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Gregory T. Papanikos
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- Abstract Submission: **3 November 2026**
- Acceptance of Abstract: 4 Weeks after Submission
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Self-sufficiency in Panzano Dwellings: A Replicable Model for Environmental, Social, and Economic Sustainability

By Paola Limoncin[*], Carlo Antonio Stival[±] & Thomas Bisiani[•]

The evolution of self-sufficient living offers significant opportunities for environmental, social, and economic sustainability through innovative residential strategies. Domestic self-sufficiency depends heavily on the optimization of household spaces and the integration of resource management technologies. Within this context, relevant experiences address bioclimatic greenhouses integrated into façades and high-performance building envelopes, which improve internal microclimates while substantially reducing energy consumption. Water resource management constitutes another crucial challenge: rainwater harvesting and reuse systems are successfully implemented across European eco-communities, where soilless cultivation techniques enable food self-production for resilient housing. Urban regulations play a decisive role in enabling these strategies, incentivizing the redevelopment of the existing building stock. The Panzano District, in northeastern Italy, serves as a compelling case study adopting an interdisciplinary approach. Historically linked to the Monfalcone Shipyard, the District features worker housing originally designed for efficiency and social functionality. Here, the adoption of passive architectural systems and advanced technologies can reduce the exploitation of raw resources while improving quality of life through reproducible solutions. Thus, self-sufficient living requires both cultural and social transformation, as demonstrated by European examples illustrate how resource and knowledge sharing strengthens community bonds while improving collective well-being. The Panzano case demonstrates that domestic self-sufficiency represents a challenge encompassing architecture, technology, regulation, and society, offering replicable models for sustainable and resilient living.

Introduction

Rethinking Domestic Self-Sufficiency: An Interdisciplinary Approach to Contemporary Living through Greenhouse Architecture

The evolution of self-sufficient living represents a crucial challenge for environmental, social, and economic sustainability, while simultaneously offering opportunities for innovation. This challenge emerges from the necessity to rethink traditional paradigms of dwelling in response to territorial transformation driven by climate change and the dynamics of nomadism and mobility that characterize our time, which now prevail over traditional models of settlement stability. These

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significant changes in how we live and perceive space define a condition of contemporary dwelling, characterized by the continuous redefinition of relationships between public and private domains, as well as between interior and exterior spaces.

The case study of the Workers' District of Panzano, in northeastern Italy, provides a significant context for exploring the potential of domestic self-sufficiency through an interdisciplinary approach that integrates architectural, technological, and social perspectives. The District, historically connected to the Monfalcone Shipyard, features an urban and architectural form characterized by a legacy of worker housing, originally conceived according to criteria of efficiency and the provision of social functions. This heritage represents an opportunity to develop self-sufficiency strategies that combine historical memory with innovative solutions, while addressing the contemporary condition of dwelling that requires flexible responses to mobility and climate change.

The exploration of the greenhouse space is considered crucial for this investigation. We consider it both in its traditional conception as an accessory structure for cultivation, and as an architectural device capable of redefining the domestic threshold through an innovative synthesis between environmental, functional, and climatic characteristics, and between the public and intimate dimensions of interior space. The boundary between domestic and urban dimensions can thus be reconfigured to meet the changing needs of contemporary living, influenced by nomadism and recent climatic trends. These factors have led to the dissolution of traditionally well-defined boundaries between different spatial experiences, giving rise to hybrid configurations characterized by transparency, visual continuity, and functional ambiguity.

The adoption of passive architectural systems with advanced technological content, and bioclimatic greenhouses integrated into building façades in particular, can contribute to reducing energy dependence and improving quality of life. These strategies, already tested in European contexts, can improve the internal microclimate and significantly reduce energy consumption while simultaneously redefining the threshold between interior and exterior spaces. The enhancement of the building envelope through such interventions represents a strategy that addresses both technical performance and the spatial ambiguity required by contemporary living patterns.

Domestic self-sufficiency is closely connected to the quality of household spaces and the integration of technologies for resource optimization. Water resource management constitutes a key element of domestic self-sufficiency, whereby the recovery and reuse of rainwater can be integrated into a sustainable local management system. Additionally, the adoption of soilless cultivation techniques offers innovative solutions for food self-production, contributing to a resilient housing model that responds to the hybrid nature of contemporary dwelling configurations.

