



# Nature-Based Solutions in Cities—Contribution of the Portuguese National Association of Green Roofs to Urban Circularity

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## Abstract

Green building–integrated systems and technologies (e.g., green roofs (GR) and walls (GW)) are classified as nature-based solutions (NBS) in the context of urban green infrastructure (GI), which contribute to add both natural elements and processes, as a result of locally designed, resource-efficient, and systemic interventions in cities. They have also been considered to address several urban challenges towards cities’ circularity. The European Union (EU) Biodiversity Strategy and the Action Plan recently adopted by the European Commission, represent a comprehensive long-term programme aspiring to protect nature and reversing the ecosystem degradation by 2030. Sustainable and resilient societies under the challenge ‘innovating with nature’ are the leading aim of the EU Research and Innovation (R&I) policy agenda goals on NBS and re-naturing urban areas. The European GI/NBS Associations build the bridge to provide a network among stakeholders from academia, municipalities, entrepreneurs and private-sector entities and other non-governmental organisations, by creating a platform to build and share knowledge and create collaboration on sustainable GI/NBS, regarding building-integrated vegetation approaches as well as related policies, regulations and technical guidelines. The commitments of the foundations to encourage and promote the advanced adoption of green urban infrastructure practice and planning as part of the built environment, drive active efforts to support NBS innovation objectives and the transition from ‘grey to green’ infrastructure. The present manuscript aims at reflecting the crucial role of the Associations on GI/NBS, mainly GR and GW, to develop local frameworks applying innovative plans of action, and allocate R&I opportunities implementing relevant and inclusive urban regeneration solutions. Within this context, it will be highlighted the example of the Portuguese National Association of Green Roofs.

**Keywords** Circular city · Ecosystem-based approaches · EU framework policies · Green economy · Sustainable development · Urban biodiversity

## Introduction

According to the European Commission (EC) (2021) [1, 2], the level of urbanisation in Europe (i.e. urban land expansion and increasing population density) is an ongoing and observable

trend which is expected to increase to approximately 83.7% of urban citizens in 2050. The challenges that contemporary European cities and societies will tackle (e.g. natural capital depletion, human health and well-being, food security, energy and water) are closely connected with environmental events together with the urbanisation and its new perspective from innovation and transformative opportunities with nature-based solutions (NBS) following environmental, social and economic demands [2–4]. Accordingly, the foreseeable future of cities in Europe will require tackling better knowledge, transversal research, public and private investments and policy strategies on NBS (e.g. the European Union (EU) Research and Innovation (R&I) policy agenda for NBS) to shape more sustainable and efficient urban conditions boosting the combined effect among nature, society and economy [2, 4–6].

The different characteristics of these rapid expansion trends of urban areas—involving land use patterns and urban planning and design—are triggering risks to human health, quality of human life, and threat biodiversity conservation [7], among other negative externalities [8]. Besides this continued population intensification, the multiplier threat behind human-induced climate change will amplify current and future social and natural disaster risks [2, 9]. However, the impact of these events at the local city level such as weather, climate and environment predictions remains challenging to forecast, being essential the development of decision support systems for anticipate and mitigate urban hazards based on predictive services [10].

Some consequences from the sprawl of urbanised areas are linked to the climate emergency, the current biodiversity crisis and the United Nations (UN) 2030 Agenda for Sustainable Development Goals (SDG) [2, 11–13] in need of transformative change by 2050. Science, technology and innovation on NBS act as catalyst components for addressing and promoting all the SDG across Europe [4, 14]; (see Fig. 1 as a relevant NBS real case implementation). Understanding cities as novel ecosystems and implementing approaches that use NBS would support the environmental, social and economic costs of inaction that would lead to ecosystem collapse considering how the special urban conditions affect biodiversity in green spaces [16, 17].

