distinguishes key attributes that shape **rooftop potential**: a building's primary function (such as residential, commercial, office, public or industrial), its construction period and materials, its height category and whether the roof is pitched, flat or hybrid. These factors determine **load-bearing capacity, access conditions, fire and wind requirements**, and the level of intervention required for adding green, blue, energy or social functions. For example, many pre-war masonry buildings offer opportunities for lightweight green or solar installations, while mid- to late-20th-century reinforced-concrete structures often support heavier systems or extensions.

Large roof surfaces in **commercial or industrial buildings** offer significant technical and spatial potential but may require structural assessment due to lightweight steel construction. Conversely, **residential buildings**—particularly apartments governed by homeowners' associations—may offer strong social or environmental opportunities but require collective decision-making and careful alignment with local regulations. Public and institutional buildings often have substantial roof areas and can serve as visible demonstration projects aligned with municipal priorities.

Because each building type comes with distinct constraints and opportunities, the typology helps local authorities match rooftop functions to what the structure can **realistically support**. It also highlights where advisory support or staged interventions may be needed—for example, addressing access, safety or structural reinforcement. Combined with the urban district framework, this enables cities to assess "what the building can do" in a consistent and comparable way, creating a practical basis for prioritising multifunctional rooftop activation.

Building type categories:

- **Residential buildings**
- **Commercial buildings**
- **Office buildings**
- **Public and institutional buildings**
- **Industrial buildings**

4.5. Building Owners

The consortium worked further on the definitions from the document 'Concept Omgevingsprogramma MFD' (2022, by P2, Plaattaal and Superworld, commissioned by the municipality of Rotterdam) and adapted them to the needs of the different **Local Authorities**.

Building owners play a crucial role in activating multifunctional rooftops. Their motivations, decision cycles, financial capacities and regulatory constraints differ widely, which means effective rooftop strategies must tailor engagement and incentives to each owner category. The shared typology developed in the sprint provides a transnational, comparable way to understand these groups while leaving room for local variation in behaviour and market conditions.

Owner categories range **from individual homeowners to institutional investors and public-sector real estate holders**. Each group responds to different triggers: homeowners often decide based on comfort and personal values; landlords and developers focus on return on investment; housing corporations balance long-term social missions with budget constraints; and municipalities act from public interest and policy goals. Heritage owners and religious institutions require specific approaches due to regulatory limitations and limited financial flexibility. These distinct profiles influence how quickly and under what conditions rooftop transformations can take place.

Understanding these differences helps public authorities determine which incentives—financial, advisory, organisational or regulatory—are most effective for each group. It also helps **identify decision making moments** (such as renovation cycles, maintenance, reroofing or energy upgrades) when owners are most open to considering rooftop transformation. Aligning rooftop proposals with these moments reduces barriers and increases uptake.

Building owner categories:

- **Private individual homeowners** (owner-occupied)
- **Landlords** (individual/small companies)
- **Homeowner Associations** (HOAs) (collective ownership)
- **Housing corporations / social providers** (mission-driven, portfolio-managed)
- **Municipal real estate owners** (public buildings/land; policy-led)
- **Corporate real estate owners** (owner-occupied offices/retail/logistics)
- **Industrial property owners** (production/logistics; operational focus)
- **Private project developers** (short-/mid-term, profit-driven)
- **Institutional investors** (pension and investment funds, insurance companies; finance-driven)
- **Religious institutions** (community-driven; often heritage constraints; limited liquidity)

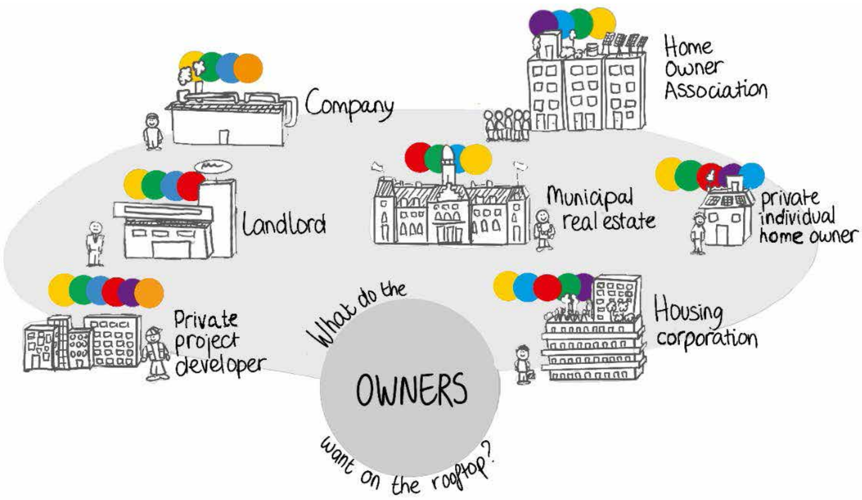

Figure 2: building owner types

4. Typologies and Definitions (SP2)

4.6. Roles of the Local Authorities (LA)

To define the different roles of local authorities we worked on a Dutch framework: 'Sedimentatie in sturing: 'Systeem brengen in netwerkend werken door meervoudig te organiseren', (215, Van der Steen, M., Scherpenisse, J. and van Twist, M.)

