

# Urban Renovation: An Opportunity for Economic Development, Environmental Improvement, and Social Redemption



Paola Caputo, Simone Ferrari and Federica Zagarella

**Abstract** This study finds its origin within the framework of the EU-cofunded UIA-OpenAgri project, fostering the creation of small and medium enterprises in the agri-food sector, through the lens of circular economy, while also promoting the urban regeneration of a degraded peri-urban area and social inclusion of disadvantaged people. The project is led by the Comune di Milano and involves 16 partners. The ABC Department participates mainly by contributing to energy and environmental evaluations and also by supporting with tools and indicators. The first part concerned the preliminary analysis of the energy uses and potential renewable supply in the area. Within this framework, a preliminary design was included of the building energy retrofit of Cascina Nosedo, an ancient farmhouse. Other parts focus on the assessments of the food chains involved in the agricultural lands which are involved in the project.

**Keywords** Agri-food · Food chains assessment · Jobs and skills development · UIA-OpenAgri · Rur-urban · Circular economy

## 1 Introduction

In Europe, over 70% of the total population lives in urban areas, which can reasonably play a key role in pursuing a sustainable development (UIA Web site). In order to provide urban areas with resources to test innovative solutions to the main urban challenges, the European Union (EU) has launched a set of initiatives named ‘Urban Innovative Actions’ (UIA). Among the challenges faced, a lively debate looks at the strategic role of the agri-food sector in ensuring sustainable urban development. Broadly speaking, the agri-food sector has multidimensional implications on the economy, society, health, and the environment and is interconnected with several sectors in mutual competition for resource exploitation, e.g., fishery, forestry,

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energy, and transportation. On a worldwide level, food production is responsible for about 30% of end-use energy, 70% of global freshwater withdrawals, and 22% of greenhouse gas emissions. Given the expected increase in the global food demand, in step with population growth, and the ongoing dietary changes due to cultural and technological attitudes, policies increasingly encourage this sector's transformation, promoting innovative agricultural practices with a reduced use of land, water, fertilizers, and energy (FAO 2017).

In this framework, under the UIA umbrella, the project 'OpenAgri-New Skills for new Jobs in Peri-urban Agriculture' (UIA-OpenAgri Web site) was launched in order to foster the creation of small and medium enterprises (SMEs) in the agri-food sector, while also promoting urban regeneration of a degraded peri-urban area and social inclusion of disadvantaged people. In detail, it promotes: an inclusive, coherent, and reflexive urban-rural food governance system; the development of an infrastructure to reduce the distance between producers and consumers and to boost circular economy; new opportunities for local quality food producers; the challenge for experimenting new forms of entrepreneurship in the agricultural sector and for creating new jobs and skills. At the core of the UIA-OpenAgri project is the creation of an 'Open Innovation Hub on Peri-Urban Agriculture' as a 'living lab' for promoting open innovation on the different dimensions of the initiative involved (entrepreneurial, social, and technological). The hub will be located in a peripheral district of south Milan, an 'urban fringe,' i.e., a peri-urban area between the urban built environment and the nearby rural areas within the surrounding parks ('Parco della Vettabbia' and 'Parco Sud'). The project site includes some existing facilities that play a key role. The ancient farmhouse Cascina Nosedo is expected to be renovated and host new functions for the coordination and promotion of foreseen activities, the agricultural area of Vaiano Valle to host agricultural enterprises; moreover, the close wastewater treatment plant (WWTP) Depuratore Nosedo, managed by Metropolitana Milanese SpA (MM SpA), and other farmhouses are important symbols of the local territory (Fig. 1).

The project involves 16 partners among municipal institutions, universities and research centers, social cooperatives, start-ups, and non-governmental organizations.<sup>1</sup> For its realization, nine work packages (WPs) have been set and the ABC Department is charged with contributing to WP7, 'Environmental modeling and impacts,' by defining and implementing analytical tools for supporting and monitoring the energy and environmental performances of the implemented project. Such analyses are divided into three main phases:

- the preliminary outline of the main energy and environmental figures of the project area (Caputo et al. 2017b), as outlined in Sect. 2;

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<sup>1</sup>Municipality of Milan, Milan Chamber of Commerce, Industry, Craft and Agriculture, Fondazione Politecnico di Milano, PTP Science and Technology Park, Milan University—UniMi, Politecnico di Milano—Polimi, Poliedra, La Strada Social Cooperative, Sunugal, IFOA—Training Institute for Enterprises Operators, Mare s.r.l. social enterprise, Food partners SRL, Avanzi SRL, Cineca, Future Food Institute, ImpattoZero SRL.



