IEREK PRESS Academic Research Community
http://www.press.ierek.com
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ISSN (Print: 2537-0154, online: 2537-0162)
International Journal on:
The Academic Research Community Publication
**DOI: 10.21625/archive.v6i1.877**

# Carbon neutral district project for regenerating a suburban area within the Reinventing Cities C40 framework

**Lavinia Chiara Tagliabue[1], Jacopo Muzio Treccani[2,3], Antonio Della Bella[4]**

[1] *University of Turin, Computer Science Department,Turin, Italy*

[2] *Politecnico di Milano, Department of Architecture and Urban Studies DASTU Milan, Italy,*

[3] *Studio Jam Architecture, Milan, Italy/London, UK*
[4] *R4M Engineering S.r.l., Italy*

## Abstract

A multidisciplinary approach to urban regeneration is crucial when the project of suburban areas provides a functional program that includes the combination of technological, environmental, and social innovation. The Reinventing Cities C40 design contest represents an opportunity for designers to deal with the crossing topics of innovation, sustainability, and circular economy. The project proposals focus on the regeneration of urban areas with specific needs, ranging from the reconstruction of urban ecosystems to the re-weaving of fragile and damaged urbanity, to the promotion of areas devalued by functional empty. The Reinventing Cities C40 framework is supporting worldwide the cities in the renovation process, oriented in developing the abandoned areas with the aim of social, energy, and environmental resilience. The framework promotes the link between the Municipalities, the designers, and the local communities to create innovation on multiple levels, in the design process, in the architectural product, in the validation tools based furthermore on the new contractual definition of business models for social support. The renovation of the Crescenzago area in Milan, Italy, is based on an architectural project that entails an integrated mixed-use system of tower and line buildings ensuring an adequate social and housing mix and connection with the surrounding points of interest and green areas. The architectural project relates to the existing context with a synthesis between macro and micro-urban scale: territory, neighborhood, and the new district. The project moves by the definition of the open spaces that imprints the built ones and defines a direct connection with the green system, which pledges the carbon neutrality of the intervention. The site-specific proposal results from the matrix of strategic and technological transferable solutions that provide solar electricity for 82% of the energy needs and the green capture allows to achieve the zero-carbon goal of the district.



***Keywords***

*Carbon zero district; Urban regeneration; Housing mix; nZEB; Green absorption; Resilient built environment*

## 1. Introduction

The challenge of Reinventing Cities (Sedova & Balakina, 2020; Strippoli 2020), is widely integrated in the Air-Climate Plan (PAC) (Bringault at al., 2016; Poupeau 2014) of which the Municipality of Milan has recently started the expansion process aimed at the reduction of air pollution (Ripple at al., 2019), to protect health and the environment and thus responding to the climate emergency (Crichton at al., 2009) in a certain and planned time. The challenge expands the perspective of urban regeneration action (Bamdad at al., 2021) in a concrete environmental

sense (Huovila, 2007). This challenge, together with the strong emerging demand for new generation of social, collaborative and sustainable housing (Power, 2010), effectively aligns the city to a redevelopment prospect (Carli et al., 2015). This prospect is being pursued concretely by many cities, not only in Europe (Gong at al., 2018; Harding et al., 2004; Dwikardana, 2020). The redevelopment is achieved both through the adaptation of the instruments of the Plan and therefore normative (Boddy & Parkinson, 2004), and through the facilitation of private interventions oriented in this direction (Kline, 2000). These strategic objectives, naturally integrated with the morphological characteristics of the area of intervention by invitation to tender, are the guidelines of the presented project. The area is located in a suburban area to the northeast of the city of Milan, aligned on the radial route of Viale Palmanova. In this area the building density is soon interrupted by the green section of the Lambro Park and by proximity agricultural residues linked to the ancient rural system (Toccolini at al., 2006). In fact, there are farmsteads and irrigation ditches. The area participates in that morphological complexity made up of fragments - traditional fabric, open building and large single-functional complexes - separated in a rather drastic way from the Palmanova/Surface metro system - just like a river - from the historical agglomeration to the north, that is the core of the village of Crescenzago (Ambrosiani & Quadri, 2020). This subway represents one of the main resources for both banks, however they are connected to each other only by a cycle/pedestrian underpass. As in many suburban areas, this 'shore' seems to lack a centre for the social and daily life of its inhabitants (Dalton et al., 2008). Although it has multiple services and connections, in fact, there is a lack of places of aggregation (Graham and Aurigi, 1997) and the whole area appears dominated by a peripheral tranquillity at the limit of anonymity (McQuire, 2017). The main goals of the project are to reconnect the territorial fragments, provide quality architectural spaces, promote a new concept of green as a social enabler and boost sustainability of the intervention by achiving the Carbon Neutral District.

## 2. Methodology

The poject methodology can be organized in fondamental steps that are used to create the space and the services in a coodinated and oriented way towards sustainability and efficiency based on archetipical local and cultural factors:

- *Study of the exisitng green system and morphology*: The project stares at the system of farmsteads and ancient irrigation ditches emerging in the morphology of the Lambro Park. Today's farmsteads are characterized by super local social services partly linked to the production of proximity. In many ways, these farmsteads are a resource for the area, nevertheless they are also, and above all, a settlement and functional reference point for the organization of the intervention. The intervention is developed around the concept of community.
- *Creating space for social interaciton and community growth*: Community means in particular an idea of mixed development, which provides a typological variety of housing. It is oriented to include not only a greater variety from a social point of view, a prerequisite of a community, however, it includes the different activities of a collective nature, varied in different commercial, productive or service types. In this sense the project is generated precisely by the relationship between open space and the buildings that contain it, namely the square or the open hand, that gives the name to the renovation project. This relationship defines the different degrees of fruition, public, semi-public, social and private. It outlines the flow of activity between and within the built margins, in relation to the transit generated by the interchange system between the bicycle and fast transport (the underground MM).
- *Definition of the connections with the city*: The transit considered also comes from the pedestrian cycle connection with the historical fabric through the existing underpass, which has been upgraded through its connection with new hypogeous square. The square also intercepts the flow between the built city and the transition city scattered in the green Milanese metropolitan area, towards the neighbouring villages and the San Raffaele system. In short, an idea of flow that gives shape and quality to the internal and external spaces of the new complex.
- *Funcional segmentation and integration:* The idea favours the integration between social services and commercial and productive functions located at the bottom, even on a larger scale between the community to be settled in the upper residential floors and the neighbourhood. In the centre of the large pedestrian public space is the weekly market, a symbol of the social, environemental and economic sustainability pursued by

the project. Furthermore, the market is a symbol of the civil and cultural value of sharing, it is a meeting place, together with personal services and other commercial activities of proximity. Next to it, the daily flow of connection to the Crescenzago stop of the MM, correspondingly participated by various public spaces and services that overlook it, also coming from the other side. Putting cycling, intermodal and zero-emission mobility at the centre of the intervention allows to combine the most significant challenges with the issue of community and social housing.

- *Green infrastructure to connect the intevention to the city and support the carbon zero target:* Alongside it, there is a strong forestation action through the requalification of the more or less spontaneous greenery existing inside the former car park. This action is integrated to the new constitution of urban vegetable gardens linked both to the social residence and to the district with the character of rotation, with the various services that these involve.