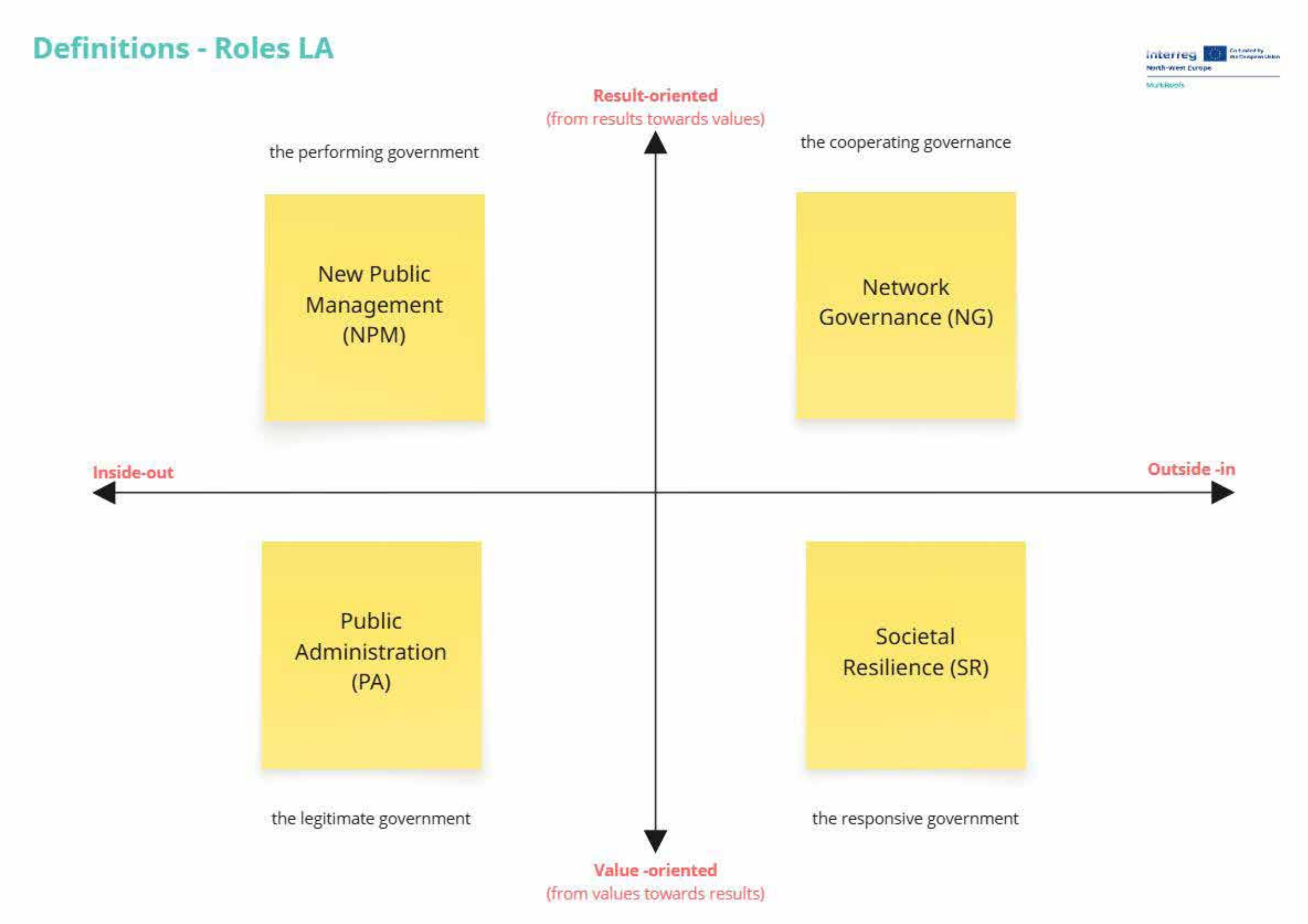

Figure 3: NSOB-model on Roles of the Local Authorities

4. Typologies and Definitions (SP2)

Local authorities play multiple roles when activating multifunctional rooftops. They are not only regulators or programme managers; they also act as partners, facilitators and connectors. The NSOB governance framework recognises four complementary perspectives—**Legitimate, Performing, Cooperating and Responsive**—each shaping how a public authority engages with building owners and the wider urban ecosystem. These roles coexist rather than follow a sequence, and cities must navigate between them depending on context, partners and project goals.

As **Legitimate Government**, authorities create clear and lawful conditions for rooftop activation by setting planning rules, integrating rooftop functions into policies and ensuring transparent, accountable procedures. This provides the stable regulatory foundation that owners and investors need to act.

As **Performing Government**, they focus on delivering concrete results—pilots, programmes and permitting processes that move from ambition to implementation. This includes coordinating complex projects, monitoring progress and demonstrating what is possible through leading examples on public buildings.

As **Cooperating Government**, they work with private, civic and institutional partners to achieve impacts that cannot be reached alone. Through agreements, partnerships and network building, they align shared ambitions, enable group approaches, and create favourable conditions for owners to act together.

As **Responsive Government**, they engage with bottom-up initiatives and emerging practices, recognising the value of community energy, civic creativity and informal networks. This includes supporting co-creation, opening channels for local ideas and incorporating societal dynamics into rooftop strategies.

In practice, these perspectives underpin several concrete roles:

- **Policy maker**, embedding rooftop functions into planning norms and regulatory frameworks (within a Legitimate government).
- **Project manager**, coordinating delivery, solving practical bottlenecks and ensuring measurable outcomes (within a Performing government).
- **Public networker**, connecting owners, tenants and partners to enable area-based

solutions and collective investments (within a cooperating government).
- **Co-creator**, working with civic groups and local initiatives to support experimentation and shared learning (within a responsive government).

Together, these roles allow local authorities to guide rooftop transformation confidently and flexibly, using regulation, collaboration, delivery capacity and community engagement as mutually reinforcing tools. This integrated approach is essential for scaling multifunctional rooftops across diverse building types and ownership structures.

4.7. Financial Mechanisms

Financial mechanisms help **reduce the barriers that property owners face** when investing in multifunctional rooftops. Because rooftop upgrades often require structural checks, technical installations and coordination among multiple stakeholders, **owners need financing options** that minimise upfront costs, spread risks and create predictable conditions for decision-making. **Local authorities** can use a broad set of mechanisms that either support individuals directly, link financing to the property, lower initial investment thresholds or mobilise external capital.

Person-based mechanisms, such as flexible or green loans, grants, tax benefits and interest subsidies, improve affordability for individual households and small landlords by adapting repayment terms or reducing overall renovation costs.

Property-linked financing, including on-bill and on-tax repayment systems, allows the investment to stay with the building rather than the owner, making long-term improvements more feasible and reducing the financial risk of ownership turnover. Performance-based agreements, such as ESCO contracts, enable owners to undertake energy-related improvements with guaranteed results.

Reduced upfront investment can be achieved through collective purchasing, pre-financed grants or leasing arrangements, which make it easier for owners to begin rooftop projects without large initial payments. These approaches are particularly valuable for households, homeowners' associations or organisations with limited liquidity.

In parallel, **larger renovations or district-scale initiatives** may require raising external capital from crowdfunding, revolving or investment funds, green bonds or public-private partnerships, which can pool resources, share risks and finance complex interventions.

In practice, **financial tools** work best when combined with advisory support, clear communication and stable long-term rules. This mix helps owners **understand their options**, **align rooftop upgrades with renovation cycles** and **make confident investment decisions**. By offering predictable, accessible and well-designed financial mechanisms, local authorities can accelerate the adoption of multifunctional rooftops and enable a wider range of owners to participate in the transition.

4.8. Urban Challenges

The framework below is created for the Roofscape project in 2022 (MVRDV in collaboration with the Municipality of Rotterdam). However, this framework has been further developed **for MultiRoofs**.

Urban challenges define the pressures that multifunctional rooftops can help address. The MultiRoofs framework groups these into **ten families**, covering climate risks, biodiversity loss, energy transition, aging infrastructure, mobility pressures, housing needs, circular-economy goals, public health, social inequality and governance constraints. These challenges represent the "demand side" or needs against which rooftop potential is assessed.

Many districts face rising **heat stress**, **frequent flooding** and **water-system pressure**, making green and blue roofs valuable for cooling, buffering and resilience. Biodiversity decline and fragmented ecological networks highlight the need for nature-inclusive solutions that rooftops can help provide. At the same time, cities must reduce energy use, expand renewable generation and manage limited grid capacity; rooftops offer space for PV, insulation and thermal comfort measures, though heritage restrictions may limit options. Aging energy, water and mobility infrastructure further intensifies the need for distributed, space-efficient solutions like water retention on rooftops.

