



*Research article*

## **The perception of green integrated into architecture: installation of a green facade in Genoa, Italy**

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**Abstract:** In October and November 2014, a green facade was built on an office building owned by the National Institute of Social Insurance (Istituto Nazionale di Previdenza Sociale) in Genoa's Sestri Ponente district, an area characterized by relatively high population density (13,000 inhabitants/km<sup>2</sup>). As in many Italian cities, Sestri Ponente has high rates of air pollution, and the Department of Sciences for Architecture at the University of Genoa (Italy) is conducting monitoring activities in collaboration with RSE SpA (Research on Energy System) to evaluate the effectiveness of the facade in summer cooling, winter heating, air quality improvement, and economic and environmental sustainability. A sociological survey of local residents and employees who work in the building on their perceptions of the green facade is also under development. This monitoring includes surveys before and after the installation of the facade to evaluate if the introduction of foreign elements has destabilizing effects in the context of the domestic environment. This article discusses the results of the survey done before the implementation of the green facade. Other surveys will be carried out in subsequent months in order to understand if the experience of prolonged contact with this new "presence" has changed citizens' perception.

**Keywords:** urban greening; green architecture; urban area; social survey; perception

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### **1. Introduction**

Perception is often incorrectly interpreted as the mere "vision" of something. In fact, experiencing architecture and the built environment is synesthetic, meaning it is not only visually enjoyed, but experienced across and between the senses [1]; indeed, synesthesia of perceptual experiences is clearly supported by Merleau-Ponty in 1945's *Phénoménologie de la perception* [2]. Knowledge can influence the interpretation of what one perceives with the senses, however, and knowledge and experience

interact in evaluating these perceptions.

Architecture is particularly difficult to separate from prejudices of the observer. Benjamin in 1936 [3] reminded that while art is understood through contemplation, architecture is perceived via habit.

The opinion of an observer, of a building or on a part thereof (e.g., subjected to changes, as in the case of the subject of this paper), is also influenced by the condition in which the observation is made. Judgments are strongly influenced by the experience of the user, and, therefore, also by the cultural model of reference (where and how they live, level of education, occupation, etc.). In fact, according to Lewin's theory in 1951 [4], the behavior of an individual is a function regulated by interdependent factors constituted by one's personality and the environment that surrounds it.

All of these elements must be considered when interpreting citizens' feedback about the introduction of new buildings or elements in an urban context. The possibility that, over time, observers' opinions are dynamic has to be taken into account, especially as they relate to the interpretation of sensory perceptions. For this reason, the present study on the perception of the green facade of the National Institute of Social Insurance (Istituto Nazionale di Previdenza Sociale, or INPS) building in Genoa Sestri Ponente district looks at the survey conducted before the installation of the green facade in order to better consider the sociocultural environment.

The massive integration of vegetation in the urban environment allows for improved air quality, increased biodiversity, and reduced urban heat islands due to its cooling and refreshing capacity [5–9]. The integration of vegetation in architecture exploits the surfaces (both horizontal and vertical) of buildings to obtain these benefits and, consequently, an improvement in environmental quality and inhabitants' wellbeing [10–14]. This type of green envelope improves urban environment conditions generally; as many European cities, including Genoa, are densely built, these integrations address environmental issues related to pollution in the atmosphere [15]. As demonstrated by several studies, the presence of green urban spaces also plays an important role in the broader psychological wellbeing of a society [16–18]. The reason that people feel better in natural environments is mainly psychological, according to the hypothesis of Wilson [19] about the phenomenon of *Biophilia*, which asserts that humans need contact with nature and with the complex geometry of natural forms as much as metabolism needs nutrients and oxygen.

## 2. Methodology

The green facade (Figures 1, 2) was installed during the months of October and November 2014 on the south wall of an office building built early in the last century, owned by INPS, and located in the city center of the Genoa neighborhood of Sestri Ponente, an area characterized by a relatively high population density (13,000 inhabitants/km<sup>2</sup>).