## 3. Case study: La Main Ouverte project

As described above, the project La Main Ouverte is located in an area characterized by the mixture of the historical mesh of the agricultural fields, the orthogonal mesh of the most recent development coming from Via Padova. The partly artificial and partly natural sediments of the Martesana and the Lambro rivers are added to this mix. From this system emerge the 18th century holiday homes on the Martesana, such as Villa Lecchi, the Romanesque Church of Santa Maria Rossa and the Lambro Park. The park, in this part, with its farmsteads and its waterway, certainly offers suggestive views. The history of the eastern area of Milan is linked over time to avant-garde phenomena: it was visited in the mid-19th century by partisans of the Risorgimento (who found themselves in a trattoria in Turro, now Piazza del Governo Provvisorio), a destination of pilgrimages by realist artists of the 1940s. Moreover, destination of libertarian happenings in the 70s for the "naked king". Zone of commitment and underground creativity in the 90s with Leoncavallo and Transiti social centers. Today, this area of Milan is similarly frequented by well-known rappers and street artists, although it is a residential area. It appears to be an important resource for Milan, consequently, to be enhanced. The proposed "social housing" project catches its main reason in the presence of the Lambro Park, in the overcoming of the "great river" consisting of Via Palmanova and the connection with the Milanese underground. The project focuses in particular on three objectives on an urban scale. The first objective is the creation of a centrality for Crescenzago east, now missing, through the creation of a green axis towards the Lambro Park. The second objective aims to give shape to a fabric of link with the existing building and natural segment. Therefore, the third objective supports the fluid connection with the "old" Crescenzago through the enhancement of the existing cycle and pedestrian underpasses, offering visual references consistent with the Milan - Bergamo road axis. The closest existing urban fabric is composed in a rather rhapsodic way of 4, 5 and 7 storey residential buildings from the 1970s. It likewise includes a 2-storey terraced economic buildings. The urban pattern contains besides a more recent cluster system of 5 and 9 floors which is the result of a more recent design competition wanted and realized by the Municipality of Milan. The reading of the fabric is further complicated by the large production and tertiary buildings in the north-east of the former Rizzoli, defining, a morphological complexity made up of fragments – traditional urban fabric, open building and large single-functional complexes (Figure 1). The envisaged community settled in this context is gathered around a court emblematically called La Main Ouverte, the open hand. The courtyard is defined by the volumes of the three buildings (units A, B and C set back from Via Palmanova by 30 m) developed on an open plan which find reason and measure in the relationship with the surroundings (Figure 2). They rise four floors above ground, from which stand out as many towers of nine floors.

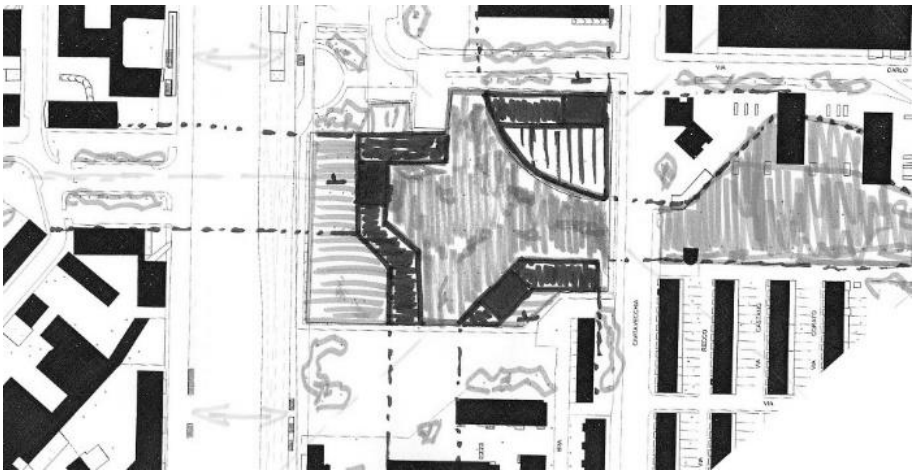


Figure 1 (a) Concept design

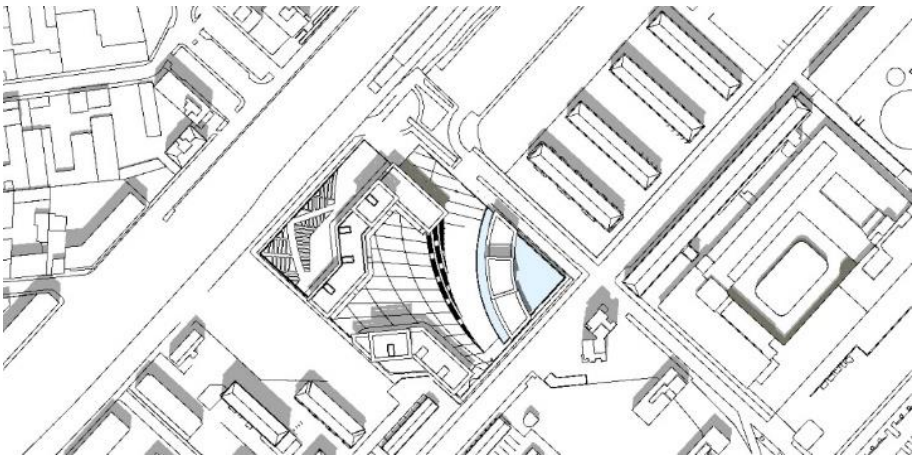


Figure 2 (b) Project definition for renovation of Crescenzago area

The towers are in dialogue with the overlooking tower house on Via Civitavecchia, thus forming a protective riverbed of the internal open space. The internal open space is organized on different dimensions that are divided into two elements for descriptive simplicity, even though it is a single reservoir. The first, the *market square*, where the weekly municipal market takes place, overlooked by bodies B and C (Figure 3). In these, the semi-public and service activities are contained on the ground floor, equipped with gardens, and reception areas raised by +1.2 m. The second, the *hypogeous square*, at an altitude of -3.50 m, which opens to transit to the north-east towards the metro, to the north-west towards the underpass and to the south towards the park. It constitutes a proposal to the city that involves a small area outside the perimeter of the project area. This area is connected to the MM stop and especially to the underpass, surrounded by commercial and service areas. It is connected by a gentle slope of about 3% towards via Civitavecchia along which there are several shops or alternatively personal services under a large porch in body A (Figure 3). The services are in continuity with the market square through a staircase with variable steps, dotted with mulberry trees. All the external paving, integrated with green tree-lined areas adjacent to the shops overlooking the public space, or to the tree-lined rows in the junction between the two squares, where even the existing trees are recovered and integrated in the design, prosperous and of greater interest, are made of permeable material such as beaten *calcestre* and characterized by a design consisting of curbs and stairs in light-colored hard stone, for a total of 6’029 square meters, which together with the green areas of the gardens and the green appurtenant add up to 10’455 square meters, or over 70% of the surface between green and permeable.