Other challenges are **social and spatial**. Congestion, limited active-mobility space and growing logistics demands strain the public realm; rooftops can relieve pressure by hosting alternative routes or functions. Housing shortages and affordability concerns make densification an important—but context-sensitive—option. Lack of accessible green or recreational space, as well as issues of health, loneliness and unequal access to services, underscore the value of social and community-oriented rooftop uses. Finally, governance barriers such as fragmented responsibilities, outdated regulations, insufficient funding and limited monitoring frameworks influence cities' capacity to respond.

By structuring these challenges clearly, cities can align rooftop functions with the areas of greatest need, identify high-value combinations and prioritise interventions where multifunctional rooftops can deliver the strongest environmental and social impact.

Ten challenge families (from physical to social/governance):

1. **Climate adaptation & resilience** (heat, fluvial/pluvial flood risk, drought, water quality, reuse).
2. **Nature & biodiversity** (nature connection corridors, habitat fragmentation, species abundance; balancing food production and biodiversity).
3. **Decarbonising energy systems** (efficiency, renewables uptake, storage, network capacity, heritage constraints).
4. **Ageing/fragile infrastructure** (water, energy, mobility systems; Electric vehicle charging readiness).
5. **Sustainable & equitable mobility** (congestion, active travel networks, shared mobility/logistics, parking pressure).
6. **Affordable housing** (supply, mismatch, affordability crisis, social housing; heritage constraints).
7. **Transition to circular economy** (material/water reuse, recycling performance, service spaces for repair and storage).

4. Typologies and Definitions (SP2)

8. **Urban health & well-being** (air/noise quality, green/sport deficits, facilities access, mental health, loneliness).
9. **Social inequality & segregation** (access to services, neighbourhood segregation, third spaces, social safety).
10. **Governance** (split of competences, regulation updates, funding, data/monitoring frameworks).

4.9. MultiRoofs framework

When the forementioned typologies and definitions are combined, the following schematic MultiRoofs Framework can be generated showing the connections between capacities (what can be done, on the left and what needs to be done (urban challenges, on the right). Via rooftop passports (left) and a local menu for urban priorities (right) a match for rooftop activation can be made (middle). Then, 'needs' and 'capacities' must meet with 'desires' (what do stakeholders want?)

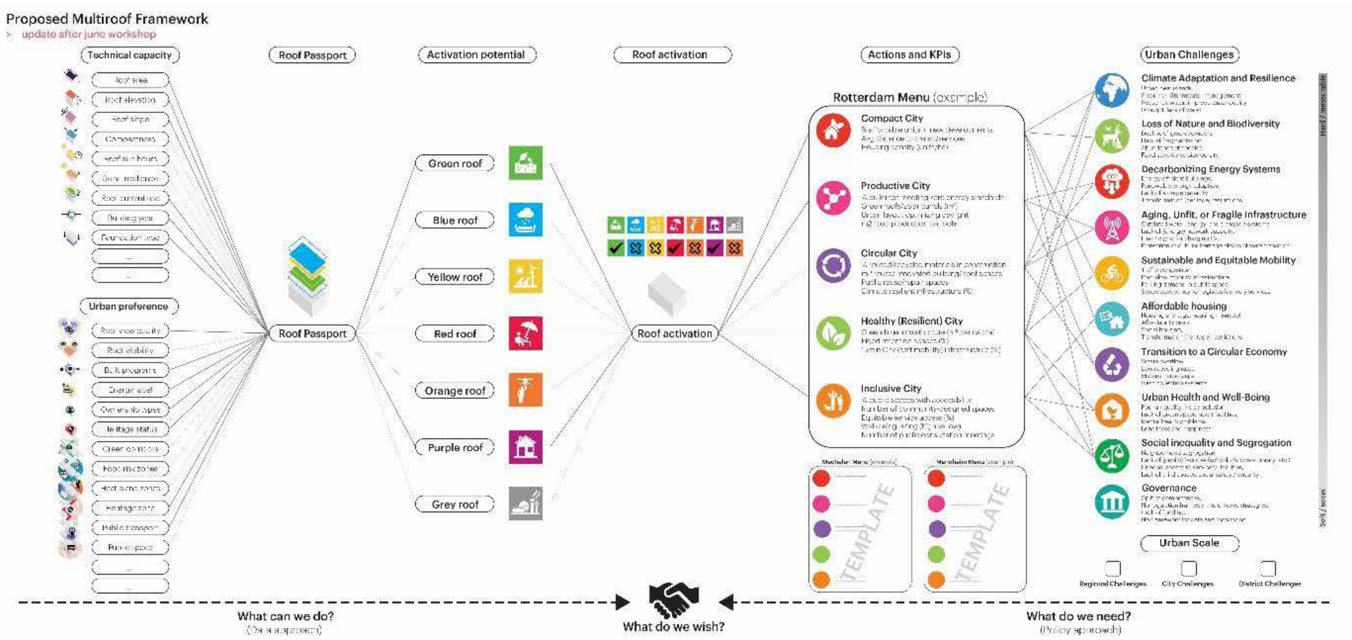

Figure 4: The MultiRoofs framework

4. Typologies and Definitions (SP2)

Where to find additional information?

D.1.2.3 §5.1 AND ANNEX 11.1 FOR DEFINITIONS, BENEFITS, AND EXAMPLES
D.1.2.3 §5.2–§5.3 AND ANNEX 11.2 FOR DETAILED TYPOLOGY TABLES AND NOTES
D.1.2.3 §6 FOR DEFINITIONS & IMPLICATIONS FOR ENGAGEMENT
D.1.2.3 §7 AND ANNEX 11.3 FOR PRIMARY/SECONDARY PARAMETERS AND EXAMPLE TABLES
D.1.2.3 §8 FOR ROLE DEFINITIONS AND EXAMPLES
D.1.2.3 §9 AND ANNEX 11.4 FOR DEFINITIONS AND STRUCTURING GUIDANCE
D.1.2.3 §10 AND ANNEX 11.5 FOR DEFINITIONS, PROS/CONS, AND EXAMPLES


HOTEL

5. Strategic Prioritisation Framework (SP3)

5. Strategic Prioritisation Framework (SP3)

The Strategic Prioritisation Framework developed through Strategy Sprint #3 provides a **practical method** for cities to decide **where to begin activating multifunctional rooftops**, **which rooftop solutions are most valuable in specific contexts**, and **what forms of support will actually motivate owners to invest**. The framework does not offer a single "answer" but instead introduces a structured way to navigate the complexity of real-world decision-making in dense, diverse urban settings. It brings together three pillars:

- prioritisation of needs
- comparison of costs and benefits,
- identification of effective incentive mechanisms.

When used together, these components help local authorities move **from ambition to a realistic, actionable roadmap**.

