

# Building Integrated Greenery systems from the New European Bauhaus perspective

Giulia Mazzucco<sup>1,\*</sup>, Adriano Magliocco<sup>1</sup>, Paolo Rosasco<sup>1</sup>, and Katia Perini<sup>1</sup>

<sup>1</sup>Department of Architecture and Design, University of Genoa, 16128, Genoa, Italy

**Abstract.** Building Integrated Greenery systems (BIGs), such as green roofs and walls, present valuable solutions to the environmental challenges that we are facing today. These systems provide numerous environmental benefits enhancing biodiversity, controlling the Urban Heat Island phenomenon, improving air quality and water management, decreasing energy consumption by improving roof insulation. Recently, academic researchers have predominantly centred on the environmental sustainability and economic issues, often neglecting other socio-cultural aspects. However, since the definition of the Triple Bottom Line in the late 1990s, the complexity of sustainability and its various facets, including the social dimension, have been recognized. Nevertheless, the social dimension has frequently been overlooked due to its complexity and perceived lack of immediate relevance. The needed green transition has yielded significant economic growth, but it has also diverted attention from social indicators such as shared governance, community involvement, and affordability. Initiatives like the New European Bauhaus (NEB), promoted by the European Commission, illustrate a comprehensive approach to sustainability including good design practices and strategies aimed at fostering a sustainable, inclusive, and aesthetically pleasing future. The paper aims at identifying aspects for BIGs design and evaluation considering the NEB approach, emphasizing not only environmental dynamics but also other issues related to socio-economic and cultural consequences.

## 1 Introduction

The recent growth and evolution of urban areas have significantly impacted our everyday lives, affecting both the environment and the society [1]. The increasing frequency of tragic events and natural disasters necessitates immediate actions to prevent and compensate more severe consequences. From the late 20<sup>th</sup> century, numerous studies and publications on green systems, including walls and roofs, have been disseminated within the scientific community, highlighting mostly their environmental benefits [2].

Under the umbrella of the Nature-based Solutions (NBS), Building Integrated Greenery systems (BIGs) address critical urban issues. They mitigate the Urban Heat Island effect [3-6], counteract biodiversity loss due to insufficient green spaces [5, 7-9], retain rainwater to prevent sewer overload and reduce flood risk [10-12], improve air quality [13-14], and reduce noise pollution [15]. Additionally, BIGs decrease the need for heating and cooling, thereby saving energy and providing economic benefits [16].

Green roofs and walls offer crucial solutions in densely populated urban areas where creating parks and ground-level green spaces is not feasible. These projects impact both the environmental and social dimensions by providing valuable services to communities [17]. The lack of natural environments in cities leads to significant issues

for people who lack recreational and cultural spaces to interact and connect [18].

Moreover, numerous studies emphasize the importance of frequenting natural settings as restorative spaces to enhance well-being and health [19]. Spending time in healthy environments, exercising, and connecting with nature can reduce stress, improve mental health, and accelerate various healing processes [20-21].

Since Elkington's 1997 definition of the Triple Bottom Line, achieving sustainability goals has required equal attention to environmental, economic, and social dynamics, whose interplay theoretically yields optimal sustainability. To assess the sustainability of a process or product, it is essential to quantify benefits and performance using evaluation methods like Key Performance Indicators (KPIs) [22]. However, this quantification process is well-defined for environmental effects, where data on temperature differences, pollutant concentrations in the air, energy savings also in economic terms etc. can be collected and analysed. The assessment of benefits is not as straightforward when it comes to the social impact these systems have on the community [23]. All the benefits that natural element brings to individuals, such as the creation of gathering spaces, enhanced well-being, and aesthetic appeal, are difficult to collect and quantify. However, these aspects are relevant to society, it must be considered that every environmental or economic benefit also has consequences on social dimension.