## 3.1 Open and close space organisation

The outdoor open space, apart from the related gardens, which mostly constitute small private vegetable gardens of the residences in front, is instead made up of green areas. In general, they are equipped with urban vegetable gardens for the district use, with different possible management expressions. For example, urban farming, or vegetable

gardens in rotation, equipped with huts, greenhouses, possible nurseries crossed by bicycle and pedestrian paths. In this sense, similarly here it would seem important and consistent with its function, to involve for similar use the disused state-owned riverbed located south-west of the area to ban, therefore outside the project area. In this area there could be more space for the vegetable gardens, but correspondingly equipped with pergolas. In this way a design imprint born from the context is underlined, oriented to critical regionalism and aimed at a de-globalized architecture. As we have said, the ground floors of the buildings overlooking the inner courtyard are, in principle, all service activities. In this way, buildings B and C overlooking the market square and equipped with reception areas raised by +1.2m. This threshold reconciles public space and private or service space and at the same time acts as an inhabited garrison of the square and its surroundings. In particular, building C near the underground square will contain social activities connecting the two levels. On the opposite side, outside the square of the two buildings, that is, towards the portions of greenery used as public vegetable gardens, there are instead particular social residences. The latter, being on the ground floor, can more easily accommodate homes for the elderly. Or, since they are easily accessible, they can host particular study houses or laboratories on two levels, always with an open green space or private vegetable garden in front of them. The base of building A, on the other hand, consists of a 4.5m "illuminated floor" on the street front towards via Civitavecchia, intended for commercial activities of different sizes. For example, a medium shopping mall, finger food, neighbourhood businesses such as newsagents, housewares, clothing, grocery store, wine shop, tavern / bookshop, etc. in general, of interest at the scale of the neighbourhood. It is also possible to imagine, depending on the emerging demand, that these activities can be alternated with productive activities with an aggregative nature. For example, coworking spaces, art workshops, workshop/coffee shop cycle, but as well small crafts such as barbershop, laundry, shoemaker, ice-cream shop/pastry shop. Towards the courtyard, on the other hand, under the porch along the sloping hypogeous square and connecting to the MM and the underpass (Figure 4), there are commercial businesses, enabled by the traffic induced by transit to and from the Metro, but which can also easily be sized for social functions. The basement of the foundation of all the buildings is occupied by parking lots, cellars and connected by internal ramps and elevators. Since it is based on the idea of a settlement mixité, even the conceived residential system allows to manage the distribution inside the buildings with extreme ease. The accommodation between social and free residences is located on the three lower floors and in the towers with very flexible and variable housing sizes. The housing units are connected by illuminated and ventilated staircases, with a maximum of four accesses for each one. Assuming that body A is assigned to the free and B and C to the social housing, 8'205 $m^2$ of SL social residence are obtained, in the different forms of agreed or moderate rental. In addition to the 1'230 $m^2$ of personal services, located on the square floor. These spaces are at the service of the elderly, children, immigrants and disabilities. These areas can also be at the service of possible workshops and student services to be configured in different possible forms, compared to 2'892 $m^2$ of SL free residence, and 1.397sqm of SL between commercial and free production that fund substantially the operation. The 30% of the total volume built, is in fact equal to only 0.31 Ut, index of use. Each apartment is equipped with a *loggia* of about 6 $m^2$, a sort of small room to live outside that offers feedback of natural air often double and triple exposure. Other accommodations can always be easily merged into larger accommodations. Principles that allows to imagine more or less pushed forms of cohousing, with the placement of common service spaces to give more space for private use, even for social housing. They can be for example: laundry, reception/lobby room, living/ guest house/common kitchen, study room/library, utensils, gym, swimming pool lounge, common room, music room, etc.). Last but not least, the settlement of different generations, young and old, allows to trigger ways of mutual support in the care and distribution of individual times. The roofs of the buildings naturally host some elements of planting, but for the most part, they are common space configured as a roof garden, with spaces for games and vegetable gardens. They are protected by a crowning canopy projecting outward of 1,6 m to support a circle of photovoltaic panels. In terms of construction, the design was based on a buildings' structural framework of 6,4x6,4m. The structural mesh is designed to allow all spaces to be modulated both in the traditional way, with ordinary 30x40cm pillars and thick reinforced concrete beams, and in x-lam or drywall. However, in buildings with a social purpose, where a rather intense turnover of guests is desirable, the flexibility of the traditional structure is relevant. The use of lightweight internal partitions therefore remains the solution even with the most competitive economic balance sheet.

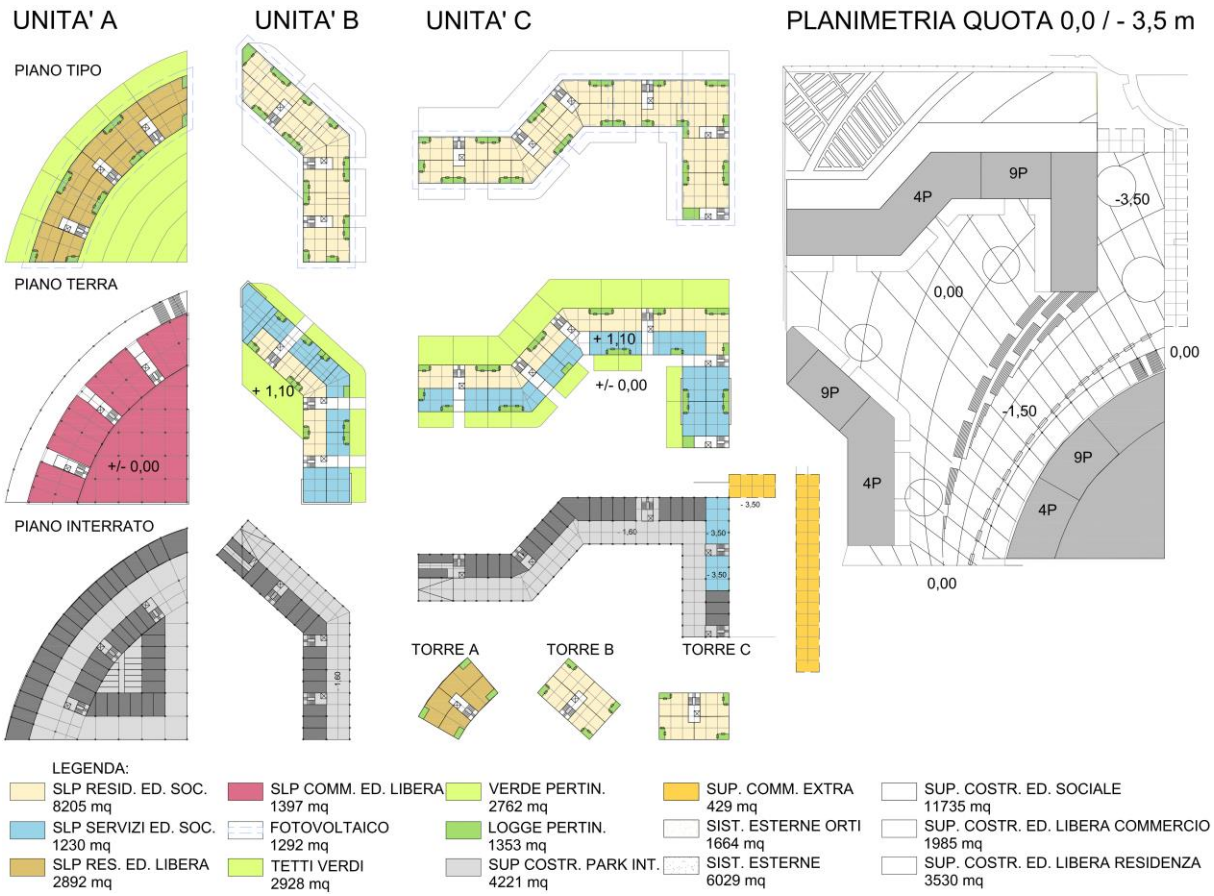



Figure 3 (a) Uses in the different Units

Figure 4 (b) underpass and connection with the city.