5.1. Prioritisation

The first component of the framework focuses on **understanding priorities**. Because cities face overlapping challenges—heat, flooding, high energy demand, lack of green space, pressure on the housing stock, growing mobility needs and increasing social inequality—any rooftop activation programme must begin by **clarifying which issues matter most** in a given location. The participating cities were asked to score the relevance of ten urban challenge families for each district type in their city. They also estimated how strongly different owner types might prioritise these same challenges. Though this exercise was based on expert perceptions rather than formal council positions, it produced **extremely useful insights**. It revealed that while many urban challenges are broadly recognised across cities—particularly climate adaptation and energy decarbonisation—the degree of urgency varies by district type. Based on the inquiry with the participating cities, **high-density urban districts** tend to struggle most with heat and lack of green space; **industrial districts** face water and energy challenges; and **residential neighbourhoods** express a mix of environmental, mobility and social needs. These contrasts help determine where rooftop interventions have the strongest added value and which rooftop functions have the most impact.

Equally important was the discovery that city priorities and owner priorities do not always align. For instance, **municipal planners** may see heat reduction or biodiversity enhancement as essential in a district, while **private owners** may be more interested in energy savings, property value, or reduced maintenance. This misalignment is central to the prioritisation challenge: even a well-designed rooftop proposal may struggle if it does not resonate with the motivations of those who have to approve or pay for it. The **prioritisation tool** proved especially helpful because it made these assumptions visible and comparable. By **scoring district needs**, owner needs and project objectives on the same scale, local authorities could immediately see where alignment existed and where incentive mechanisms would be essential. It was demonstrated that while the scoring itself is indicative, the process of making implicit decision pathways explicit is one of the most valuable outcomes. This exercise helped cities to **structure internal discussions**, and it will become even more important when the method is applied in pilots with local stakeholders.

5.2. Cost Benefit Comparison

The second component of the framework—the comparison of costs and benefits—helps cities understand **what rooftop interventions can achieve** relative to **conventional ground-level solutions**. Rooftops are often evaluated on their own merits, leading to incomplete assessments. A structured comparison approach was introduced that asks cities to **assess the benefits and constraints** of rooftop options for each challenge, while also noting how these compare with traditional alternatives such as parks, stormwater basins, solar installations at ground level or community facilities in public space. This method encourages a **broader** and **more realistic understanding of value**. It also helps clarify when rooftop use creates advantages that are otherwise impossible, such as adding nature, water buffering or social functions in highly built-up areas with no available ground-level space.

The sessions consistently showed that **multifunctional roofscapes generate synergies** that are difficult to achieve through single interventions. Combinations such as green and blue roofs for water retention, green and yellow for improved energy efficiency or green and red for urban farming and social use were repeatedly identified across cities as offering **more benefits** than the sum of their parts. At the same time, participants identified several important constraints that must be considered early in the planning process. Structural limitations, heritage restrictions, complicated ownership, administrative burdens, maintenance needs and potential conflicts between rooftop functions (such as access versus safety) **all represent costs, even when they are not directly financial**. One of the most important conclusions of the cost-benefit session was that these **non-financial constraints must be treated as part of the cost equation**. If overlooked, they can undermine feasibility even when the environmental or social benefits are attractive.

While the initial comparison exercises produced **rich qualitative insights**, the partners highlighted the need to improve the accuracy and completeness of data—especially financial data. For example, while green roofs' maintenance requirements or solar installations' performance profiles are widely documented, the combined economic value of multifunctional systems is less clear and depends heavily on local regulatory and technical contexts. Pilots under Work Package 2 will therefore be critical for collecting evidence that can be used to **refine cost–benefit models**. At this stage, the framework already provides a robust starting point for conversations between urban planners, building owners and technical experts, and it gives cities a structured method for evaluating rooftop solutions against their most pressing challenges.

5.3. Incentives

The third component of the Strategic Prioritisation Framework addresses incentives. Even when priorities are well defined and cost–benefit comparisons support rooftop activation, **success still depends on owners' willingness to act**. A rich set of examples is gathered from partner cities about which incentive mechanisms they use today—and which ones work best. The most important insight was that **financial incentives** alone rarely achieve the desired uptake. Cities consistently reported that subsidies, loans or tax reductions were not sufficient in themselves unless supported by advisory services, clear communication, accessible tools and stable regulatory frameworks. Advisory services in particular stood out across all cities. They help owners **navigate practical challenges**, **understand feasibility** and **reduce perceived risk**.

Many owners—especially HOAs and small landlords—struggle to interpret technical guidance, evaluate long-term costs and benefits or coordinate decision-making among multiple parties. Advisory services **provide the capacity and clarity** needed to turn interest into action.

Another decisive factor was **predictability**. Owners—especially larger property managers, housing corporations or developers—**plan investments years in advance**. If policy instruments, funding sources or planning requirements change frequently, owners cannot confidently align their renovation schedules or financial planning with rooftop activation goals. Partners agreed that long-term stability, both in **funding and regulation**, significantly increases willingness to invest. Short-lived programmes, fragmented offerings or inconsistent rules erode trust and lead to hesitation or delays. It was shown that not all owner types are equally addressed by existing incentives.

5.4. Cross-cutting principles

Across all three components—prioritisation, cost–benefit comparison and incentives—several cross-cutting principles were revealed. First, **alignment** is essential. Rooftop activation requires coordinated action across city needs (urban challenges), building and district realities (capacities) and building owner motivations (desires). If these elements do not line up, activation slows down or becomes fragmented. The framework's structured methods support this alignment by making decision pathways explicit and identifying where incentives must bridge gaps.

Second, **quantification and transparent comparison** improve clarity and reduce conflict. When decisions are informed by KPIs, shared scoring systems and comparable insights, it becomes easier to explain choices and build legitimacy with stakeholders.
Third, integrated and reliable incentives matter. Cities must combine financial, advisory, digital and regulatory measures in stable, multi-year programmes if they want to unlock significant private investment.

5. Strategic Prioritisation Framework (SP3)

5.5. The 8-Step Rooftop Activation Roadmap

Taken together, the Strategic Prioritisation Framework gives cities a systematic, transferable way to **evaluate where rooftop activation will be most impactful**, **how to choose between different rooftop combinations** and **what kind of support to offer to owners**. It forms the conceptual basis for the 8-Step Rooftop Activation Roadmap and sets the stage for pilot implementation. During the pilot phase, cities will ground the framework in real building stock, real owners and real constraints, generating the evidence and refinements needed to scale the MultiRoofs approach across North-West Europe.