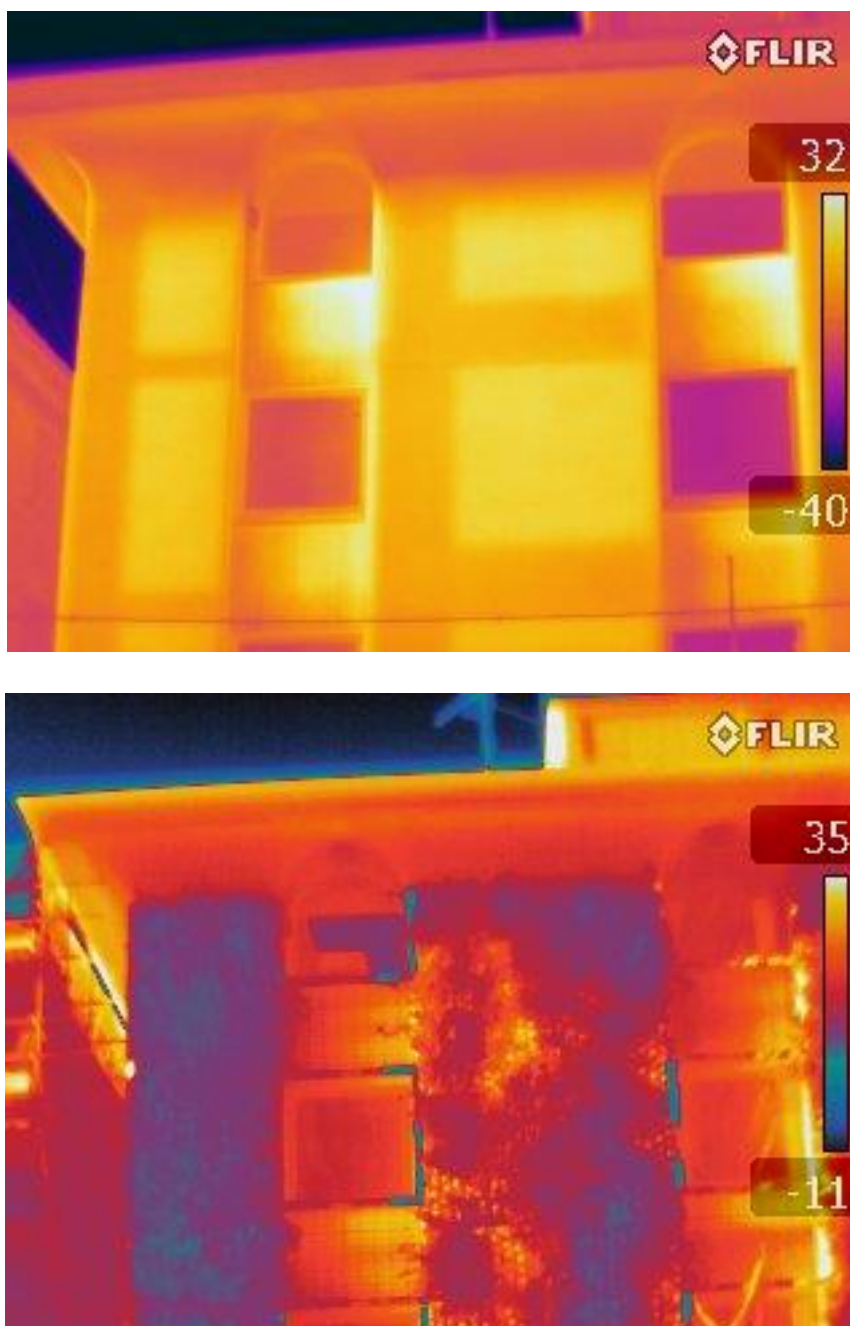


**Figure 1. INPS office building location in a dense urban area in Genoa, Italy.**



**Figure 2. The green facade during construction.**

The facade is exposed to solar radiation several hr/day in summer and 1–2 hr/day during winter. The building structure is made of concrete pillars and beams, as shown in Figure 3, a photograph taken with an infrared camera. The vertical greening systems (VGS) chosen is a living wall system made of a mat planted with different plant species (e.g., climbing plants, shrubs, evergreens). The mat contains an aggregate mix and is composed of two layers of special geotextile. The system is irrigated with a drip line in each module and is designed primarily to use recycled condensate water from a network of air conditioning units.