\* Corresponding author: [giulia.mazzucco@edu.unige.it](mailto:giulia.mazzucco@edu.unige.it)

In recent years, a focus on social dynamics has led to new perspectives. The New European Bauhaus (NEB) initiative was established to promote sustainable, inclusive, and beautiful projects, emphasizing all aspects of sustainability without prioritizing one over the others [24]. Aligned with the Green Deal objectives, the NEB showcases good practices to support both the green transition and socio-cultural transformation. According to the NEB Compass [25], a tool designed to guide decision-makers and project developers in applying NEB principles, the values focus on reconnecting with nature, creating meaningful experiences, and addressing injustices and outdated social models through collaborative and comprehensive approaches. Beautiful, sustainable, and inclusive projects enhance qualitative experiences and human well-being, promote regenerative and sustainable actions, and endure equality, accessibility and affordability [26].

In this framework, the BIG4LIFE project was funded within the LIFE programme. BIG4LIFE aims to promoting collaborative strategies for management, maintenance, impact monitoring, and evaluation of Building Integrated Greenery systems [27].

This paper aims at focusing on the social dynamics of green systems on par with economic and environmental ones by addressing the paucity of literature related to this topic. Reading BIG systems through the lens of the New European Bauhaus perspective allows for the integration of these fundamental issues into the achievement of more resilient cities and communities. This work aims at exploring a new interpretative key to the topic of sustainability, focusing on the interconnections and interoperability of the new values promoted by the New European Bauhaus.

## 2 Methodology

Through the analysis of the New European Bauhaus tools, such as the guidelines and the NEB Compass, we foster a new perspective that combines green systems and sustainability dynamics, responding to the needs of contemporary society. These tools offer the possibility to assess green systems comprehensively, providing new viewpoints. By reviewing BIG systems and their characterization, considering the three NEB pillars, as well as their relationship with the urban context, it is possible to provide a general overview of such solutions. The BIG4LIFE project provides an opportunity to investigate these aspects. In this paper, the KPI selected to measure the impacts of BIG systems within the project are analysed and discussed, considering their role in the achievement of the NEB objectives.

## 3 Results and discussion

### 3.1 The New European Bauhaus

The New European Bauhaus initiative promoted by the European Commission was created in 2020 to “bring together sustainability, beauty, and inclusivity in the built environment and development of cutting-edge products or services” [24]. In parallel with the Green Deal, the NEB promotes regenerative practices close to citizens, addressing shared governance, co-participation, community involvement by advocating the importance of disseminating and sharing knowledge [25]. The basic principles, sustainable, inclusive, and beautiful, are inspiring values of a new approach that aims to transform our common vision of the built environment rewriting old paradigms. In terms of sustainability, the initiative is focused on circular economy and processes, use of renewable energy, waste production, improvement of biodiversity and preservation of ecosystems. The second pillar is more human oriented, taking care of community need, social justice and cohesion, equal offers and opportunities breaking unfair and obsolete social models fostering accessibility and affordability. Additionally, a project has to be beautiful, it has to improve people physical and psychological wellness, be comfortable, meeting people’s needs. Beyond the environmental crisis, the climate neutrality, the emissions of pollutants, and other challenges that we are facing nowadays, the NEB wants to focus on socio-cultural and political repercussion [26].

### 3.2 Building Integrated Greenery systems

Green roofs and facades, defined as Building Integrated Greenery systems, are well recognized Nature-based Solutions that bring proven scientific benefits into the urban settings [28]. Climate change, ongoing urbanization and extreme events such as heat waves, floodings, droughts etc. appear as relevant challenges for cities [29]. Nature-based Solutions represent a wide range of actions, from the protection and management of natural and semi-natural ecosystems to the realization of blue and green infrastructure in urban areas [30]. Greening the building envelope is an encouraged action by the European Commission that is giving great results in terms of water and heat management, in addition to provide different ecosystem services, as shown by the EU Green Infrastructure Strategy [31]. The benefits offered by green roofs and walls positively impact communities by improving living conditions and creating more resilient and high-quality living areas [17-18].