5. Strategic Prioritisation Framework (SP3)

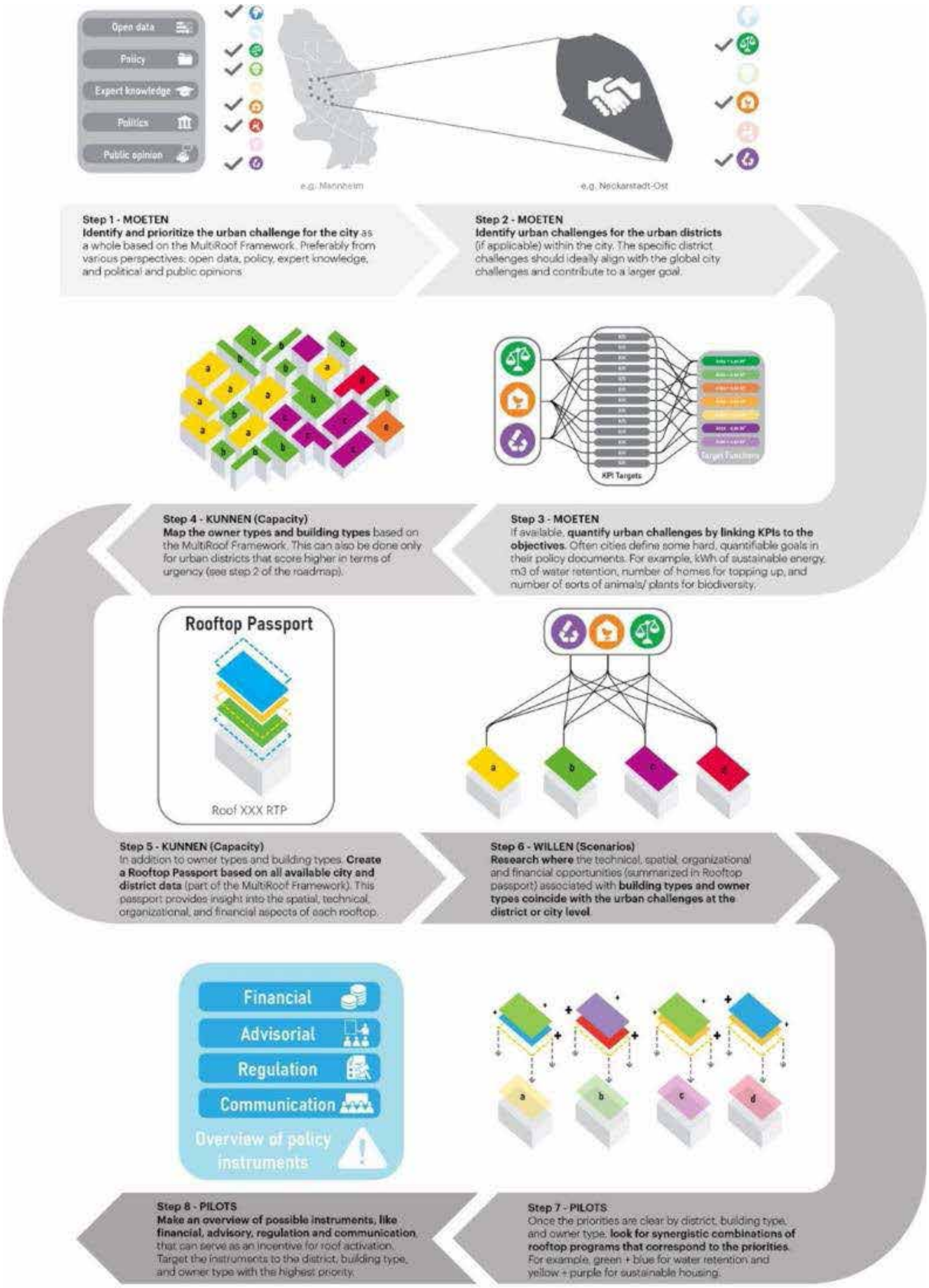

Figure 5: The 8-Step Rooftop Activation Roadmap

5. Strategic Prioritisation Framework (SP3)

Where to find additional information?

D 1.2.4 §4.1 FOR STRATEGIC PRIORITIES
D 1.2.4 §4.2 FOR COSTS & BENEFITS OF ROOFTOP OPTIONS
D 1.2.4 §4.3 FOR EFFECTIVE INCENTIVE MECHANISMS
D 1.2.4 §5 FOR CROSS-CUTTING PRINCIPLES
D 1.2.4 §8 FOR THE 8-STEP ROOFTOP ACTIVATION ROADMAP

6. Outlook for Work Package 2

6. Outlook for Work Package 2

As the project moves into the next implementation period, the emphasis will shift **from preparatory work to the development and execution of targeted action plans**. This phase is critical for translating the insights and frameworks established during the initial stages into tangible outcomes that deliver measurable impact across the participating regions.

The first step will **involve designing action plans** that reflect the project's strategic objectives and stakeholder priorities. These plans will serve as operational roadmaps, detailing specific actions, timelines, responsibilities, and performance indicators. By adopting a structured and participatory approach, we aim to **ensure that all partners and stakeholders** are fully aligned and committed to the proposed actions.

6.1. Action Plan Development

The Action Plan details the digital twin technology development, development of approaches to identify property owners that are susceptible to utilise their roofs multifunctionally, and pilot action execution of Work Package 2. The development process will be guided by three key principles:

Stakeholder Engagement
Active involvement of local authorities, industry partners, and community representatives will be central to the planning process. This collaborative approach will ensure that the proposed actions are relevant, feasible, and supported by those who will implement and benefit from them.

Evidence-Based Design
Action plans will build on the data, analyses, and lessons learned during the previous phase. This will enable us to prioritise interventions that offer the highest potential for impact and scalability.

Clear Accountability
Each action plan will define roles and responsibilities, supported by transparent governance structures. This will facilitate effective coordination and timely decision-

making throughout implementation.

6.2. Implementation and Monitoring

Once validated, the action plans will move into the **execution phase**. Implementation will be carried out in close collaboration with project partners and local stakeholders to ensure ownership and sustainability.

Work Package 2 is about developing and **piloting the data and policy driven**, **digital twin visualising tool**, **approaches to identify public and private owners** who are susceptible to building a multifunctional roof, and **incentives for these property owners to (re)build the roof** with multiple functions.

The digital twin technology gets developed by the knowledge institutions and private partners. Parallel to this process, the local authorities (LAs) together develop the approaches in which they can **identify public and private property owners** who are susceptible to building a multifunctional roof & the incentive scheme to influence these property owners. In Rotterdam, Mechelen, Brussels, Île-de-France, Mannheim & Dublin pilots are facilitated to validate the digital twin technology with the **local data**, and to identify the best way to **identify and incentivise building owners** in those areas. During these pilots the LAs work together transnationally to exchange approaches and results.

During Work Package 2, following actions will be taken:

6.2.1. Development of Digital Twin Technology

- Create virtual models of urban areas for public authorities, identifying and classifying rooftops by potential functions using a colour-coded system (adapted from Rotterdam), with particular emphasis on multifunctional rooftops.
- Built on MIM principles for interoperability across systems.

6.2.2. Identifying Susceptible Property Owners

- Develop methods to spot property owners likely to adopt multifunctional roofs during key moments (construction, renovation, solar panel installation).
- Public authorities collaborate transnationally to develop approaches for tracking these moments.
- Investigate the possibilities to integrate datasets, with the details on the location, building ownership and susceptibility of property owners, into the digital twin for actionable insights.

6.2.3. Incentivisation Mechanisms

- Rank Financial incentives for technical feasibility studies (not construction), based on multiple parameters.
- Eligible services for financial incentives are: architectural design, structural calculations, technical/legal/policy checks, feasibility studies.
- Create informational incentives: benefits of multifunctional rooftops based on research (eg. Dutch National Roofplan, LIFE@Urban Roofs, ECRN, Bio Agora).