**Figure 3. Thermography before and after the installation of the green facade.**

The project's monitoring aims to quantify the positive effects of green envelopes in densely built urban environments, particularly their role in improving environmental conditions and reducing

ecological imbalances. Monitoring activities are focused on evaluating these environmental benefits, both economic and social, in the context of densely urbanized areas, especially those in the Mediterranean region. In addition, a cost-benefit analysis and a life-cycle assessment will be carried out to measure the environmental impact for the entire life of the green facade in relation to the obtainable environmental and microclimatic benefits. The monitoring activities focus on the following aspects:

- Air quality monitoring;
- Comfort and energy performance monitoring, in collaboration with Research on Energy System (RSE);
- Vegetation monitoring; and
- Sociological investigation.

The presented study aims to understand how a VGS, which strongly modifies the aesthetic of a building, can come to be accepted by those who see and/or use that building every day. By means of social surveys to be carried out before construction, after a few months, and after one year, it will be possible to understand how (and if) the opinions of people interviewed will change. Following an informational campaign, this study will also allow for an understanding of how (and if) the progressive awareness of the green facade's positive effects can influence their judgments. This paper discusses the outcome of the survey carried out prior to the installation of the INPS green facade.

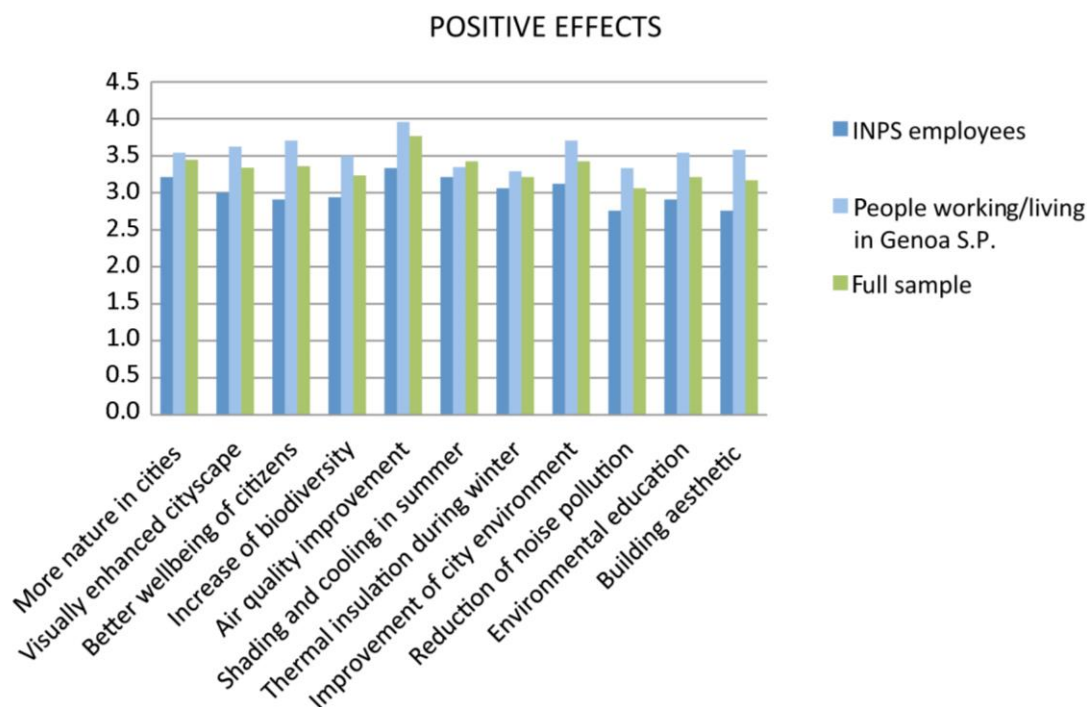
This survey (see supplementary material) was carried out in July 2014, 3 months before the installation of the green facade, to evaluate the perception of the VGS installed on the INPS office building in Genoa. This paper shows the results of a primary analysis; such results will be compared with a second and a third survey to evaluate (possible) changes to locals' perception of the system analyzed. Sixty citizens, some of them (59.9%) working in the INPS office building, others working (25.4%) or living (23.7%) in the same neighborhood, were involved in the survey. The people interviewed were selected based on random sampling categories, the survey was developed considering the results of previous research investigating positive and negative opinions about green envelopes and vegetation in cities [16–20]. Questions about positive and negative effects were included in the survey and it was filled independently by people interviewed before the green facade was built (interviewees who worked in the INPS office building had knowledge that the green facade was going to be built). Survey results were added and divided into categories to identify the influence of the factors considered.