Finally, the external cladding of buildings is naturally based on the principles and materials of bio-architecture. They are composed of bush-hammered brick facades, with reference to the nearby Romanesque church of Santa Maria

Rossa or the glorious buildings in the Feltre district. The inserts of the window compartments are equipped with external sliding shutters, coloured in bright colours like the window frames, protected by flashings.

## 3.2 Sustainability and energy aspects

The residential portion accounts for a majority share of the built area of 78% while services account for 9% and the trade section covers a share of 13%. Considering also the green areas that are an integral part of the functional program of the project, however, the distribution is 58% for the residence, 26% of green areas distributed on the ground and on buildings, 10% for commercial areas and 6% for services for social housing. These account for 74% of the share of residences, while 26% is free building. The energy uses of the various functions weigh more from the point of view of electricity consumption as the building will be thermally efficient thanks to insulation and thermal mass (Uav,op = 0.16 W/m$^2$K; Uw = 1.1 W/m$^2$K) and will use low energy content materials in LCA (Life Cycle Assessment) and equipped with EPD and the use of efficient systems. The buildings will in fact be equipped with heat pump systems powered by electricity from solar renewable energy. The heat pump systems will be of the vertical geothermal probe type or with active foundations for the production of heating, cooling and domestic hot water. A centralised VMC (controlled mechanical ventilation) system will be used in commercial spaces while for the residential section natural ventilation will be maximised, possibly integrated locally.

57% of energy uses will therefore be for electrical uses, including kitchens, while 20% will be used for the preparation of domestic hot water, 14% for space heating and 9% for cooling. The use of the green system as a characterising element will also reduce the need for local air conditioning thanks to wind protection (in winter) and solar shading (in summer), with energy savings of up to 15%. In the calculation of the potential of the site, a conservative estimate has been used considering the $CO_2$ assimilated and stored by the plant apparatus and not the $CO_2$ avoided thanks to the reduction of the temperature of the site and therefore for cooling, which in any case will benefit the project. Below are the Key Performance Indicators (KPIs) of the project (Figure 5, Figure 6)).

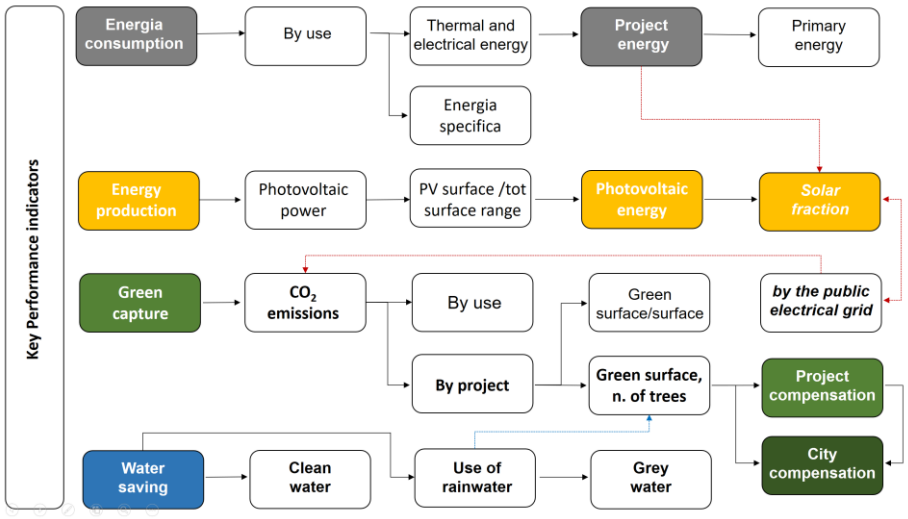



Figure 5 (a) Key perfformance Indicators


Figure 6 (b) Uses and consumption distribution diagrams

In order to carry out a zero-impact project, the energy consumed for winter and summer air conditioning, ventilation, domestic hot water preparation and electrical uses was considered. This energy is produced by high-efficiency plants powered by renewable sources for the pursuit of a near-zero energy settlement whose emissions are absorbed by the plant that is part of the project and that allows to achieve a neutral and indeed positive balance, i.e. to provide oxygen to the city as well as making the project zero impact. Therefore, the absorption by the green areas on the roof and in the square has been calculated, in addition to the planned plant essences, to connect the new settlement to the Lambro park using native or naturalized essences and paying attention to the seasonal and maintenance effects of the greenery as well as the ornamental value and the effects from the point of view of $CO_2$ absorption. Water saving has also been included among the KPIs and the use of rainwater for compatible uses is expected.

## 3.3 Strategies for the 10 Climate Challenges

The project is the result of the analysis of the specificity of the site with respect to the built, natural and biological and social context. The project has in fact considered the social support activities present in the territory as an integral part for the inputs of the project proposal. The project provides strategies and actions for all the proposed challenges with respect to the specificity of the area of intervention. It enhances the resources and constraints of the territory that in this case allow a strong relationship of the intervention with three areas. The first is represented by the public park. The second is the infrastructure for the connection and distribution of public transport passenger flows that is reorganized and implemented, correlating the activities included in the buildings in the community social fabric that allows to promote inclusive actions that operate in parallel. The third is the activities of the local Onlus that deal with culture, pedagogical methodologies oriented to the recovery of social discomfort and work for the protection and social cohesion at wide range. The 10 Climate Challenges proposed by the call are the basis of the reflection on the project. From these challenges develops the configuration of the proposed settlement for the Crescenzago site even before a morpho-typical concept (Figure 7). Compared to the 10 Challenges, therefore, the reduction of the environmental impact generated by carbon emissions from all proposed activities was considered in the first instance. In the second instance, high efficiency buildings were considered with regard to the energy containment carried out by the building-plant system. Below is the relational model that shows the transversal of the strategies and technologies adopted. They make it possible to respond to several challenges at the same time, placing the user and the promotion of sustainable behaviour at the centre.