The implementation and promotion of NBS or nature-based green and blue infrastructure solutions and technologies enhancing the natural capital would be target opportunities for innovation in a really smart way as sustainable and cost-effective ways and interactive services for creating a greener, competitive and resource-efficient (“resourceful”) urban circular economy (CE) [2, 4, 15, 18, 19]. The NBS and CE are side by side interconnected concepts towards the development of re-natured and circular cities. Closing urban cycles thus encompass the transition to a more CE [20, 21]. Understanding the urban metabolism is determining to pave the way to more sustainable communities [22]. It is of utmost importance to consider the CE principles into the phases of a building's cycle. Further on, how buildings are designed is pivotal to how they are used and the influence they have on their surroundings. Nature-inspired building design, such as entailing green roofs (GR) and green walls (GW) (i.e. green façades and vertical gardens or living walls), is an opportunity to spark a transformation in buildings creating effective solutions [23–25]. Nature-based solutions implementation in the built environment contribute to a CE, for instance through the provision of ecosystem services (ES), and can be integrated at three scales: green building materials, systems for the greening of buildings and green urban sites [26]. Further on, NBS can support the cities shift from linear to circular resource management addressing the urban circularity challenges (UCC), as mentioned by Atanasova et al. [15], through (1) ‘restoring and maintaining the water cycle’; (2) ‘water and waste treatment, recovery and reuse’; (3) ‘nutrient recovery and reuse’; (4)

“material recovery and reuse”; (5) ‘food and biomass production’; (6) ‘energy efficiency and recovery’; and (7) ‘building system recovery’ (see Fig. 1 as case study).

Effective knowledge and engagement to assist mechanisms and instruments on legal and stakeholder level, involving communication and interdisciplinary research programmes and activities, provide constructive information and valuable transdisciplinary networks on NBS proper designs, implementation and performance-based assessment tools and techniques, and methods and analyses for socio-economic benefits and preferences based on nature [17, 27, 28]. The following sections highlight specific and/or combined NBS initiatives and actions that support an urban circular thinking; and, provide an overview of the current existing EU policies and regulations aimed at a systematic development, consideration and implementation of NBS, which would be promoted by citizens, researchers, investors/funders, policy-makers



**Fig. 1** Porto’s largest green roof located on Praça de Lisboa (Portugal) as an example of nature-based solution addressing a number of Sustainable Development Goals of the United Nations’ 2030 Agenda, and enhancing specific urban circularity challenges (1, 5, 6 and 7) proposed by Atanasova et al. [15]

and practitioners, with a protagonist emphasis on the strategic character of the green infrastructure (GI) Associations in Europe. Further on, it will be highlighted as an example, the role of the Portuguese National Association of Green Roofs.

## Green Infrastructure, Biodiversity and Ecosystem Services in the Context of Nature-Based Solutions

Citing some of the approved and adopted conclusions from the Council of the EU in 2015 [29] and 2016 [30]—about the mid-term review of the EU Biodiversity Strategy to 2020, and on the action plan for a CE, respectively—the EU Council ‘recognises the importance of integrating GI and NBS into financing instruments such as the European Regional Development Fund (ERDF)’ (conclusion 31), within the target 2 of maintain and restore ecosystems and their services [29] and ‘invites the Commission and the Member States to promote nature- and bio-based solutions, the use of sustainably sourced renewable materials without compromising food security and environmental integrity, resource efficiency, the resilience of ecosystems and their services and the sustainable use of renewables’ (conclusion 18) from support for circular innovation and business [24, 30–33].

The EC defines NBS as a beneficial opportunity for innovation to address global and societal challenges with ‘solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions’ [18, 34, 35] (see also EU-funded COST Action CA17133 Circular City ‘Implementing nature-based solutions for creating a resourceful circular city’, <https://circular-city.eu/> [36]). Nature-based solutions in the EU play a crucial role in advancing towards a just and inclusive green transition (e.g. the ‘Just Transition Mechanism’ [JTM]) [37] to facilitate the adoption of an innovative, resource-efficient, sustainable and holistic growth model—from ‘take-make-waste’ to a CE, by transforming the greatest challenges into opportunities at a local level [4, 38].

The term NBS can be explored regarding the element of (i) nature: pertaining to biodiversity (individual species, habitats, ecosystems), and/or ES; (ii) nature-based: pertaining to ecosystem approaches, biomimicry, or direct use of elements of biodiversity; and (iii) solutions: pertaining to a solution or a more beneficial outcome to a specific problem or challenge [39]. Since its emergence in the 2000s, the International Union for Conservation of Nature (IUCN) and later the EC, in its research programme Horizon 2020 (H2020), have actively committed attention to the NBS concept on specific consultations, outreach initiatives, and policy dialogues to promote nature as a source of solutions in tackling challenges integrating ecosystem-based approaches—i.e. integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way’ [40] (e.g. ecosystem-based adaptation (EBA) and disaster risk reduction, GI, and natural water retention measures policy strategies at European level) [4, 18, 20, 41, 42].