6.2.4. Pilot Actions (6 Pilots in 6 Cities)

- Pilot and validate transnationally the technology and approaches to address a lack of space in the diverse contexts of the participating LA's.
- Put the geographical data inventory into the tool and investigate the possibilities to add the data from the incentivisation mechanisms.

6.2.5. Pilot of incentivisation mechanisms (communication)

- Public authorities test incentivisation mechanisms by contacting identified property owners.
- Owners receive tailored reports detailing:
    - o Possible rooftop functions
    - o Benefits and costs
    - o Cost-benefit analysis
- Incentives promoted publicly; owners apply for funding.
- Selection of property owners, based on multiple parameters until budget is spent.

6.3. Expected Outcomes

By the end of this phase, we anticipate:

6 Pilot Actions
Pilot Actions in Rotterdam, Mechelen, Île-de-France, Brussels, Dublin and Mannheim that iteratively test the:

- data and policy driven, digital twin tool with which public authorities can determine optimal multifunctional utilisation of specific roofs in their cities,
- approaches to identify predetermined owner types who are susceptible to utilise their rooftops multifunctionally, and
- financial incentives for these property owners to build the roof in the optimal multifunctional manner.

3 Jointly developed solutions
Three solutions to affect how property owners utilise rooftop space consisting of

1. data and policy driven, digital twin tool with which public authorities can determine optimal multifunctional utilisation of specific roofs in their cities,
2. approaches to identify predetermined owner types who are susceptible to utilise their rooftops multifunctionally, and

6. Outlook for Work Package 2

3. financial incentives for these property owners to build the roof in the optimal multifunctional manner.

These outcomes will not only fulfil the immediate objectives of the project but also lay the groundwork for future initiatives, contributing to broader European goals of sustainability, competitiveness, and social cohesion.

7. Outlook for Work Package 3

7. Outlook for Work Package 3

7.1. How to scale up and disseminate lessons learned in MultiRoofs

The MultiRoofs project already embeds a comprehensive strategy encompassing tools, communication pathways and stakeholders' mobilisation activities, described in Deliverable D.1.5.1 – Communication Strategy and Deliverable D.1.5.3 – Communication Amplification Strategy Report. **Three main pillars** have been identified.

7.1.1. Multi-channels communication and visibility

The communication strategy sets out a **multi-channel approach** to reach primary and secondary target audiences, including local and regional authorities, policymakers, urban planners, environmental agencies, researchers, NGOs, and private-sector solution providers. The strategy outlines the use of website, project social media channels (Bluesky, LinkedIn, YouTube if deemed necessary), partners' websites and networks and influential European networks, such as OASC. This approach enables large-scale outreach and ensures that knowledge, tools and pilot results are accessible and reusable by actors beyond the initial consortium.

7.1.2. Strategic engagement of identified target groups

The amplification strategy complements this by identifying high-impact collaborations with networks such as Eurocities, OASC, ICLEI Europe, Dutch "Nationaal Dakenplan", Belgian "5e Gevel", and major European events including the European Week of Regions and Cities, Smart City Expo World Congress, OASC Conference, FARI Conference, ChangeNOW, NEB Festival, and Urban Futures. These partnerships and events are explicitly identified as opportunities to extend MultiRoofs visibility and impact across the EU and beyond. Participation in three high-profile European events or conferences per year, as defined in the **SMART objectives**, directly supports scaling by situating MultiRoofs within Europe's central urban-innovation ecosystems.

7.1.3. Structured dissemination mechanisms

Scaling up is supported through targeted **publications and media engagement**.

Deliverable 1.5.3 outlines the objective to produce a minimum **four total strategic publications** in top-tier scientific journals or high-impact professional outlets, alongside securing 5 media placements, including at least two at EU level. This ensures long-term uptake of MultiRoofs methodologies and data by practitioners, policymakers, and researchers.

In addition, all project activities will be considered as an opportunity to **contribute to the amplification and scaling up strategy**. For instance, the promotion of the Training programme and the Final Event will explicitly reinforce scaling by inviting public authorities and relevant stakeholders to engage with the project's tools, pilot insights and strategic recommendations.

The overall communication, dissemination and amplification strategy provide a **clear and actionable path** for scaling MultiRoofs beyond direct pilot cities, ensuring structured replication and broader adoption of multifunctional rooftop strategies.

7.2. Developing a training scheme for MultiRoofs

The MultiRoofs project includes a dedicated capacity-building component under Work Package 3, designed to ensure that MultiRoofs approach (digital twin tool, involvement of building owners, incentives strategies) can be understood, used and replicated by public authorities across the North-West Europe region. The training scheme is explicitly conceived as a jointly developed and delivered programme, intended to equip public authorities with the knowledge and skills needed to **implement multifunctional rooftop strategies** beyond the core consortium.

Strategies regarding the training programme (related to communication, content creation and delivery) are to be produced for **June 2026** (period 3), and a dedicated process of involving all consortium partners will be implemented in building such strategies. This will ensure that all necessary inputs, lessons learned and initial results are considered in creating a capacity building programme benefiting **involved public authorities and their own ecosystem**.

7.2.1. Initial vision of the training programme content

The content of the training programme directly reflects MultiRoofs methodology, on **three main dimensions**:

- **Stakeholders' engagement and ecosystem building** with local and regional ecosystems, and approaches to identify predetermined property owner groups, enabling participants to understand how to recognise, segment and target different types of building owners who may be susceptible to take action.
- **Digital Twin Tool**, as the central technical solution for supporting public authorities in determining what is desirable and feasible on rooftops at building and district level. The training content will consider methodological approaches to equip public authorities outside the project with the necessary information to incentivise the use of innovative tool in planning and policymaking processes.
- **Financial and information-based incentives** developed and tested through WP2 pilots, including strategies to influence property owners to utilise their rooftops multifunctionally. The training must disseminate these incentive models and demonstrate their practical implementation.

7.2.2. Who participates?

Each public authority involved in the pilot actions must recruit five additional public authorities to participate, amounting to 30 additional public authorities. This means the target audience includes, at this stage:

- **Public authorities** within the existing pilot regions
- **Relevant urban planners**, policy developers and local government bodies

- **Local and regional government** staff who are responsible for spatial planning, climate adaptation, energy strategy, asset management and long-term urban development.

FARI (ULB) leads on the creation and delivery of the joint training scheme and pilot city partners are explicitly involved in the tasks to ensure that the training programme is built on the projects results and lessons learned.

7.3. Proposed approach for the implementation of the training

Implementation of the MultiRoofs training scheme will draw on a **structured and tested approach** for accompanying public authorities through complex urban transitions, using Communities of Practice (CoP) and peer-learning groups as the central mechanisms for knowledge transfer and replication. MultiRoofs adopts this logic by **organising each group of participating local authorities**—and the cities they select—into their own peer-learning group / community of practice, following similar principles and methodology.