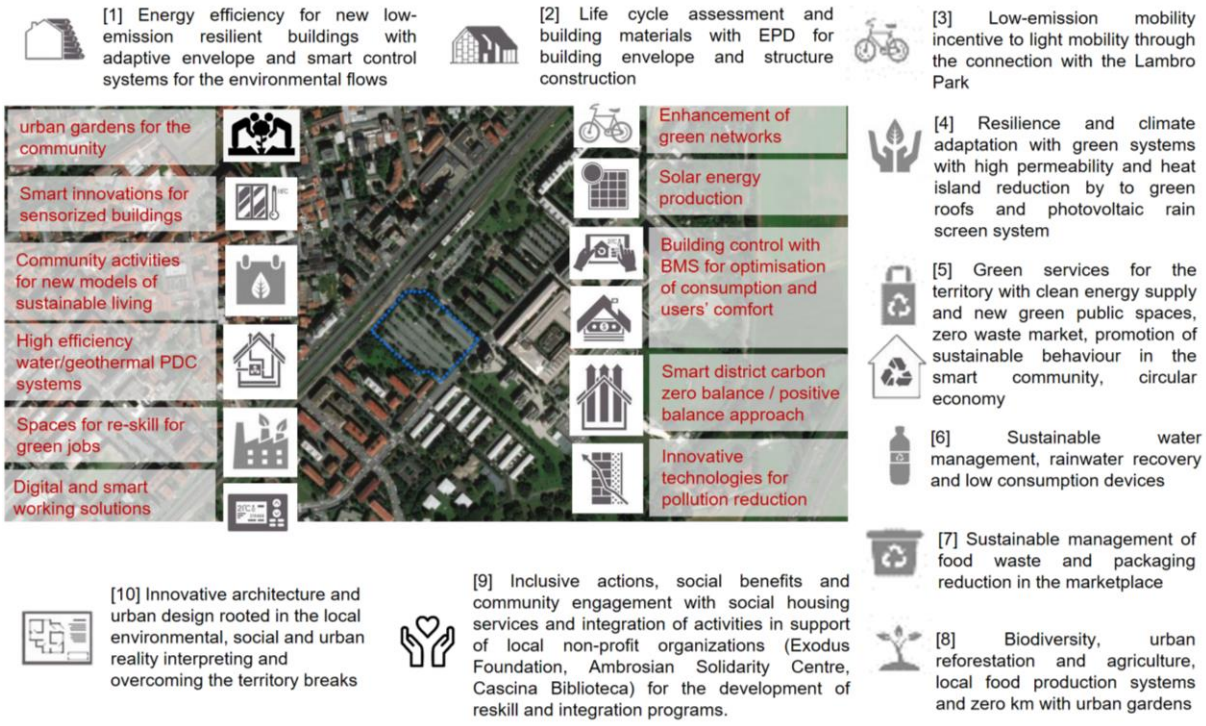



Figure 7 (a) The Reinventing cities challenges and the project strategies.

In the diagram (Figure 8) the largest nodes are the ones that have the most connections. It can be seen that many strategies of the project support the mandatory challenges of energy efficiency and sustainable materials management and circular economy while the connection between the two themes is represented by the central action of promoting sustainable behaviour in the smart community (red dots). The strong environmental and social footprint of the La Main Ouverte project are evident in the diagram.

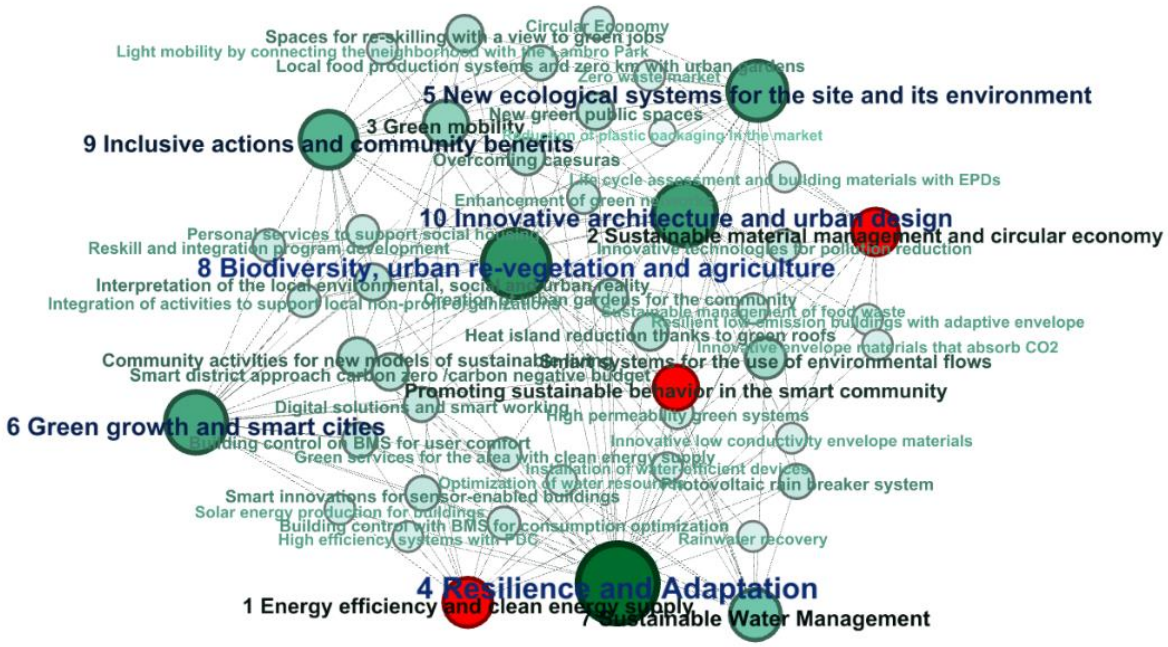



Figure 8 (a) Relational diagram of the strategies adopted considering the 10 climate challenges.

It shows how most of the proposed strategies and actions respond to the challenges of resilience and adaptation, biodiversity-urban biodiversity and agriculture, through actions related to innovative architecture and design, smart cities, inclusive strategies and new ecological systems. The proposed strategies, actions and technologies make it possible to respond simultaneously to several challenges by showing the systemic vision that has guided the project that addresses all the challenges of the call for proposals.

## 3.4 Smart technologies and renewable energies

A system of photovoltaic sunshades, to protect the facades, will be installed on the perimeter of the green roof that allows a low reflection index (to reduce the heat island): The roof also allows a high permeability power of the surface (to counteract washout and excesses of extreme weather events. I.e. resilience of the system from the point of view of weather events). The green roof will be of the extensive type with high thermal and acoustic insulation and with the possibility of rainwater drainage. The water is partly absorbed by the soil and partly returned to the natural cycle through transpiration. The photovoltaic system is expected to have a peak power of 292 kWp, with Cradle to Cradle certified panels from an environmental point of view and maximum efficiency of conversion of solar radiation into useful energy.

tablThe system will be of the mixed type connected to the grid but equipped with a storage system that allows to mitigate production peaks due to climate change. In this way the grid is not totally burdened and a strategy for electricity continuity is proposed in the direction of security of energy supply (resilience and climate adaptation). In consideration of the new version of the European Directive EPBD 844/2018 for the containment of energy in buildings, the project pursues energy optimization through the “sensorisation” of environments in a smart way. This promotes virtuous attitudes and awareness of the energy effects of their lifestyle for users. Users will have the possibility to monitor the internal consumption of homes, detecting the internal conditions through significant parameters for the characterization of IEQ (Indoor Environmental Quality). These are temperature and humidity, in order to maximize savings and ensure thermo-hygrometric comfort, the illuminance, to allow to modulate the indoor

lighting compared to daylighting saving electricity, $CO_2$ and PM10 sensor for ventilation control and air pollution reduction (Figure 9, Figure 10).