The term GI has received a considerable interest from several scientific, political, and, professional disciplines at different levels, as an integrated approach with significant impact from both environmental and socio-economic perspectives, particularly in urban areas [43–45]. The EU Strategy for promoting GI, launched in 2013, proposed in its communication on enhancing Europe’s Natural Capital, a short definition of GI as ‘a strategically planned

network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ES', being able to be present in urban settings [46]. Green infrastructures can be also known as NBS or can integrate NBS [6]. Urban ES is becoming an influential concept to guide the planning, design, and management of urban landscapes towards urban sustainability [47–49], and the core objective of certain GI policy initiatives [13, 50].

In support of the successful implementation of NBS and GI (standards and guidelines), the conservation of biodiversity and/or the ecological restoration remains as an objective or principle, being the functioning of the ecosystems (e.g., reducing ecosystems fragmentation) essential to ensure the capacity of ES delivery at a landscape scale [4, 51]. Urban GI planning and management decisions should be strategically conceived to contribute towards high and effective multifunctional and quality construction and capacities [7, 50, 52], combining and balancing the specialised ES integration with diverse and social perception factors within urban areas [7, 53–55]. The multifunctionality principle is the ability of GI to perform several functions (e.g. environmental (conserving biodiversity or adapting to climate change), social, economic, cultural and aesthetic) and provides numerous ES—from a social-ecological perspective (i.e. regulating, economic/provisioning, habitat (ecological), and social/cultural services)—and NBS at the same time and spatial location [13, 48, 49, 56, 57]. Assuring the services and benefits of healthy ecosystems, and preserving the long-term delivery of simultaneous ES linked to strategically planned (accessible and well-connected and managed) networks of GI at multiple spatial scales (i.e. spatial and temporal multifunctionality and connectivity aspects), coordinate and support numerous EU policy objectives, in areas such as agriculture, air pollution (air quality), biodiversity and nature, climate change and energy, environment and health, environmental technologies and earth observation (EO) [58], sustainable consumption and production, urban environment, waste and water among others; and fulfill variety of policy-maker and stakeholder group needs based on the best existing science and policy networks [13, 57, 59].

Nature-based solutions should aim at maintaining and enhancing natural capital, promoting biodiversity and human well-being while bringing other co-benefits (e.g. potential of GR and GW in providing holistic urban benefits), as being integrated into policies and planning [60]. As multifunctional surfaces, GR can foster biodiversity and deliver a range of ES such as thermal regulation (micro and regional climate regulation) and insulation, stormwater runoff control, habitats for pollinators, food production, recreational and relaxation opportunities, the facilitation of social cohesion, aesthetics, mediation of noise (noise insulation), and protection of the building structure (roof longevity) (see Fig. 1 for selected real case initiative) [14, 24, 58, 61, 62]. Faivre et al. (2017) [4] exemplified the strategic environmental, social and economic challenges faced by an urban GR as an innovative implemented NBS and suggested a three-scale (i.e. high, medium, low) classification grouping potential benefits as: high (biodiversity), medium-high (social cohesion, climate, health and green jobs), medium (water) or low-medium (disaster and food). Green urban infrastructure as NBS can therefore be a favourable planning policy assessment tool to successfully promote smart, sustainable and inclusive growth by addressing socio-economic and environmental demands and pressures for achieving and contributing to the European urban sustainability [63, 64].

## Nature-Based Solutions and Major European Union Research Policy Priorities

The EC has actively supported and fostered excellent environmental research and technological development and demonstration activities in the European Research Area (ERA) since the start in 1984 of its series of multi-annual EU funding Framework Programmes for R&I (FP), H2020 (2014–2020) and, currently Horizon Europe (2021–2027) [4, 65], having the last a special emphasis on mission areas to society and citizens' needs, such as (i) adaptation to climate change, including societal transformation; (ii) soil health and food and (iii) climate-neutral and smart cities, among others EU defined missions areas [66].