7.3.1. Building Communities of Practice within MultiRoofs

Organising the training scheme around "Communities of Practices" will allow to empower pilot public authorities **as circulators of the knowledge and results** that have been acquired throughout the project. Each participating local authority will similarly become both a learner and a disseminator of the training content, ensuring that replication and implementation capacities grow beyond the initial pilot areas.

7.3.2. Training implementation structure: peer-learning as the core mechanism

In MultiRoofs, peer-learning will enable selected participants to directly observe and experience already developed solutions they are interested in replicating, which ensures that the potential replication strategies and the reuse of the MultiRoofs approach is aligned with practical considerations and lessons learned from the initial implementations. It will be implemented the following **components**:

- **Kick-off meeting** for each peer-learning group – to introduce all participants to the Community of Practice and create a welcoming environment enabling trust and collaboration
- **Thematic conversations** on the MultiRoofs approaches and main themes for trainings (ecosystem building, use of innovative tools and incentives strategies), offering a shared space for dialogue, to exchange on the methodologies, tools and practices developed throughout the project. Thematic conversations will be built around key modules around policy learnings taken from the pilots implementation, as well as technical support related to data and concrete use of digital twin.
- **Visits to pilot sites** allowing a direct exposure to rooftop transformation initiatives and hands-on demonstrations of the results of the use of an innovative tool, stakeholder engagement practices and governance models.

7.3.3. Responsibilities of partners

In this structure, each public authority is acting as the **main contact point** and **representative in the training programme**, with the support of FARI (ULB) staff and other responsible partners in the implementation of the programme.

This approach will be discussed in the creation of the dedicated strategies, for **June 2026** (period 3), and ensure a co-creation of such a delivery plan and ownership of the partners involved.

7. Outlook for Work Package 3

7.4. Final closing event in 2029

The MultiRoofs project concludes with a **final event** organised under Work Package 3, Activity 3.4, entitled "**Creating liveable, resilient and future-proof cities with multifunctional roofscapes**." This event will serve as the formal closing conference and is designed to consolidate and showcase the progress and outcomes of the project. It is coordinated by the **City of Rotterdam**, with all project partners involved, and the overall organisation led by the **Communication Manager**.

The final event will take place in **March 2029** (exact date to be determined) and could be hosted on a multifunctional rooftop. Its purpose is to celebrate the progress made with the project and promote multifunctional rooftop utilisation as a solution for creating liveable, resilient and future-proof cities in NWE. The event is explicitly positioned within a broader European context, with timing aligned to other conferences or events that have European public authorities as their target audience to aid with attendance of public authorities.

The programme could include several **components**:

- **Exhibitions showcasing images** of the multifunctional roof sites developed through the project.
- **Presentations outlining best practices** for addressing space scarcity challenges through multifunctional roofs.
- **Interactive sessions** highlighting pilot solutions developed and tested through the pilots

8. Conclusion

8. Conclusion

This report shows that **rooftops can become an essential part of how cities tackle climate, energy and social challenges**. Across Europe, urban areas are running out of space at street level, while pressures continue to grow. Rooftops, however, offer a large and often overlooked opportunity. When treated as shared urban infrastructure rather than isolated surfaces, they can host greenery, store water, generate energy, create social spaces and, in some cases, even add new usable floor area.

Over the past months, the MultiRoofs partners developed a **common approach** that helps cities understand where this potential is strongest and how local authorities can activate it in a fair, efficient and scalable way. Together, they created shared definitions, mapped data needs, built a typology for districts, buildings and building owner types, and explored how public priorities align— or sometimes clash—with what owners want or need. This shared foundation makes it possible to compare situations across very different cities and to design strategies that work in real-world conditions.

Central to this work is the development of the **digital twin tool**. This tool brings together data, local knowledge and shared frameworks in a simple, visual way. It will help public authorities to see what is technically possible on a specific roof, what functions could be combined, and where rooftop interventions align with district challenges such as heat, flooding or lack of green space. The digital twin does not make decisions for cities, but it makes decision-making far clearer. It allows urban planners, policy officers and colleagues from different departments to work from the same picture—and it gives building owners understandable, trustworthy insights into the opportunities on their roofs. In this way, the tool supports faster, better-informed and more consistent decisions across the city.

This interim strategy is a **starting point**. The next phase of MultiRoofs will test the approach in real districts, with real buildings and real building owners. The pilots will show how the digital twin performs when fed with local data, how easily authorities can use it to identify the right building owners at the right moment, and which forms of support actually lead to action. These experiences will help refine the tool, improve the cost–benefit understanding of rooftop solutions and strengthen the guidance for cities that want to follow the same approach.

8. Conclusion

As MultiRoofs moves into implementation, the project shifts from building a shared strategy to demonstrating impact on the rooftops. The insights from pilots will feed into a Europe-wide training programme and a broader dissemination effort, making sure that other public authorities can use the same methods, with or without being part of the project consortium. By 2029, the project aims not only to improve rooftop use in the pilot cities, but also to contribute to a broader shift in how urban space is planned, shared and valued.

The core message is simple: cities already possess enormous unused potential—right above our heads. With a shared framework, a clear method and a powerful digital tool, public authorities can turn rooftops into assets that support climate goals, improve neighbourhood quality and make cities more liveable. MultiRoofs provides the roadmap and the tools. The next step is to turn this shared vision into everyday practice.


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9. List of abbreviations

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Abbreviation	Explanation (as used in this report)
ADEME	Agence de la transition écologique (French Agency for Ecological Transition). Source of national datasets (e.g., energy/EPC-related) referenced by Île-de-France partners.
API	Application Programming Interface; standards-based services for data access (e.g., OGC APIs).
BAG	Basisregistratie Adressen en Gebouwen (NL national Address and Building Register), used for footprints/IDs in Rotterdam.
BAN	Base Adresse Nationale (FR national address database), used for consistent addressing/IDs in Île-de-France.
BDNB	Base de Données Nationale des Bâtiments (FR national building database).
CAPEX / OPEX	Capital expenditures / Operating expenditures, used in LCC and owner-economics.
CBA / SCBA	Cost–Benefit Analysis (project view) / Societal Cost–Benefit Analysis (public-economy view: avoided drainage, heat-health, grid upgrades).
CBS	Centraal Bureau voor de Statistiek (Statistics Netherlands), e.g., neighbourhood boundaries/indicators.
CityGML	OGC standard for semantic 3D city models (source format for some partners).
CityJSON	JSON encoding for CityGML used as canonical 3D schema in MultiRoofs (target: LoD2.2).
CoP	Community of Practice; peer-learning structure in WP3 training.
CRS	Coordinate Reference System (e.g., EPSG codes) for spatial data.
DCAT-AP	EU Data Catalog Vocabulary – Application Profile for dataset/service metadata and discoverability.
Digital Twin (DT)	Data-driven 3D/2D model and workflow used to visualise, analyse and communicate rooftop options.
DPIA	Data Protection Impact Assessment, triggered when handling sensitive/personal data (e.g., ownership/EPC joins).
DSO	Distribution System Operator (electricity/gas networks), relevant to energy/grid capacity constraints.
DUB (local)	Rotterdam internal process related to data/governance/procurement; referenced in partner context notes.
ECW	Enhanced Compression Wavelet—raster image format for high-resolution orthophotos (e.g., Brussels).
EIF / EIF4SCC	European Interoperability Framework / EIF for Smart Cities & Communities—guidance for technical/semantic/organizational/legal alignment.
EPC	Energy Performance Certificate (building-level energy rating; availability varies by partner).