- |   |                                      |
|---|--------------------------------------|
| 1: Agricultural lands "Vaiano Valle"      | 7: Chiaravalle Abbey                 |
| 2: Farmhose "Cascina Nosedo"              | 8: Farmhouse "Cascina Gerola"        |
| 3: Farmhouse "Cascina Corte San Giacomo"  | 9: WWTP "Depuratore Nosedo"          |
| 4: Farmhouse "Cascina Grande Chiaravalle" | 10: Farmhouse "Cascina Ambrosiana"   |
| 5: Farmhouse "Cascina Carpana"            | 11: Farmhouse "Cascina Vaiano Valle" |
| 6: Farmhouse "Cascina San Bernardo"       |                                      |

Fig. 1 UIA-OpenAgri project area

- the ongoing evaluations to evaluate the energy consumption and the global warming potential (GWP) of different food chains, as outlined in Sect. 4;
- and the final phase regarding the simulation and representation of different scenarios to provide guidelines for a low energy/carbon and efficient agri-food hub enhancing local resource exploitation and its economic and social effectiveness.

## 2 Main Energy and Environmental Figures of the Project Area

At the beginning of the project, the area of Cascina Nosedo was investigated in order to define the current performance of the built environment and its relation to the natural one.

The main energy and environmental figures of the project area have been intended for both the demand and the supply sides, as to follow the concept of a metabolic analysis (Caputo et al. 2016), and have been assessed according to three different spatial scales: the urban one, the whole district one (1-km radius around Cascina Nosedo), and the one corresponding to the Cascina Nosedo buildings involved in the project.

An analysis of the district built environment has been accomplished showing that the area encompasses 220 residential buildings, the majority of which was built between 1946 and 1960, and 86 non-residential ones. For those buildings, a statistic evaluation of the energy demand was carried out according to a proven method considering building age, shape, and use category (Caputo and Pasetti 2017), as described in Fig. 2.

Regarding local energy resources, by the first draft investigation, it was calculated that the potential energy production that could be obtained by installing crystalline silicon photovoltaic (PV) panels covering 75% of the residential buildings' rooftops in the district has been estimated as able to cover 80% of the electricity consumption.



**Fig. 2** Main energy figures for the district area

However, the most important local energy source is that relating to the operating WWTP. Despite not being already exploited, the plant treats about 150 million m<sup>3</sup> per year of wastewater that can be considered as a:

- source of heat by waste or treated water;
- source of biogas in the case of anaerobic digestion of the sludge;
- source of power (or heat and power in cogeneration) in the case of biogas use in engine<sup>2</sup>;
- source of bio-methane in the case of upgrading of the biogas;
- source of power in the case of PV integration on the components.

Considering only the heating season, about 157 GWh could be made available by the WWTP to heat pumps, and supplying about 79 GWh of electricity, about 236 GWh could be made available as heating for buildings.

Another interesting source of heat could be the sewer collector (SC) located near Cascina Nosedo, since its temperature is generally between 10 and 20 °C, all year round. Considering only the heating season, about 37 GWh could be made available for heat pumps, and supplying about 19 GWh of electricity, about 56 GWh could be made available as heating for buildings.

## ***2.1 Cascina Nosedo Renovation***

The ancient farmhouse Cascina Nosedo (its origins date back to 1600 AD) is made up of 11 protected buildings around a courtyard. In the UIA-OpenAgri proposal, two buildings (called B9 and B10 in the following) were foreseen to undergo the energy retrofit (Fig. 3). Hence, to assess the feasibility of implementing energy efficiency measures and of the local RES integration, consistently with the protected buildings constraints, a conservation status survey was carried out to identify the elements and materials to be kept unaltered or restored.