Figure 9 (a) Green roofing surfaces for $CO_2$ capture


Figure 10 (b) PV panels ans smart technologies scheme.

## 4. Results

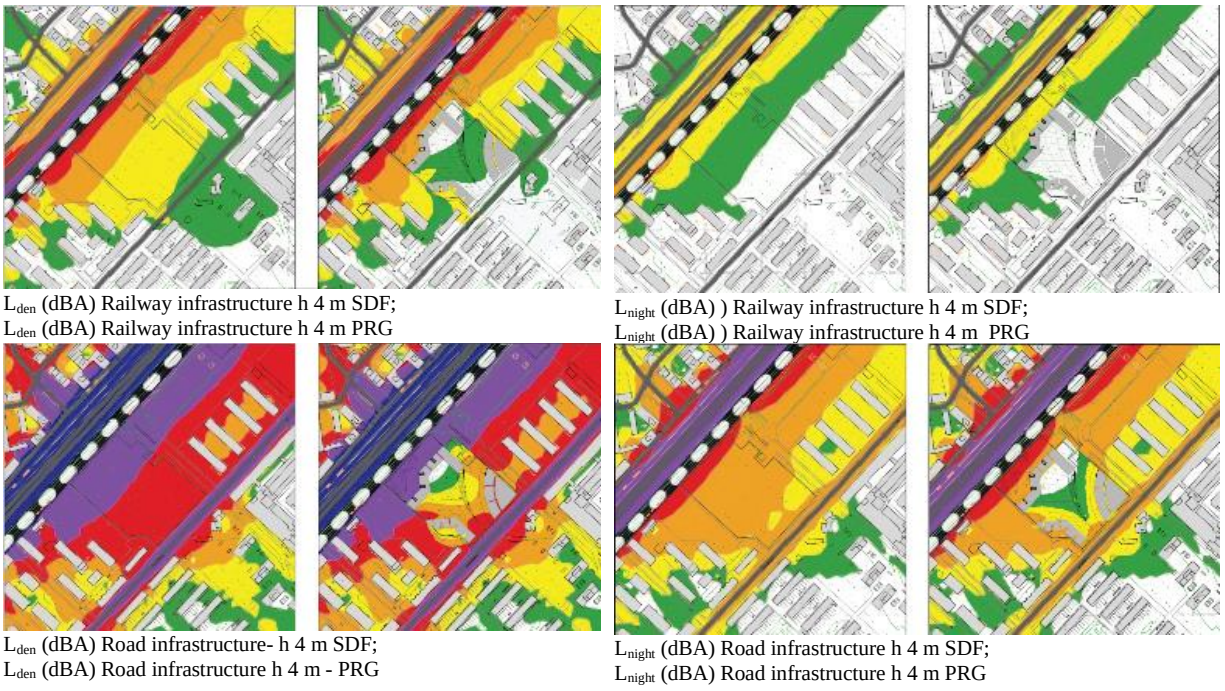
### 4.1. Acoustic design

The intervention is within the framework of the acoustic standards prescribed by the DPCM of 5 December 1997, which indicates the passive performance limits of the casing, internal and external partitions and system noise limits. The DPCM also indicates the performances relative to the internal acoustic comfort of all spaces used for collective activities, as well as those for residential use. For these spaces in particular, the requirements relating to standardised façade sound insulation [$D_{2mn,nT,w}$], airborne sound insulation [Rw] and footfall sound insulation [Ln,w] between different building units and the levels of discontinuous cycle [$LA_{smax}$] and continuous cycle [$LA_{eq}$] systems will have to be verified, also due to the design forecast in conjunction with residential and commercial functions and small laboratories and neighbourhood activities. It is also necessary to verify, according to the common procedure of the acoustic climate assessment, the respect of the emission and emission limits. For the verifications, reference is made to the provisions of art.8 of Law 447/95 and in compliance with the Piano di zonizzazione Acustica of Milan. These checks are also important in view of the presence of the Via Palmanova (type B - main suburban roads) as well as the MM2 line on the surface, relative to the Cascina Gobba - Milan axis. This line extends along the entire Via Palmanova as far as the border with the Municipality of Vimodrone (for the purposes of drawing up the Soundproofing Plan, surface underground sections are assimilated to railways), coinciding with the Cascina Gobba station.

The intervention site is identified in class IV (areas of intense human activity) by the acoustic classification of the Municipality of Milan, with LAeq limits of 65 dB(A) diurnal and 55 dB(A) at night and quality values (art.7 DPCM 14.11.97) LAeq 62 dB(A) diurnal and 52 dB(A) at night. The input limit values are extended to 70 dB(A) diurnal and 60 dB(A) nocturnal since the area is included in band A, referred to in Article 3, subparagraph 1, letter a) of DPR No.

459 of 18/11/1998. With reference to the Piano di Azione 2013 for the Milan Agglomeration - DL 194/2005 "Implementation of Directive 2003/49/EC relating to the assessment and management of environmental noise", the part relating to the area of interest that shows the mapping of day-night and night noise related to road and rail traffic (MM2) is deleted, verifying graphically the variations following the inclusion of the project plan. The diagrams exemplify the acoustic criteria that partly guide the positioning and sizing of the new building curtains. In particular, the body of the building on the side of Via Palmanova, whose facade wire placed about 45m from the axis of the underground line tracks and about 53m from the road axis of Via Palmanova, is prudentially spaced from the two environmental noise generators. It also shields the rest of the settlement (Figure 11, Figure 12).


Figure 11 (a) Acoustic situation of the area



$L_{den}$ (dBA) Railway infrastructure h 4 m SDF;
$L_{den}$ (dBA) Railway infrastructure h 4 m PRG

$L_{night}$ (dBA) ) Railway infrastructure h 4 m SDF;
$L_{night}$ (dBA) ) Railway infrastructure h 4 m PRG

$L_{den}$ (dBA) Road infrastructure- h 4 m SDF;
$L_{den}$ (dBA) Road infrastructure h 4 m - PRG

$L_{night}$ (dBA) Road infrastructure h 4 m SDF;
$L_{night}$ (dBA) Road infrastructure h 4 m PRG

Figure 12 (b) Acoustic analyses related to the main roads and railway.

The design configuration promotes a significant reduction in noise pressure in correspondence with the new square. It is planned on a double level and extends to a lower level as far as the entrance to the pedestrian underpass in Via Palmanova with access to the underground station. In this way it offers a precious opportunity for the creation of protected collective spaces characterized by low sound input levels within better standards of environmental comfort. In compliance with the input, emission and differential limits provided for by the regulations and the acoustic zoning plan, all the necessary measures must also be taken to ensure that the sum of the sound levels due to the anthropic contribution, the plant engineering contribution (U.T.A.) and the contribution from road traffic induced by the new activities installed do not exceed the permitted limits. Finally, with regard to the above-ground underground section, ATM has drawn up the Piano d'Azione pursuant to Legislative Decree 194/05 "Implementation of Directive 2002/49/EC relating to the assessment and management of environmental noise". For the above-ground underground section between the Udine - Cimiano - Crescenzago stops, vertical soundproofing barriers will be installed to replace the current rail fence. For the area of interest, this Plan provides for the construction of a barrier 300m long and 4m high, which is expected to be completed within the twelfth year of implementation of the Plan (2024).