The reproducibility of interventions on a district scale, through standardized solutions applicable to recurring building types, could facilitate the transition toward a sustainable living model. Urban planning regulations play a decisive role in the success of self-sufficiency strategies. In some European regions, the recognition of standards for nearly zero-energy buildings has incentivized the redevelopment of the building stock, increasing the value of residential spaces and

promoting sustainability on an urban scale. In Panzano, the adoption of local policies aimed at energy efficiency and sustainability could make the transformation of existing homes affordable, while simultaneously encouraging experimentation with new housing models that accommodate the fluid boundaries between different spatial experiences.

Beyond technical and regulatory aspects, the transition towards self-sufficient living implies a cultural and social transformation. The sharing of resources and knowledge can strengthen the sense of community and improve collective well-being, while addressing the contemporary conditions in which the boundaries of traditional typologies, between public and private, interior and exterior, are continuously redefined.

Approaching the case study of Panzano allows us to highlight how domestic self-sufficiency is not merely a technical issue but an interdisciplinary challenge involving architecture, technology, regulation, and society. The integration of greenhouse architecture as both a functional and spatial device demonstrates how contemporary dwelling can respond to the dissolution of traditional spatial limits while maintaining environmental performance. In comparison with other European contexts, it demonstrates that integrated strategies can improve energy efficiency, contribute to water and food autonomy, and enhance the value of existing building heritage, while accommodating the hybrid configurations that characterize contemporary living.

The adaptation of these models to the Panzano District represents not only an innovation but also an opportunity to promote a vision of sustainable and resilient living that embraces the ambiguity and flexibility required by contemporary patterns of mobility and climate adaptation. This approach, characterized by transparency, continuity, and functional hybridization, offers a replicable model for similar contexts facing the challenge of redefining dwelling in response to territorial transformation and changing lifestyle patterns.

Drawing from this context, the present study employs an integrated modeling approach to quantify the contribution of the proposed bioclimatic threshold-greenhouse system within the prevalent ‘H-type’ residential units of the Panzano District. This investigation is guided by a single core research question: To what extent does the integration of the threshold-greenhouse system contribute to the multidimensional self-sufficiency of these units, specifically considering the measurable enhancement of energy performance (passive and active gains), water autonomy (rainwater harvesting capacity for domestic and irrigation uses), and food resilience (potential yields from micro-horticultural cultivation)? The subsequent ‘Materials and Methods’ section will detail the specific scenarios (E-scenarios for energy and W-scenarios for water) and parameters used to evaluate these three dimensions.

Structure of the Paper

Section ‘Literature Review’ provides a scientific and cultural background on the implementation of bioclimatic greenhouses in the context of existing building

heritage, with particular reference to multi-family residential buildings characterized by historical, cultural, and architectural values. The background outlines the features of bioclimatic greenhouses that can contribute to the self-sufficiency of the user unit, including: the improvement of the building's energy performance and management; increased efficiency in the use of water resources for domestic uses; and the potential for allocating resources to food production within the dwelling unit.

Section 'Materials and Methods' outlines the methodology adopted to assess the performance of a greenhouse in contributing to the energy performance of an existing building, by determining both direct and indirect contributions as well as thermal comfort conditions throughout different periods of the year. The section also describes the methodology for evaluating the volume of recoverable water that can be allocated for domestic use. Furthermore, the key parameters for assessing the bioclimatic greenhouse's contributions to user self-sufficiency within the identified thematic areas are defined. The methods and assumptions used to estimate the impact of solar spaces during the evaluation of the intervention's potential effectiveness are also detailed. In addition, the implementation of the methodology in the case study of the working-class district of Panzano is described, according to specific intervention scenarios. The selection of this case study is justified by the objectives related to energy efficiency, social revitalization, and the potential effectiveness of interventions on the existing building stock. The application of the proposed methodology enables an assessment of the impacts resulting from the integration of bioclimatic greenhouses into one of the prevalent building typologies within the Panzano District.

Section 'Discussion' highlights both the advantages and the critical issues associated with the implementation of these solar spaces within the context of significant housing pressure in the Panzano neighborhood. The analysis of the results is conducted in accordance with the scenarios outlined in the previous section, identifying possible configurations of the solar space and their respective impacts on the resources that contribute to the establishment of self-sufficiency within the existing urban fabric. Additional factors related to the nature and ownership of the building stock are also discussed.

Section 'Conclusions' summarizes the proposed approach for supporting self-sufficiency in historic and culturally significant building stocks, whose homogeneous nature allows for the potential replication of the intervention at a scale beyond that of the individual building. The limitations of the research conducted provide a basis for outlining future research developments.