### 3. Results and Discussion

The results of this study show that the people interviewed recognize both positive and negative effects of green facades, although almost half of them (45%) had never seen a green facade and nearly a third (32%) had never heard of green facades. The average values given to the positive effects of green facades by the whole sample of interviews are in a range of 3–3.6 (Figure 4). The choice “air quality improvement” was the most recognized positive effect. This result is related to the environmental conditions of the Sestri Ponente district, where the green facade was built, as described in the introduction. Among the positive effects that received the highest ratings were the selections “more nature in cities” and “improvement of the city environment.” Results show that although the people interviewed recognized an aesthetic value to green facades, as demonstrated by the evaluations on “visually enhanced cityscape,” they did not recognize at the same level the possibility of increasing the “building aesthetic.” As it will be shown, “increase of biodiversity (small animals),” which is technically a positive effect, was considered by many to be a negative one. The values given to



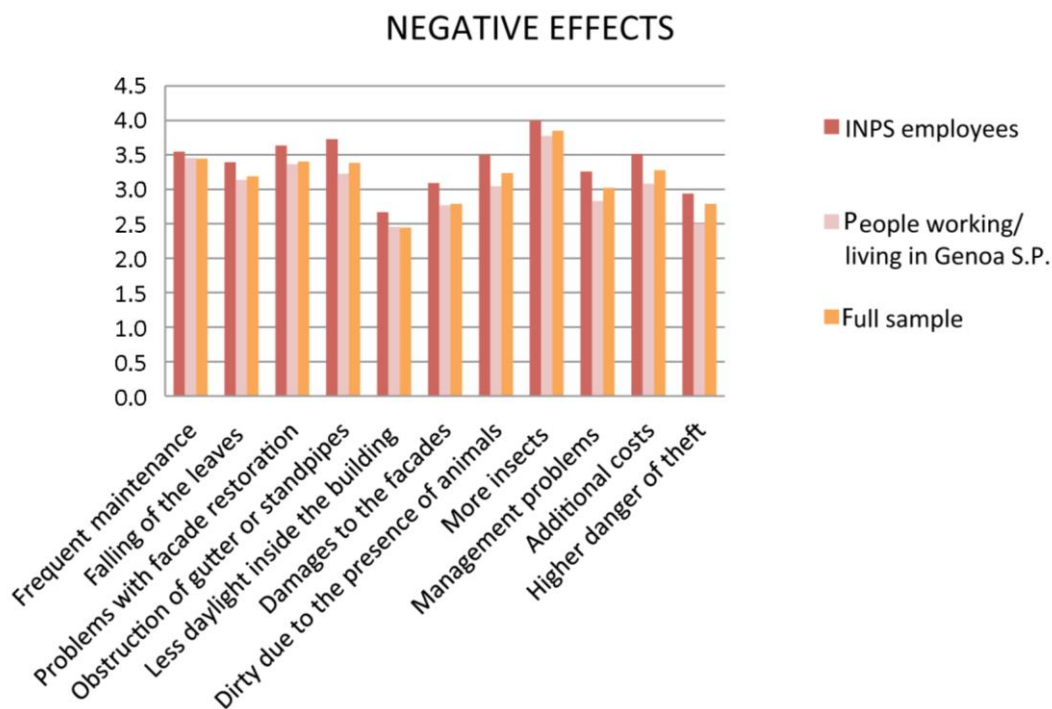
“shading and cooling in summer” and “thermal insulation during winter season” show that the people interviewed do not really recognize the thermal performance of green envelopes.