## 4.2. Green design

In general, to widespread greenery has a great importance in the project. The roofs of the new buildings, almost 3'000 $m^2$, are configured as extensive roof gardens. They include some intensive inserts that make it possible to integrate both vegetable gardens available to condominiums and more decorative plants in the subdivision given by the walkways equipped with playful neighbourhood functions. Above is the reason for the constructive benefits in terms of insulation and induced energy savings. No less, in the public spaces of squares and gardens we think it is crucial to maintain a balance of the microclimate through the insertion of rows of vines. In particular in the squares where there are many activities related to services and exercises located on the ground floor of all buildings. For this reason, we have inserted, where possible, rows of Morus nigra in the tiered areas, characterized by relatively high foliage and also edible red fruits. In the parking areas, on the other hand, where the design of the ground is enriched with additional greenery and equipment for administration or work, we have introduced large celtis australis, solid and of great urban and Milanese tradition, partly taken from the existing greenery design. For the private and rotational vegetable gardens in treated soil along the western border, on the other hand, the design is built from the projections of the shadows of the buildings during the solstice periods, characterized by the easily manageable modular design of 1.60m and service corridors between them (Figure 13).


Figure 13 (a) Architectural configuration and activities/strategies.

## 4.3. Site potential calculation model

A calculation model for the energy balance of the La Main Ouverte project was used from the very first phases of the functional distribution in order to verify in real time the impact and the resources to be deployed to meet the objectives of energy efficiency and reduction of environmental impacts. Indeed, the energy needs for heating, cooling, ventilation, domestic hot water production and consumption for electrical equipment and distribution spaces (service uses) for the various sectors were considered. The thermal, electrical and primary energy shares of the project have been calculated (Table 1). The Building integrated Photovoltaic (BiPV - Building integrated Photovoltaic) system allows to produce 82.5% of the electrical needs of buildings that include all uses, while 17.5% of the energy will be taken from the grid or stored; in the calculation in any case the grid is conservatively used as a reservoir and therefore a share of emissions that must be absorbed by the green system (Table 2). The photovoltaic system optimizes the positioning using a horizontal inclination so that it can become extensive on the perimeter of the roofs of buildings without distinction of orientation and in order to simultaneously perform a building function of protection of the facades from rainwater. As far as water saving is concerned, there will be a reduction of 30-50% of white water and 100% of grey water, using rainwater for compatible uses in buildings and for irrigation (Table 3).

Table 1. Energy consumption of the project

| Energy Consumption | Unit | Housing | Services | Commercial |
|---|---|---|---|---|
| Thermal energy | | | | |
| Heating | kWh | 221’940 | 12’300 | 18’260 |
| Cooling | kWh | 110’970 | 24’600 | 36’520 |
| DHW | kWh | 355’884 | 7’580 | |
| Electricity | | | | |
| Appliances | kWh | 110’910 | 18’904 | 35’420 |
| Services | kWh | | 7’296 | |
| Total eletrical energy | kWh | | 406’304 | |
| Total primary energy | kWh | | 983’257 | |
| Specific primary energy | kWh/m2 | 69.68 | 60.58 | 64.53 |
| Total Specific primary energy | kWh/m2 | 69.47 | | |

Table 2. Energy production of the project

| Energy production | Unit | Housing | Services | Commercial |
|---|---|---|---|---|
| Nominal PV power | $kW_p$ | | 292 | |
| PV surface /project surface | $m^2/m^2$ | | 0.091 | |
| PV production | kWh | | 335’036 | |
| Solar fraction | % | | 82.5 | |

Table 3. Water saving of the project

| Water saving | Unit | Housing | Services | Commercial |
|---|---|---|---|---|
| Clear water saving | % | 50 | 30 | - |
| Grey water saving | % | 100 | 100 | 100 |

The green absorption will take place through green roofs and the planting of an urban forest of trees and shrubs (≤10% single species, ≤20% same genus, ≤30% species of the same family) chosen with respect to the compatibility with the uses of the square, maintenance and durability of the systems in addition to the specific absorption capacity and it will be possible to absorb all the $CO_2$ resulting from the share not covered by Solar Fraction (share of electricity from photovoltaic sources) and also to absorb a greater share of $CO_2$ serving the area and the city (Table 4). In this configuration the new intervention and the green infrastructure are creating a zero carbon settlement and a system that can improve significanlty beyond the border of the intervention area and it is beneficial for a brader city context. The approch and the calculation model can be adopted and replicated for achiving the eficiency targets in similar renovation actions and the results can raise awarness about the energy impact of different building uses. Ths can be remakable when new mixed uses settlements are required and critically approached.

Table 4. $CO_2$ emissions capture by greenery

| Green Capture | Unit | Housing | Services | Commercial |
|---|---|---|---|---|
| $CO_{2e}$ emissions to capture | $tCO_2$ | | 30.87 | |
| Green surface (square, green rooftops) | $m^2$ | | 5104.4 | |
| Project Green surface / $m^2$ | $m^2/m^2$ | | 0.36 | |
| Trees for carbon absorption | n. | | 30 | |
| $CO_{2e}$ emissions compensated | $tCO_2$ | | 34.28 | |

## 5. Inclusive actions, social benefits, community involvement

For a community, the involvement of the wider physical and social territory in which it is located is intrinsic to its existence. Systemic actions involve neighbourhood relations at the most diverse scales -local or neighbourhood- as well as time - in the short or long term. The weekly market linked to the farmsteads, the local social, cultural or recreational associations, the subsistence groups linked to services to the person already rooted in the territory, will be able to guide in a more concrete way the choice of services and equipment to be installed. Therefore some actions starting from the various realities already existing, combined with the potential of space and functions existing in the project La Main Ouverte are listed (Table 5).

Table 5. Actions for community cultural growth.

| Sector | Activities and cultural renovation |
|---|---|
| Culture and art | a programme of artist residencies, mentorship projects and musical, artistic, cultural and multimedia workshops. On the long term, actions already experienced as a festival of participated music, protagonists the citizens and that, starting from the central square, extends throughout Mano Aperta until the original settlement of Crescenzago, the metro station and beyond. |

***Table 5 continued***

| | |
|---|---|
| Nature and Sustainability | an annual calendar of workshops for different age groups with Cascina Library on Garden Culture and Sustainability, zero-kilometre agricultural production, gardening. |
| Knowledge and memory | fostering mutual support between the different components of the community, through support actions involving young people, teachers, neighbourhood associations and parents, promoting the meeting between "memory bearers" (adults and seniors) and young people. The result can be a "participated" documentation that can give life to blogs, web radio or community podcasts in the neighbourhood. An exchange of knowledge between generations that is of skills and "know-how": by the elderly linked to more traditional and artisan activities, by young people to technological and digital practices: a perfect definition of community of co-workers and workshops. |
| Associations and companies | The exchange of knowledge on a larger scale, with the locally already active associations -cyclotourism associations or local craftsmen- to create a Ciclofficina or a social carpentry shop that becomes a meeting point and a space for collaboration of the inhabitants. Particular attention will be paid to developing, together with the private companies present - e.g. RCS and Sony - incubation of activities and training courses that provide the skills needed to enter the world of work. |