Literature Review

The integration of sunspaces and bioclimatic greenhouses in existing building retrofits represents a multifaceted approach to addressing contemporary challenges

in sustainable architecture.[1] The current state of research also addresses the incorporation of passive solar systems into residential building renovation projects, with particular emphasis on energy efficiency improvements, decarbonization potential, and impacts on occupant well-being and self-sufficiency, in relation to the EU's commitment to achieving carbon neutrality by 2050. The analysis reveals a growing body of evidence supporting the effectiveness of these interventions, aligning with broader sustainability objectives while addressing the challenges of retrofitting existing residential stock.[2]

Research in Europe has made significant contributions to the field, particularly in the areas of architectural integration and climate-responsive design. Studies conducted in Mediterranean climates by Elaouzy and El Fadar provide comprehensive evaluation frameworks for bioclimatic design implementation, offering methodologies applicable across similar European climatic zones.[3] Northern European research has focused on cold climate applications, with significant contributions from Scandinavian researchers on thermal buffer zone concepts and high-performance glazing systems. The emphasis on heritage building integration and architectural sensitivity reflects European priorities in building renovation practices.[4] Southern European research has concentrated on cooling applications and thermal comfort optimization, with particular attention to passive cooling strategies and advanced glazing technologies aimed at overheating prevention.

Energy Performances and Thermal Effects

From a bioclimatic perspective, the threshold-greenhouse functions as a buffer space that shields the dwelling from adverse weather conditions during the colder seasons, while simultaneously acting as a passive solar system. The passive solar greenhouse represents an environmentally sustainable approach that, through its components and design, minimizes heat loss by capturing solar energy during the day and releasing it at night.

Recent research by Ma et al. provides a comprehensive review of sunspace applications in buildings, highlighting significant energy-saving potential.[5] Their analysis demonstrates that adding a south-facing sunspace to a cold-climate rural house significantly reduces January heating demand. This finding is corroborated by experimental studies conducted by Ma et al. in Qingdao, China, where a sunspace addition to an apartment building achieved substantial energy savings

1. S. Brunoro, "Passive Envelope Measures for Improving Energy Efficiency in the Energy Retrofit of Buildings in Italy," *Buildings* 14, no. 7 (2024).

2. R. Albatici, F. Passerini, and J. Pfafferott, "Energy Performance of Verandas in the Building Retrofit Process," *Energies* 9, no. 5 (2016).

3. Y. Elaouzy, and A. El Fadar, "A Multi-Level Evaluation of Bioclimatic Design in Mediterranean Climates," *Sustainable Energy Technologies and Assessments* 52 (2022).

4. G. Allesina, C. Ferrari, A. Muscio, and S. Pedrazzi, "Easy-to-Implement Ventilated Sunspace for Energy Retrofit of Condominium Buildings with Balconies," *Renewable Energy* 141 (2019): 541-548.

5. Q. Ma, X. Chen, X. Wang, W. Gao, X. Wei, and H. Fukuda, "A Review of the Application of Sunspaces in Buildings," *Energy Sources*, Part A 47, no. 1 (2021): 10292-10314.

through passive solar gain and thermal buffering effects.[6] The thermal performance of sunspaces is heavily influenced by design parameters, as demonstrated by Vukadinović et al.[7] who investigated the impact of façade structure, glazing type, and window-to-wall ratio on energy performance. Their study revealed that optimized glazing configurations could improve thermal efficiency by up to 25% compared to conventional designs. Similarly, the integration of Phase Change Materials (PCMs) in sunspace systems has shown promising results.[8] Advanced thermal storage solutions have been explored by Afshari et al. who investigated solar energy storage in black-covered sunspaces using water-filled containers.[9] Their experimental and numerical study demonstrated effective thermal mass integration, providing stable indoor temperatures and reduced energy consumption fluctuations.

The evolution toward bioclimatic greenhouse systems represents a significant advancement in the field. Lotfinejad et al. developed a computational approach for integrating greenhouses with traditional architectural elements, utilizing genetic optimization algorithms to enhance thermal comfort while maintaining cultural and architectural integrity.[10] This approach demonstrates the potential for the sensitive integration of modern bioclimatic systems with existing building fabric, emphasizing architectural integration. The concept of thermal buffer spaces has gained prominence in cold climate applications. Yao et al. investigated the application of thermal buffer spaces in rural dwelling renovation for nearly zero energy consumption in cold regions of China, demonstrating the versatility of sunspace concepts across different climatic contexts and building types.[11]

Impact on Well-being and Quality of Life

A growing recognition of sunspace and greenhouse systems' contribution to occupant well-being beyond energy performance has emerged. Mazzeo et al. specifically addressed plant well-being in solar greenhouses, examining climatic conditions, glass selection, and environmental quality factors that influence both

6. Q. Ma, C. Xu, X. Chen, W. Gao, and X. Wei, "Experimental and Simulation Research on the Energy-Saving Potential of a Sunspace: An Apartment in Qingdao," *Sustainability* 15, no. 1 (2023).