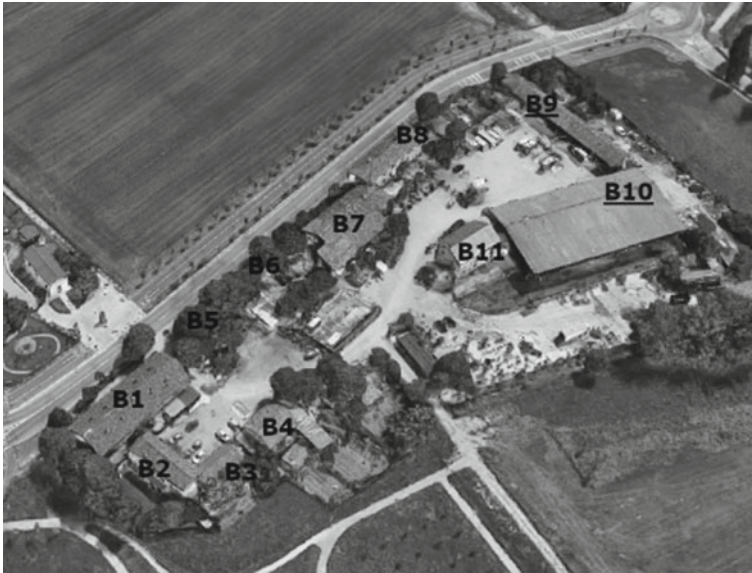
A building retrofit scenario was proposed (Caputo et al. 2018) consisting of the replacement of windows and roofs and the opaque envelope insulation from the outer side. However, based on the Superintendence's opinion, an alternative retrofit solution, regarding the insulation from the inner side of the walls, was defined. Both retrofit scenarios, having 10-cm wood fiber panels and the same thermal transmittance, have been assessed.

A building energy model was developed with the IESVE tool, by adopting hourly data on internal gains, ventilation rates, and domestic hot water (DHW) from the swiss technical workbook SIA 2024 for five thermal zones (kitchen, restaurant, laboratory, expo/conference room, and office).

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<sup>2</sup>Sludge anaerobic digestion with Combined Heat and Power (CHP) has been adopted in some WWTPs.





**Fig. 3** Cascina Nosedo farmhouse

Then, through dynamic simulations, the energy needs for space heating, space cooling, and DHW as well as the electricity demands for appliances and artificial lights were evaluated.

In terms of annual energy needs (heating and cooling), the simulations accomplished show negligible differences between the two alternatives, while, in terms of thermal power, the external insulation scenario provides a slightly lower peak. Therefore, it can be stated that, by having an intermitting control system regime, serving many adjacent zones that are thermally independent and considering the constraints involved in a protected building retrofit, the internal insulation scenario could be the optimal solution in terms of energy behavior, architectural integration, and feasibility in this particular case of study. Of course, the results obtained are strongly affected by the software calculation method and by the assumptions carried out on the thermal zones functions that could slightly change in the definitive version of the project.

As a further analysis, considering the closed presence of the sewer collector, the possibility of extracting heat through reversible heat pumps (HPs) and exploiting it in the heating/cooling and DHW systems was analyzed. Moreover, an estimate of the potential production from building integrated photovoltaic (BIPV) was accomplished. Considering only B10, the first simulations showed that the south-western pitch presents a potential annual production of 50.7, 47.5, and 31.7 MWh in the case of monocrystalline, polycrystalline, and thin film, respectively (Table 1).

After these elaborations, the project went ahead and the executive design for the renovation of Cascina Nosedo is now in progress. Due to encountered obstacles, the renovation will consist of the refurbishment of the external floor of the whole

**Table 1** Results of overall energy evaluations for B9 and B10

Energy service	Thermal energy needs [MWh/y]		HP efficiency <sup>a</sup> [-]	Electricity demand [MWh/y]	Potential electricity production from PVs <sup>b</sup> [MWh/y]
	II	EI			
Heating	32.8	39.9	4.0–5.0	9.1–7.3	
Cooling	36.4	33.7	3.0–4.0	11.7–8.8	
DHW	3.8		3.0–4.0	1.3–1.0	
Lights				46	
Appliances				71.5	
Total				139.6–134.6	50.7

<sup>a</sup>Seasonal performance coefficient for WWHP from (Hepbasli et al. 2014)

<sup>b</sup>PVs previously calculated in the case of monocrystalline technology

complex, the realization of a new dedicated electricity cabin, and the renovation of the ground floor of B10, which is expected to be equipped with reversible air-to-water heat pumps.