The active coordination and engagement of the EC in the direction of investing in NBS through the ambitious EU R&I policy (e.g. agenda on NBS and re-naturing cities) tackle cross-cutting societal and environmental challenges with aiming research on NBS for the benefit of biodiversity (i.e. habitat and species protection) and the support of urban-values ES delivery (e.g. ecosystem-based approaches) as drivers for innovation on smart growth, green economy and creating direct and indirect job opportunities in Europe [4, 20, 34, 60, 67]. Consequently, the EU encompasses the necessary and effective leadership qualities as a prerequisite to understand and adopt the concept of 'innovating with nature', to procure resolute action in addressing the global sustainability challenge through technological innovation and environmental policies for more resilient societies [4, 60].

Innovative spatial and environmental (e.g. ecosystem-based) planning is one of the most effective ways of building a GI, accompanied by proper governance and transformation models, sustainably mainstreamed into municipal planning procedures, i.e., including planning strategies and frameworks, processes and regulations, policies and legislation, and associated organisational structures, instruments and measures [59, 68]. Policies adopting nature-based spatial planning approaches, know how to get better spatial interactions to integrate economic and environmental strategies development and implementation throughout a considerable geographical area (i.e. urban, regional, and national scales) towards sustainability initiatives [50, 69]. Spatial planning implies interactions—connecting different EU-driven sectors, policies and actions, with the aim of investigating and deciding on land-use precedencies with interest in cooperative integrated development models and methods that establish multi-criteria and scientific foundations for sustainable development measures, supporting connected instruments and technologies [50, 68].

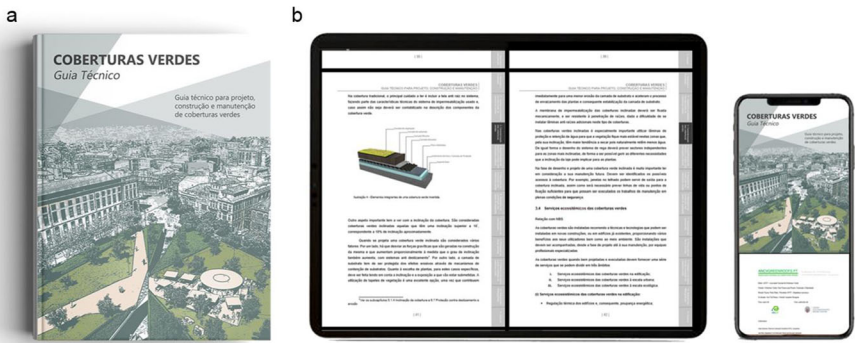
Andreucci (2013) [50] proposed a scheme on major EU initiatives, based on a series of key specific leading objectives that primarily included (1) to protect biodiversity decline and/or damage (i.e. enhance, conserve, and restore) in natural and semi-natural areas (see also [70]); (2) to protect ecosystem functioning (maintain, strengthen, and restore), and to promote ecosystem and cultural services [70]; (3) to mitigate and to adapt against climate change impacts and scenarios, evaluating its options and strategies [59], and to intensify resilience by implementing approaches to vulnerability reduction toward pressures on environment and climate risks as combination of environmental issues (natural disasters) and anthropogenic factors (e.g. floods, urban heat island (UHI) effect); (4) to ensure adequate opportunities for health and well-being, creating and promoting open green spaces for relaxation, recreation and social interaction [71], getting stronger urban-rural connections, supporting the development of affordable, accessible and sustainable transport systems and, strengthening the 'sense of community' and community building as basic human needs in the urban environment; and (5) to boost the scientific, economic, cultural and societal resources' connections among

nature, biodiversity and ES values, and to conceive new policies and incentive structures seeking to build capacity for it [13, 72, 73].

Current research initiatives and policies from existing environmental and NBS R&I agendas, plans and programmes in Europe, will assist the EU to accelerate steps forward to a circular, resource-efficient and low-carbon economy, besides smart, inclusive and sustainable development and growth [4, 44, 74, 75]. The EC aims to integrate innovative urban NBS in existing strategy and policy frameworks, through the alignment of the R&I agenda on NBS with numerous European policies, actions and responsibilities (e.g. information and services), reflecting its commitments on NBS successful deployment timely and at scale via ecosystem-based approaches at their core to achieve biodiversity and climate objectives [4, 34]. Thereby, NBS support major EU policy priorities [2, 4] which include (1) the European Green Deal and its action plan on climate-proofing, resilience-building, prevention and preparedness [37, 76, 77]; (2) the EU Biodiversity Strategy—including the Commission’s GI Strategy—aims at restoring and protecting nature (biodiversity and ES) and promoting GI in Europe to build resilient societies [29, 46]; and (3) the EU Adaptation Strategy, which distinguishes EBA measures to enhance GI in urban areas and deliver multiple economic, social and environmental co-benefits [78]. Additional planned Union-funded R&I actions and activities promoting NBS innovation are in line with the current policy goals to produce distinctive European added value and demonstrable benefits from nature to cities and territories across Europe. Thus, the collaborative community at the EU, national and regional level aims to strengthen the planning, implementation, monitoring and evaluation capacity, providing the evidence base for deploying NBS; to develop a European interdisciplinary R&I and stakeholder community; and to mainstream NBS in international R&I alliances to build on future markets [2, 4].