**Figure 4. Average values given by the whole sample, by INPS employees (55.9% of the people interviewed), and by people living and working in Genoa Sestri Ponente to the positive effects of green facades.**

The average rates given by the whole sample to the negative effects of green facades show that a majority of those interviewed recognized the negative effect of the presence of “more insects.” In general, the survey shows that the negative effects, connected to functional aspects (i.e. “frequent maintenance,” “obstruction of gutter or standpipes,” and “problems with building restoration”), are highly considered, followed by economic aspects (“additional costs”).

In order to measure if the opinions of employees of the INPS office building (i.e., where the green facade was built) reveal a different approach to the topic, the results were divided and separately evaluated (Figure 4). Looking at Figure 4, which evaluates the positive effects of green facades, differences can be seen between the two samples (i.e., INPS employees versus the people living and working in the area). In general, INPS employees attributed less importance to the positive effects of green facades, with average values in a range of 2.8–3.3, while for the second sample, average values were in a range of 3.4–4. On positive effects, no relevant differences can be noted: “air quality improvement” and “reduction of noise pollution” are for both groups the most and the least important positive effect, respectively, although a difference can be seen in “building aesthetic” and in “better wellbeing of citizens.” Regarding negative effects (Figure 5), lower values are noted for the sample made of people living and working in the area, with average values in a range of 2.3–3.7; for INPS employees, the range was 2.7–4.



**Figure 5. Average values given by the whole sample, by INPS employees (55.9% of the people interviewed), and by people living and working in Genoa Sestri Ponente to the negative effects of green facades.**

For total values, the INPS employees sample was 47.4% positive and 52.6% negative. Alternatively, people interviewed living and working in the neighborhood gave values of 43.2% negative and 56.8% positive. The reactions observed during the construction of the green facade were particularly interesting, demonstrating the difficulty people have in accepting what they do not know and, in some cases, do not understand. This analysis is not reported as a scientific result, but as a casual observation. The most frequent objection of INPS employees related to the inappropriateness of spending money on a building that houses offices of the National Institute of Social Welfare, as the money should instead be used “for retirement funds.” The need to reduce the cost of managing public buildings seems to be ignored. Other frequent objections related to the abnormality of imagining vegetation on the ground, not on the walls (Genoa does not have Northern Europe’s tradition of walls greened with vines) [21]. Very few stopped to read the explanatory board on the wall and positive notes came exclusively from more highly educated individuals (e.g., architects, journalists).

Greening the building envelope is a rapidly developing field in ecology, horticulture, and built environment, combining nature and buildings (and, thus, linking different functionalities) in order to address environmental issues in dense urban surroundings [5,7,22].

The first projects relating to nature and the environment, such as the works of the American SITE (Sculpture in The Environment) group, the Argentinean Ambasz, the Austrian artist Friedensreich Hundertwasser, and the Italian Gabetti e Isola, were published in the 1970s [23–26]. In many of these, a strong interest in aesthetic and symbolic aspects connected to nature is evident, as in more recent projects [27]; starting in the 1990s, greening began to be considered as a microclimatic and environmental control device following the initial research into this topic, especially in Germany [21]. The last few years have seen an apparent growth in the number of projects characterized by the use of vegetation [27]. Green architecture can be understood as an ecological element par excellence,

communicating and making explicit the sustainability of a given project, even beyond its positive influence on the environment and on the building microclimate [27].