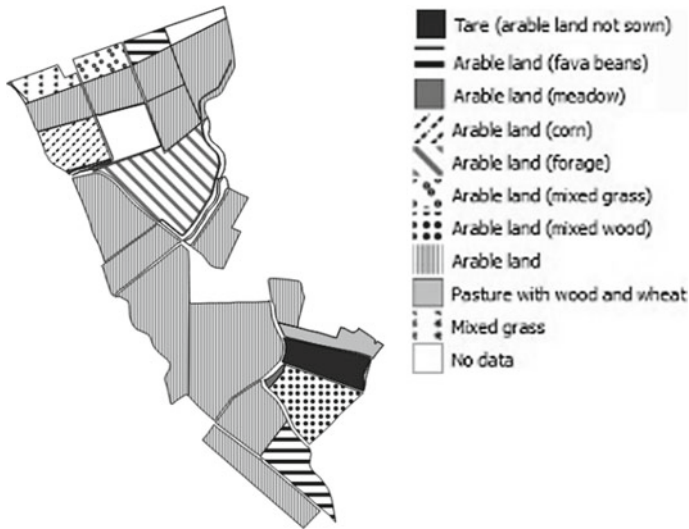
### 3 Energy and Environmental Evaluations of the Food Chains in Vaiano Valle Area

During the progress of the project, the opportunity to include an agricultural area of about 30 ha located in Vaiano Valle was presented. Despite many criticalities relating to the current abusive use, abandonment, environmental degradation, and unavailability of water for irrigation purposes, this challenging condition was integrated since it is appropriate to the implementation of an actual agri-food innovative hub (Fig. 4).

In the frame of the UIA-OpenAgri project, these lands are expected to host agricultural start-ups adopting innovative, sustainable, short, and participated food chains: ‘**AgriPorto**’ is cultivating legumes and cereals intercropped, ‘**Birra per ilCorvetto**’ is cultivating barley for brewing beer, ‘**City\_organic\_delivery**’ would have cultivated vegetables, ‘**Narrare il pane**’ is cultivating spelt for baking, ‘**Zappada**’ could cultivate vegetables, ‘**Sinergie AgriCulturali in Vettabbia**’ could set a regenerative agroforestry system (Götsch 1996) and ‘**Officine Agricole Milanesi**’ would have integrate automation and heliculture.

To provide insights into the energy-environmental effects from the UIA-OpenAgri concepts, a set of improved scenarios is defined:

- **Intermediate implementation:** already operating agricultural enterprises (i.e., the ones that have proceeded with crop sowing by 2019) and state of the art of the B10 retrofit;



**Fig. 4** Vaiano Valle area consistency before the OpenAgri project

- **Design scenario:** all the foreseen agricultural enterprises, considering the current drawbacks of the project (e.g., lack of water) and B10 retrofit;
- **Ideal scenario:** similar to design scenario but with all the needed resources (e.g., water);
- **Optimal scenario:** as ideal scenario but with an optimization of food chain management and all Cascina Nosedo buildings retrofitted.

The different scenarios have been compared to each other and to a ‘Scenario Zero’, i.e. referring to a different and more impactful agricultural use of the area.

The different food chains implemented in the framework of the project are investigated in order to evaluate the fossil cumulative energy demand (CED) and the global warming potential (GWP) throughout the different steps of the productive chain. To that end, LCA-based methods and tools and the relative datasets are studied, also taking into account the outlines of the previous experiences in local institutional catering (Caputo et al. 2017a).

In the frame of the UIA-OpenAgri project, an assessment of food production and, for some pilot foodchains, of its transformation and distribution are carried out with the additional aim of evaluating the relating environmental impact per equivalent hectare of the area, as to be comparable with other projects.