## Associations as Stakeholder Groups for Innovation with Nature in Europe

Green infrastructure and/or NBS-related Associations or non-governmental organisations (NGOs)—regardless of their social or environmental nature—can act as a bridge between stakeholders towards providing a network and comprehensive platform to build and share expert knowledge and experiences (e.g. good practices and lessons learned) and create synergistic collaboration on sustainable NBS implementation, regarding building-integrated vegetation approaches as well as related and relevant policies, regulations and technical guidelines of common awareness (see Fig. 2) [79]. Moreover, the associations provide help in supporting current European and national policies’ objectives and frameworks for urban NBS/GI implementation and offer in practice opportunities for NBS/GI upscaling and mainstreaming in cities. The integration of NBS entails several actors, from citizens and stakeholders to policy-makers, that can only be effective if proper methods of communication, involvement, and feedback are envisaged [27, 80]. The associations may not be considered, in general, business stakeholders, but they are of great value having into consideration their insight on NBS, the mission that sets their foundations and, the members that represent. When considering intervention in territories, different stakeholder groups are called to stand, leading often to complex and conflictual relationships, needing of a high degree of coordination and negotiation. Without a solid background of collaboration, the intention of NBS matching the scale



**Fig. 2** Technical Guide for Green Roofs (GR) published by the Portuguese National Association of Green Roofs (ANCV) on the subject of guidelines for GR project, installation and maintenance ('Coberturas verdes: Guia Técnico – Guia técnico para projeto, construção e manutenção de coberturas verdes'): **a** printed version; **b** digital format

of the solution to the scale of the problem may be in jeopardy. It is thus important that different categories of stakeholders from public to private sector, citizens and associations are engaged in the process of NBS implementation [27, 51]. Associations can thus support (i) the elaboration of quantitative and qualitative norms for key NBS; (ii) the recognition of policies and the critical actions to reach the targets; (iii) the networking to useful NBS knowledge acquisition and good practices exchange and (iv) the outline of the problem and possible approaches [81]. Several associations may be found at international level within the GI/NBS thematic, by country or representing several country organisations. Thereby, the European Federation of Green Roof and Living Wall Associations (EFB) was established in 1997, thanks to the founding GR Associations from Austria, Germany and Switzerland, and, in 2019, had integrated fifteen-member associations from different European countries. Not limited to, its mission encompasses the active promotion of the use of GR and green façades at different dimensions. At this level, it is possible to leverage not only the dynamics between members but also to strengthen the participation in projects, events and network actions (<https://efb-greenroof.eu/>). Another example is the not-for-profit association World Green Infrastructure Network (WGIN) that in 2019 had expanded to twenty-six national members and focuses the efforts on the transition from 'grey to green' infrastructure for building and establishing a collaborative global network under its motto 'vegetation makes it possible' (<https://worldgreeninfrastructurenetwork.org/>).

In general, GI/NBS organisations and associations are engaged in promoting urban greening and supporting their members in order to meet their interests. Moreover, several publications are issued and made available on each website. As an example, the GR and GW market report as a white paper was published in 2015 by the EFB [82] and is predicted the European green market report (<https://greenmarketreport.eu/en/green-market-report/>) by this year 2021, published by the EFB and the Innovation Lab GRÜNSTATTGRAU (GmbH) of Österreichischer Verband für Bauwerksbegrünung (<https://gruenstattgrau.at/en/>). To different extents, publications are important for project dissemination, outreach activities and to cope with market demands.