## 6. Conclusions

The project promoted the development of a social housing with services and mixed use in the area of Crescenzago, Milan, using the public space and the community aggregator of the local market as a key activity for social development and design enhancement. The climate challenges adopted to define the guidelines of the Reinventing Cities contest are used in the project to shape the morphology of the architectural intervention. The project La Main Ouverte recalls the open hand and the space of the square as a fiduciary environment where social interaction are promoted and sustained to create a strong sense of belonging and community. The sustainability aspect has a key role in the project choices, the three pillar of environmental protection, economic affordability and social progress are all strongly included in the design, and strategies for the carbon zero intervention. The cooperation between built environment and natural environment achieves the goal to propose a zero carbon settlement with a buffer of $CO_2$ absorption, which can be seen as a contribution for the city beyond the housing settlement and boundaries. The calculation model developed and tested in previous C40 competitions, has been adopted to outline the energy needs and environmental impacts related to the project framing a robust methodology for organizing a zero carbon new development while the social aspects are boosted and implemented. Measures of energy efficiency, materials' choices, renewable energy production, water saving and green systems are interconnected to organize a structured systemic approach replicable and scalable in renovation interventions that are improving our cities and abandoned areas in need of a advanced paradigm shift. Sustainability and the zero carbon goal are now part of the architectural quality that is not more only defined by refined design and morphology nevertheless it includes the principles of the SDGs (Sustainable Development Goals).

**Acknowledgements**

The authors want to acknowledge the following colleagues and partners for their crucial contribution to the project phase: Francesco De Agostini founder of DeAgostiniArchitetti, International Laboratory of Architecture and urban Design ILAUD, Milan and Lorenzo Serafin for the acoustic focus. Moreover, the authors want to mention: H+ S.r.l. for the integrated socio-cultural activities design, Alberto Campolongo of Immobiliare Porpora Loreto S.r.l., Alberto Lunghini of Reddy's Group S.r.l. for their support and enlightening discussion.

## References


Sedova, A., & Balakina, A. (2020) Reinventing cities towards being smarter. In IOP Conference Series: *Materials Science and Engineering*, , Vol. **869**, No. 2, p. 022023. IOP Publishing, https://doi.org/10.1088/1757-899X/869/2/022023

Strippoli, V. (2020) Project role for climate change in the urban regeneration. Reinventing cities winning projects in Milan and Rome. *TeMA-Journal of Land Use, Mobility and Environment*, **13**(3), 375-388, https://doi.org/10.6092/1970-9870/7158

Bringault, A., Eisermann, M. and Lacassagne, S. (2016). Cities Heading Towards 100% Renewable Energy by Controlling Their Consumption, Food For Thought And Action, pag 1-28, ISBN : 978-2-919083-09-1

Poupeau, H. (2014) Adaptation of the Climat Pratic support tool to the Air Climate Plan and the context of the Grenoble-Alpes-Metropole agglomeration community; Adaptation de l'outil d'accompagnement Climat Pratic au Plan Air Climat et au contexte de la communaute d'agglomeration Grenoble-Alpes-Metropole, RN:50020495

Ripple, W., Wolf, C., Newsome, T., Barnard, P., Moomaw, W., & Grandcolas, P. (2019) World scientists' warning of a climate emergency. *BioScience, Volume* **70**, Issue 1, January 2020, Pages 8–12, https://doi.org/10.1093/biosci/biz088

Crichton, D., Nicol, F., & Roaf, S. (2009) *Adapting buildings and cities for climate change*. Routledge, ISBN 9781856177207

Huovila, P. (2007) *Buildings and climate change: status, challenges, and opportunities*. UNEP/Earthprint, https://wedocs.unep.org/20.500.11822/7783

Bamdad, K., Cholette, M. E., Omrani, S., & Bell, J. (2021) Future energy-optimised buildings—Addressing the impact of climate change on buildings. *Energy and Buildings*, **231**, 110610, https://doi.org/10.1016/j.enbuild.2020.110610

Power, A. (2010). Housing and sustainability: demolition or refurbishment?. *Proceedings of the Institution of Civil Engineers-Urban Design and Planning*, **163**(4), 205-216, ISSN 1755-0793

Carli, R., Dotoli, M., Pellegrino, R., & Ranieri, L. (2015) Using multi-objective optimization for the integrated energy efficiency improvement of a smart city public buildings' portfolio. In 2015 *IEEE International Conference on Automation Science and Engineering* (CASE) (pp. 21-26). IEEE, https://doi.org/10.1109/CoASE.2015.7294035

Gong, M., Ouyang, J. L., & Ge, J. (2018) Energy-efficiency renovation measures of existing residential buildings and their effects on reducing energy use and CO2 emission——Taking Hangzhou city in the hot summer and cold winter region as a case study. *Journal of Zhejiang University (Engineering Science*), **10**, 1822-1827

Harding, A., Deas, I., Evans, R., & Wilks-Heeg, S. (2004) Reinventing cities in a restructuring region? The rhetoric and reality of renaissance in Liverpool and Manchester. *City matters: competitiveness, cohesion and urban governance*, 33-49, https://doi.org/10.1332/policypress/9781861344458.001.0001

Dwikardana, S. Reinventing Cities as Global Players. *Jurnal Ilmiah Hubungan Internasional*, 2020, 95-102.

Kline, E. (2000) Planning and creating eco-cities: indicators as a tool for shaping development and measuring progress. *Local Environment*, 5(3), 343-350, https://doi.org/10.1080/13549830050134275

Boddy, M., & Parkinson, M. (Eds.). (2004) *City matters: Competitiveness, cohesion and urban governance*. Bristol University Press,Policy Press, https://doi.org/10.2307/j.ctt1t89c01

Ambrosiani, J., & Quadri, I. (2020) La rinascita del Naviglio Martesana: un nuovo centro per Crescenzago, Thesis, Poltecico di Milano.

Dalton, T., Horne, R. E., Hafkamp, W., & Lee, M. (2008) *Retrofitting the Australian suburbs for sustainability.* Steering sustainability in an urbanising world: Policy, practice and performance, 215-225, Ashgate Publishing Ltd, http://trove.nla.gov.au/work/32070113

Graham, S., & Aurigi, A. (1997) Virtual cities, social polarization, and the crisis in urban public space. *Journal of Urban Technology*, 4(1), 19-52, https://doi.org/10.1080/10630739708724546

McQuire, S. (2017) *Geomedia: Networked cities and the future of public space*. John Wiley & Sons, https://doi.org/10.1080/08111146.2019.1571155

Toccolini, A., Fumagalli, N., & Senes, G. (2006) Greenways planning in Italy: the Lambro River Valley greenways system. *Landscape and urban planning*, **76**(1-4), 98-111, https://doi.org/10.1016/j.landurbplan.2004.09.038