Potentially, other investigations could focus on: the potential quantity of biomass recovered by pruning urban trees; the needed water flow for land irrigation; the achievable share of organic food produced for the final users.



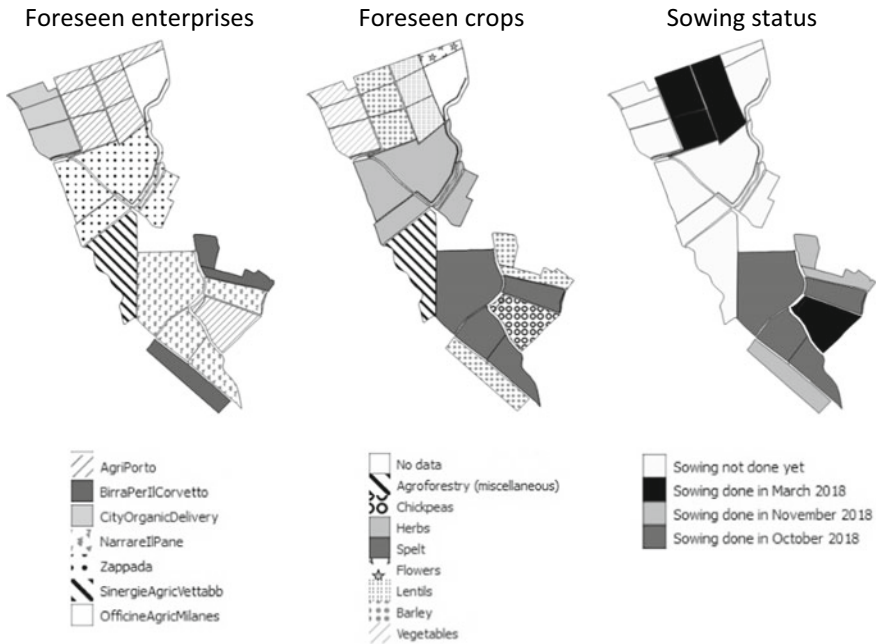


Fig. 5 Agricultural enterprises features

The mentioned evaluations are quite complex because of the data collection<sup>3</sup> from the involved start-ups. The collection of such primary data from the set of agricultural enterprises has been carried out in the period April-July 2019; in case of any lack in primary data, data from the proper technical literature are considered (e.g., Caputo et al. 2017a; Mistretta et al. 2019; Cerutti et al. 2018).

Figure 5 shows the foreseen enterprises, crops, and their sowing status.

## 4 Conclusions

This chapter introduced the state of progress of the activities of the UIA-OpenAgri project WP7 ‘Environmental modelling and impacts,’ taken on by the present research group at the ABC Department.

The authors believe that this project could be a significant pilot experience of circular economy in rural/urban areas. The idea of enhancing jobs and skills in a compromised area provokes a buildings’ renovation project which represents a real opportunity for economic development, environmental improvement, and social

<sup>3</sup>Type and quantity of seeds, fertilizers, pesticides, compost, mulching; fuels and electricity for the machines and for transportation; needed water; type, quality, and quantity of produced food and waste, etc.

redemption through the creation of an innovative food production hub, certainly able to attract other actors and investments at the end of the project. In fact, the UIA-OpenAgri has the merit of regenerating a degraded area, by avoiding further building construction, renovating existing buildings, promoting social inclusion, and mobilizing job resources. The experience is guided by a low carbon and high-efficiency approach aimed at optimizing the global metabolic performance of the area (Caputo et al. 2019). As examples, the following measures are foreseen: reduction of food waste; reuse of waste and materials throughout production, packaging, and commercialization phases; use of organic mulching from pruning plants in place of fertilizers. Furthermore, the project is consistent with the municipal food policy and the accomplished assessments can hopefully provide insights for developing analogous experiences in the territory. From an energy perspective, the whole district is made up of buildings with a high potential for retrofit and RES integration. Accordingly, the WWTP and the sewer collector could produce a significant supply of energy. Furthermore, biomass potential could be considered in the future.

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