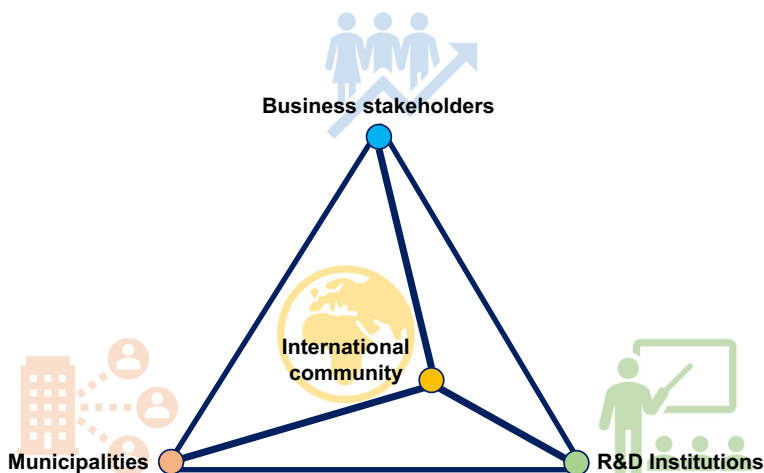
## Case study: the Portuguese National Association of Green Roofs

The role and importance of associations in the promotion of GI/NBS have been previously highlighted, and a case study is here presented that shows in practice examples of the associative dynamics.

The Portuguese National Association of Green Roofs (ANCV - Associação Nacional de Coberturas Verdes) is an NGO founded on the 19 of June 2015, which aims to promote GI/NBS in cities, especially those that can be installed in buildings (new or pre-existing) such as GR and GW, highlighting their importance and contributions to the possibility to create healthy, sustainable, biodiverse and resilient urban territories. The ANCV's activity, at national and international level, focuses on four lines of action for which specific work and partnerships are developed with: business stakeholders, municipalities, research and development institutions, and international community (Fig. 3). It is of utmost importance to highlight that the social bodies come from different fields of knowledge, professional expertise and different country regions—to assure geographic representation—which promotes interdisciplinarity and a holistic approach to face the actual challenges of GI/NBS dissemination. Currently, ANCV integrates sixteen members from research and development (R&D) institutions and universities, nine members from municipalities, nineteen members from companies, and thirty-two from individual memberships.

The ANCV mission sets the ground for a collaborative work towards the following:

- i. Promotion—in alignment with the government and municipalities—of GR and GW as part of environmental and energetic strategies
- ii. Promotion—in alignment with the EC framework—of GR and GW concerning the Biodiversity Strategy
- iii. Promotion and dissemination of standards, technical guides (Fig. 2) and scientific studies that demonstrate the benefits and services that GR and GW provide



**Fig. 3** Main lines of action of the Portuguese National Association of Green Roofs (ANCV), connecting research institutions, municipalities, companies and international community' members

- iv. Establishment of relationships and development of work with similar associations at international level, with a special focus on those sharing the typical Mediterranean climatic conditions
- v. Creation of a national database of GR and GW projects and an international database on municipal policies and strategies for GR and GW implementation
- vi. Organisation and promotion of training and dissemination events
- vii. Technical specifications editions to support high standard quality projects
- viii. Participation in the conception and revision of national sector regulation and legislation.

The crucial role of ANCV to foster GI/NBS and boost the Association aims reflects on several cross-sectional actions that have been developed, such as the following:

1. International partnerships: The ANCV is a member of the WGIN and the EFB, of which the current ANCV president is one of the four actual vice-presidents of the latter. This reinforces Portugal's position in Europe as a relevant member to underpin sustainable development in cities. At a national level, several partnerships have also been established with other associations and stakeholders.
2. Projects collaboration and consultancy: The ANCV is engaged in establishing partnerships and to participate in national and international projects. Some examples of partnership include the GENESIS project—'Green roofs and walls ENvironmental Economic and Soclal Savings: Modelling uncertainty and investors/users preferences in all-inclusive cost-benefit analysis of green roofs and walls' (PTDC/GESURB/29444/2017) (<https://www.projectgenesis-ist.com/>) [83].
3. Municipal collaboration: The Fifth Façade Project (PQAP) began in August 2016, resulting from a collaboration between the ANCV and the Porto City Council, envisioning the definition of models that the municipality of Porto should follow in order to include GR into the urban planning, environmental and climate change strategy of the city. It was an innovative approach since it was the first time that a city council in Portugal has manifested its interest to include GR in the urban planning (Fig. 1) [58, 84–86]. The ANCV is being also called by municipalities as advisory party and consultant in matters related to GI implementation.
4. Technical guideline launch: The ANCV Technical Guide was the first Portuguese publication with guidelines for GR project, installation and maintenance (Fig. 2). It was a 3-year work, built in order to cover all phases, from design to maintenance, of a GR [87]. It was conceived by an interdisciplinary team of experts from different sectors in collaboration with the public professional Engineers Order (Ordem dos Engenheiros (OE) da região Centro) (<https://www.ordemengenheiros.pt/pt/a-ordem/regiao-centro/>). Several events have been undertaken at national level to disseminate the technical guide, including technical courses.
5. Membership dynamics: The opportunity to have detailed business information on the ANCV website is provided to companies' members, allowing the online visitors to have easy access when finding who can provide GR information, including project and consultancy; implementation and maintenance; thermal insulation; anti-root impermeabilisation and layers, blankets and filters; drainage; substrates; vegetation; irrigation systems; and GW. They also can beneficiate from a set of advantages in relation to network opportunities. Moreover, the institutional members and students have special offers membership conditions.