9. List of abbreviations

Abbreviation	Explanation (as used in this report)
EPSG	Codes identifying CRSs (e.g., EPSG:31370 in Flanders).
ESCO	Energy Service Company; performance-based contracts proposed for portfolios (e.g., housing/municipal).
ETL	Extract–Transform–Load data processing pipeline (e.g., GDAL/PDAL + Roofer) to normalise inputs into CityJSON.
FME	Feature Manipulation Engine; ETL tool used by some partners (e.g., CityJSON exports).
GDAL	Geospatial Data Abstraction Library; used for format conversion/CRS handling in ETL.
GDPR	General Data Protection Regulation
GIS	Geographic Information System; 2D context layers that complement 3D models.
GLO (local)	Rotterdam municipal contracts framework (mentioned with DUB in partner context).
GPKG	GeoPackage; open, single-file geospatial format (used for building/district layers).
HOA	Homeowners' Association (collective ownership/decision-making).
HVAC	Heating, ventilation and airconditioning
ICLEI	ICLEI Europe—network of local governments; used in WP3 dissemination strategy.
ID (persistent)	Stable identifier for linking datasets (building IDs often missing; geometry-based linking or MultiRoofs IDs used).
IDF	Île-de-France (Paris Region).
INSPIRE	EU directive on spatial data infrastructure; referenced for metadata/CRS conventions.
IRR	Internal Rate of Return; part of owner-economics in project appraisal.
KPI / KPIs	Key Performance Indicator(s); minimal set defined for pilots (environmental, economic, social).
LA	Local Authority (municipality/city/regional body).
LAS / LAZ	LiDAR point-cloud formats (uncompressed/compressed).
LiDAR	Light Detection and Ranging; aerial point clouds used to reconstruct/verify 3D roof geometry.
LoD / LoD2.2	Level of Detail; LoD2.2 models capture roof geometry at detail needed for rooftop analysis (MultiRoofs target).
LCC (TCO)	Life-Cycle Costing / Total Cost of Ownership over 20–30 years.
LUCAS	EU Land Use/Cover survey; referenced for compatibility of district typologies.
M&E	Monitoring & Evaluation: template finalised after pilots

9. List of abbreviations

Abbreviation	Explanation (as used in this report)
MCA	Multi-Criteria Analysis: screening step before LCC/SCBA.
MVP	Minimum Viable Product
MIM / MIM7	Minimal Interoperability Mechanisms (OASC); MIM7 Geospatial emphasised for standardised geodata access.
NEB	New European Bauhaus—referenced in dissemination/engagement context.
NGO	Non-Governmental Organisation; part of the wider stakeholder audience in dissemination.
NWE	North-West Europe (Interreg programme region).
OBF / OBR	On-Bill Financing / On-Bill Repayment; property-linked style mechanisms discussed under incentives.
OGC	Open Geospatial Consortium; body behind WMS/WFS, CityGML, CityJSON, OGC APIs.
OGC APIs	Standards for web access to features/tiles (used/preferred for interoperable data services).
OIDC / RBAC	OpenID Connect / Role-Based Access Control—access controls considered post-MVP for sensitive joins.
OSM	OpenStreetMap; complementary 2D data source (e.g., Dublin pilots).
PDAL	Point Data Abstraction Library; LiDAR processing in ETL pipelines.
PPP	Public–Private Partnership; one of the cooperation forms under LA roles.
PV	Photovoltaics (solar electricity); co-benefits with cooling/green roofs noted.
RNB	Répertoire National des Bâtiments (FR national building register), referenced with BDNB alignment.
Roofer (TU Delft)	Open-source workflow/tool used to reconstruct LoD2.2 building models from footprints + LiDAR.
RVO	Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency), e.g., energy label data.
SROI	Social Return on Investment—narrative + quantitative capture of social value (health, cohesion).
SP1 / SP2 / SP3	Strategy Sprints #1 (data & tool), #2 (typologies & definitions), #3 (prioritisation, incentives, CBA).
TRL	Technology Readiness Level (from proof-of-concept TRL4 to demonstration TRL6, then TRL7–8 for scale-out).
UAM	Urban Air Mobility
UHI	Urban Heat Island effect—heat risk indicators used in challenge mapping.
URI	Uniform Resource Identifier; persistent identifiers/links in datasets.
WFS / WMS	Web Feature/Map Service—OGC standards for serving vector/map data.
WGS84	World Geodetic System 1984; common geographic CRS for data exchange.

9. List of abbreviations

Abbreviation	Explanation (as used in this report)
WP2 / WP3	Work Package 2 (tooling, pilots, incentives) / Work Package 3 (training, dissemination, scale-out).
3D Tiles	Streamable 3D format (e.g., Mannheim internal use) requiring conversion/ export for canonical processing.
2D / 3D	Two-dimensional / three-dimensional data; both are integrated in analysis and visualisation.

Table 2: Abbreviations used in the MultiRoofs Joint Strategy Report

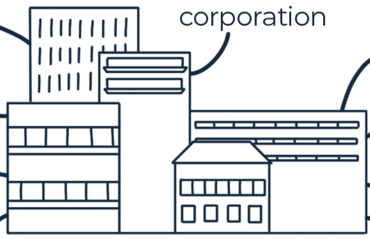
URBAN CHALLENGES

- climate adaptation
- energy transition
- gouvernance barriers
- urban health & wellbeing
- mobility pressure
- biodiversity loss
- aging infrastructure
- social inequality
- circular economy
- housing storage

MultiRoofs

transforms urban rooftops into accessible & inclusive spaces that make cities more liveable

WHO OWN THE ROOFS ?



WHAT DOES MULTIROOFS OFFER ?

STAKEHOLDER PREFERENCES what is desired ?

TECHNICAL CAPACITIES what is possible ?

URBAN CHALLENGES what is needed ?

→ **DATA TYPES & STRATEGIES** → **DIGITAL TWIN TOOL** → **A SINGLE VISUAL MODEL** in order to

- map rooftops
- test different rooftop scenarios
- support collaboration between stakeholders

ROOFTOP FUNCTIONS

- VEGETATION & BIODIVERSITY
- WATER RETENTION
- RENEWABLE ENERGY
- SOCIAL & COMMUNITY SPACES
- MOBILITY & LOGISTICS
- INFRASTRUCTURE & UTILITIES
- DENSIFICATION (BUILD EXTENSIONS)

combining functions creates greater benefits : example : green roof + water storage → urban cooling

NEXT STEPS

co-development of solutions → test and validation in the 6 pilot cities → refinement for transnational for replication

margaux lhuissier