The economic sustainability of NBS, and more specifically BIG systems, refers to the core value “Together” and, in particular, to social inclusion; a project is also economically sustainable if it is accessible and convenient, i.e. if it has positive economic impacts on the community [32].

From this perspective, the evaluation of the economic impacts of a Building Integrated Greenery systems can be developed through methods that refer to the “public” or “collective” approach, i.e. which consider, in the economic sustainability balance sheet, the costs and the benefits attributable both to direct users (users-investors) and to the community (citizens).

While most of costs can be directly estimated in economic terms (installation, management and maintenance costs), some benefits can be of different nature and not directly measurable on an economic scale [33-34]. For example, the increase in air quality, the reduction of the heat island effect and the run-off can be quantified only through the economic evaluation of an indirect effect generated by the benefit [35-36]

However, the emphasis on visible and quantifiable environmental and economic developments has led to a lack of attention to the social repercussions associated with green systems and solutions, largely due to their complexity in evaluation [23].

### 3.3 BIGs toward NEB

The BIG4LIFE project selected different Key Performance Indicators to evaluate the benefits of BIG systems and describe their effects on the environment and society. These KPIs are primarily related to BIGs performances and their provision of ecosystem services, but many also have relevant social repercussions.

**Table 1.** Selected specific KPIs for BIG4LIFE project (source: <https://www.big4life.eu/impacts/>)

Specific KPIs	Unit
Air quality	Number of people
Biodiversity	Number of species
Climate vulnerability	Number of people
Employment	Number of new jobs
Energy Savings	GW/year
GHG sequestration	Tonnes Co2e/year
Noise	Number of residents
Participation	Number of people
Wellbeing and health	Number of people
Renewable energy	GW/year
Water efficiency	m3/year
Biosolar production	KWh/year

The first indicator related to the *Air quality* regards the ability of vegetation, especially in the case of vertical greening, to collect fine dust [37]. This indicator is related to the sustainability pillar and also to the inclusivity and beauty pillars. Indeed, from one side, poor air quality

affects human health [38], especially in low-income communities, as highlighted by the environmental justice movement [17, 39]. In addition, it will also affect the quality of life of people. Also, the *Biodiversity* indicators, which is related to the possibility of integrating a number of species in the built environment, thanks to green roofs and vertical greening [40-41], regards all the three pillars. Indeed, besides improving ecosystem health (sustainability), it allows experiencing nature (inclusivity and beauty) [42].

*Climate vulnerability* indicator is connected to mitigating phenomena like Urban Heat Island effects and urban floods [43]. The relevance in terms of sustainability is unquestionable, otherwise the effects are not only to the environment but also to human beings. Vulnerability to Heat Island Effects is unevenly distributed, disproportionately affecting low-income communities, children, the elderly, the disabled, and the ethnic minorities [44-45]. These dynamics should be addressed under the pillars of inclusivity for environmental justice and quality of life, and beauty for preserving urban spaces and user comfort.

Implementing BIG systems catalyses job creation – *Employment* – significantly impacting sustainability by promoting environmental actions and generating job opportunities that support societal development and collective growth, aligning with the inclusivity pillar. Job creation fosters economic stability and improves quality of life, contributing to the beauty value [46-47].

In terms of *Energy savings* and *Water efficiency*, BIG systems enhance thermal insulation, reducing resource waste and yielding economic benefits [23,48]. Water efficiency is crucial, especially in the Mediterranean context facing recurring water scarcity. Green systems reduce irrigation needs and allow runoff water collection [11,12], conserving resources (sustainability) and increasing system affordability (inclusivity).

The *Noise* indicator is related to the BIG systems reducing sound transmission [15], benefiting ecosystems (sustainability) and improving life quality by mitigating noise pollution. The WHO’s “Environmental Noise Guidelines for the European Region” (2018) highlight the importance of protecting human health and enhancing well-being (beauty) [49].