6. Organisation and promotion of training and dissemination events: Technical and advanced courses have been carried out in professional orders (Ordem dos Arquitectos and OE da região Norte) and for municipal technicians. Further on, collaboration with schools, at the basic and secondary level, higher education entities (e.g. Universities, Polytechnics) and Research Centres have been established. Events are promoted such as the International Green Infrastructure Conference held in Porto in 2018 (<https://igicporto.webnode.pt/>).
7. Multimedia communication channels: The Association has been investing in improving the quality of information that has been made public as the diversification of multimedia channels. The ANCV website (<https://www.greenroofs.pt/>) is the main platform that gathers information concerning the association mission, vision and membership. It is an important repository of publications related to NBS and has an extensive assessment on GR and GW projects and policies. Besides that, it has the presence on several social media channels, such as Instagram, Facebook, Twitter, Pinterest and LinkedIn. A periodic newsletter is issued for all the members with the latest advances on GI/NBS and Association work.

The ANCV has been collaborating with several R&D institutions, universities and municipalities integrating proposals as partners or consultants in the area of GI/NBS.

## Conclusion

To face the social, economic and environmental actual challenges related to climate, the circular economy, biodiversity and human health, only a collaborative work can provide a step forward into a better and sustainable society. At the level of the cities, the urban infrastructures need to be transformed from resource sinks into circular resource hubs. This highlights the importance to approach to circular and ‘resourceful’ cities concept. Nature-inspired systems as nature-based solutions are shift triggers for urban green infrastructure integration. The European Union community is engaged with this alignment through policies that innovate with nature, highlighting the R&I agenda on nature-based solutions—inspired from the H2020 Expert Group report on ‘Nature-Based Solutions and Re-Naturing Cities’—to promote the adoption of innovative business and investment models besides long-term financing institutional and legal frameworks for nature-based solutions in Europe; and the Biodiversity Strategy and its action plan that was recently adopted by the European Commission, representing a comprehensive long-term programme aspiring protecting nature and reversing the ecosystem degradation by 2030. These current European policies and activities contribute and engage with the implementation and achievement of the United Nations 2030 Agenda for Sustainable Development Goals and, additionally, represent a significant role point toward to connect people with nature, involving citizens to support the conservation of nature.

In order that the policies and strategies give rise to applied action plans, every stakeholder plays a pivotal role acting in different dimensions to tackle the constraints and barriers of green infrastructure and nature-based solutions adoption. Green infrastructure and/or nature-based solution-related associations or non-governmental organisations are drivers for collaborative work promotion and networking establishment. Their role encompasses the leverage of opportunities for local frameworks to apply innovative nature-based solution plans of action, and allocate research and innovation opportunities implementing relevant and inclusive urban regeneration solutions. Likewise, the associations act to different extents, connecting multiple

stakeholders from diverse disciplines and sectors such as municipalities, businesses, academia, research centres and other organisations, compromising and being involved with the design, funding and decision-making process steps, being also the bridge to the community.

This paper delivers an overview on how association actions and dynamics can promote inclusion of nature-based solutions, although it would be interesting to look deeper into strategies to establish collaboration between stakeholders, integrate citizens' participation, and overcome barriers towards nature-based solutions implementation.

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## Declarations

**Conflict of Interest** The authors declare no competing interests.

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