This increasing interest may relate to the attraction of humans to nature. According to Wilson [19], humans need to be near by nature and other organisms. However, in one relevant study several negative opinions about the integration of vegetation in dense urban areas were noted [18], showing that, in the case of German citizens not living in buildings covered by vegetation, the presence of insects is considered a negative effect, along with possible damages to the facade, and maintenance needs. Among the positive effects found was the creation of habitats for birds, air quality, and urban environment improvement.

Environmental quality in terms of comfort and air quality has to be considered along with perceptible aspects to successfully introduce new and innovative elements into the urban space. While in some cities or countries green envelopes are widely known, for example in Sydney, Australia, where an awareness analysis shows high levels of community awareness on green roofs and walls also with regard to environmental benefits [29], in others, as in the case analyzed in this study, awareness has to be increased to make sure citizens understand the environmental benefits of vegetation as well as the aesthetic aspects.

#### **4. Conclusion**

A survey was carried out with the aim to evaluate the perception of the VGS built on the INPS office building in Genoa's Sestri Ponente neighborhood; the results of a primary analysis will be compared with a second survey to provide information about citizens' (possibly) changing perceptions.

Of the sixty citizens involved in the survey, locals were more favorable towards green facades than INPS employees. INPS employees complained of lack of funds for everyday work (paper, ink, etc.), and so, therefore, believed that the retrofitting works should be limited (regardless of which section of the budget funds were drawn from). In general, most of the people interviewed considered the improvement of animal biodiversity ("more insects") among the worst negative effects. Of the positive effects, possible air quality improvements were popular; this may be related to the poor air quality of the neighborhood.

Although vegetation was usually perceived positively as a useful element for improving the urban environment, green-integrated architecture is seen as something abnormal, expensive, and problematic (i.e., relating to insects). Knowledge of the benefits of technology solutions contributes to their favorable perceptions, however, and research shows that communicating the (possible) positive effects of green facades to citizens is needed. This survey will be repeated to longitudinally determine whether lush vegetation induces a more positive perception. As demonstrated by the current survey, the people interviewed see the importance of green envelopes as effective tools to improve air quality, especially if the urban structure does not allow for an effective diffusion of public greenery on the ground.

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#### **Conflict of Interest**

The authors declare no conflicts of interest in this paper.



## Supplementary

Survey on green facades of the University of Genoa, Department of Architectural Science (conducted in Italy, original version language Italian)

- Employee of INPS office in Sestri Ponente, Genoa
- Person working in Sestri Ponente, Genoa
- Person living in Sestri Ponente, Genoa



**Figure S1. Some examples of green facades**

Have you ever seen one or more?

- yes no

Have you ever heard about it?

- yes no

Select the importance of each of the POSITIVE EFFECTS of green facades in a city rating from 1 to 5 (highest):

More nature in cities

- 1 2 3 4 5

Visually enhanced cityscape

- 1 2 3 4 5

Better wellbeing of citizens

- 1 2 3 4 5

Increase of biodiversity (small animals)

- 1 2 3 4 5

Air quality improvement

- 1 2 3 4 5

Shading and cooling in summer

- 1 2 3 4 5

Thermal insulation during winter season

- 1 2 3 4 5

Improvement of the city environment

- 1 2 3 4 5

Reduction of noise pollution

- 1 2 3 4 5

Environmental education

- 1 2 3 4 5

**Building aesthetic**

1 2 3 4 5

Select the importance of each of the NEGATIVE EFFECTS of green facades in a city rating from 1 to 5 (highest):

**Frequent maintenance**

1 2 3 4 5

**Problems related to falling leaves**

1 2 3 4 5

**Problems with building restoration**

1 2 3 4 5

**Obstruction of gutter or standpipes**

1 2 3 4 5

**Less daylight inside the building**

1 2 3 4 5

**Damage to the facades**

1 2 3 4 5

**Dirty due to the presence of animals**

1 2 3 4 5

**More insects**

1 2 3 4 5

**Management problems**

1 2 3 4 5

**Additional costs**

1 2 3 4 5

**Higher danger of theft**

1 2 3 4 5

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