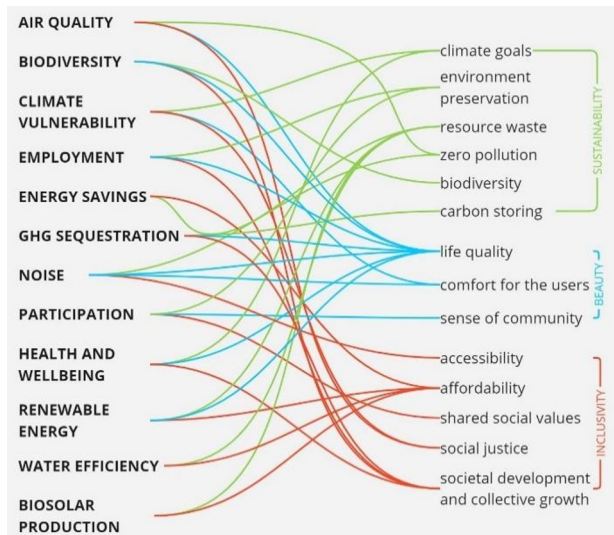
*Participation* gained attention in connection with the importance of communities involvement in green transitions [50]. Successful green systems implementation relies on community participation, fostering urban reconciliation ecology [51]. This indicator supports sustainability, inclusivity and beauty, promoting environmental preservation, shared social values and a sense of community.

BIG systems provide urban green spaces with numerous *Health and Well-being* benefits [19-21], including improved air quality, physical activity, social cohesion, and stress reduction [52]. These benefits aligned with the three NEB pillars.

Other indicators are more directly related to sustainability, such as *GHG sequestration* [53] and *Renewable energy*, which refers to the benefits of photovoltaic-green roofs [5], suggests that the parameters

are clearly environmental, but thinking about the consequences it is possible to correlate the quality of the air to the health of people living near the green systems. Even if it is not directly quantifiable, the social impact of this indicator has to be taken in account.

Lastly, the *Biosolar production* indicator supports sustainability by providing renewable energy and reducing greenhouse gas emissions [55]. The broader impacts of biosolar production on people's lives extend its relevance to inclusivity and beauty, creating new sustainable ways of living together.



**Fig. 1.** Correlations between BIG4LIFE KPIs and NEB principles (sources: BIG4LIFE project and NEB Compass)

It is now clear how purely economic and environmental aspects have repercussions on social ones. Interpreting, according to the principles of the NEB, the idea of beauty as useful, healthy, and experientially pleasant implies investigating how cultural aspects influence aesthetic evaluations and vice versa, a research area capable of connecting the acceptance of changes and new solutions in urban redevelopment [56], still worthy of being explored. Some research investigates how a healthy population is a constantly growing population capable of providing the city with stable human resources, which contribute to promoting economic and social development [57]. A healthy society is not only an economic question in terms of labour resources but also a society that spends fewer economic resources on welfare (as reported by EHCN) [58]. The inequality concerning the availability of green areas is reflected in the inequality with respect to health; various studies have linked it to the poorest areas of European cities; here, the concept of inclusiveness takes on both a social and economic connotation [59].

#### 4 Conclusion notes

This paper shows that Building Integrated Greenery systems performances can be related to the core NEB

principles, sustainable, inclusive, and beautiful. Overcoming the compartmentalization of performance will provide a broader, albeit more complex, understanding of these systems.

Following recent developments, the implementation of green roofs and vertical greening systems is no longer exclusively an environmental or economic issue. The focus on social aspects has redefined priorities, introducing new and unavoidable challenges. Adopting the New European Bauhaus perspective encourages a holistic approach to evaluating these systems, integrating social dynamics on par with environmental and economic benefits.

The wider goal remains to create more resilient and adaptable urban environments, focusing on the strong relationship between human beings and built environments. More sustainable cities require interventions from an environmental perspective, addressing and mitigating the effects of climate change, but also actions that impact the social sphere by promoting equality and social justice.

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