7. A. Vukadinović, J. Radosavljević, A. Signorđević, and M. Protić, "Influence of Façade Structure, Glazing Type, and Window-to-Wall Ratio on Energy Performance," *Journal of Energy Engineering* 149, no. 1 (2023).

8. M. Ç. Uludaş, E. Tunçbilek, Ç. Yıldız, M. Arıcı, D. Li, and M. Krajčík, "PCM-Enhanced Sunspace for Energy Efficiency and CO_2 Mitigation," *Journal of Building Engineering* 57 (2022).

9. F. Afshari, E. Mandev, B. Muratçobanoğlu, A. Çelik, and M. A. Ceviz, "Experimental and Numerical Study on Solar Energy Storage in Black-Covered Sunspace Using Water-Filled Tin Cans," *Journal of Enhanced Heat Transfer* 31, no. 3 (2023): 21-44.

10. P. Lotfinejad, A. Tarkashvand, and H. Sanaieian, "A Computational Approach for Integration of Greenhouse and Shanashir to Enhance Thermal Comfort Using the NSGA-II Algorithm," *Building and Environment* 273 (2025).

11. G. Yao, X. Guo, Z. Qian, Y. Pang, Y. Zhang, and C. Xie, "Thermal Buffer Spaces in the Renovation of Rural Dwellings in Cold Regions of China," *Journal of Building Engineering* 99 (2025).

plant growth and human comfort.[12] Their research establishes important connections between agricultural productivity and human psychological well-being in integrated greenhouse-residential systems. Rong et al. investigated renovation strategies for green spaces in aging residential communities, emphasizing the dual benefits of carbon sequestration and wellness enhancement, thus contributing to community health outcomes while addressing environmental objectives.[13] The psychological and social benefits of integrated greenhouse systems are increasingly recognized in the literature, though this aspect remains underexplored compared to purely technical performance metrics. The presence of growing plants and natural systems within or adjacent to living spaces contributes to improved mental health, stress reduction, and connection with natural processes.

Self-Sufficiency in Food and Water Production

The integration of food production capabilities in residential building retrofits represents an emerging frontier with limited but growing research attention. Yeo et al. conducted a detailed analysis of building-integrated rooftop greenhouses for urban agriculture, examining thermal energy loads and optimization strategies for combined residential and agricultural functions.[14] Current research indicates that properly designed building-integrated greenhouse systems can contribute significantly to household food security. Studies suggest that a well-managed residential greenhouse system can provide between 20-40% of a household's fresh vegetable needs, depending on system size, crop selection, and management practices.[15] Water self-sufficiency aspects are less extensively documented in the current literature: the potential for rainwater harvesting, greywater recycling, and the integration of hydroponic systems represent significant opportunities for future research.

The Sunspace as a Spatial Device

The architectural threshold is defined as a transition between two fixed states in cultural terms or between two dissimilar spaces in architectural terms. The concept of liminal space—from the Latin *limen*, meaning threshold—refers to a zone of transition between one's current position and one's intended destination.[16] In architecture, liminal entities—threshold spaces—are primarily characterized by

12. D. Mazzeo, C. Baglivo, S. Panico, and P. M. Congedo. "Solar Greenhouses: Climates, Glass Selection, and Plant Well-Being," *Solar Energy* 230 (2021): 222-241.

13. X. Rong, H. Fang, and C. He, "Renovation Strategies for Green Spaces in Aging Residential Communities in Cold Regions," *Buildings* 15, no. 8 (2025).

14. U.-H. Yeo, S.-Y. Lee, S.-J. Park, J.-G. Kim, J.-H. Cho, C. Decano-Valentin, R.-W. Kim, and I.-B. Lee, "Rooftop Greenhouse: Thermal Energy Loads of a Building-Integrated Rooftop Greenhouse," *Agriculture* 12, no. 6 (2022).

15. J. Langemeyer, C. Madrid-Lopez, A. Mendoza Beltran, and G. Villalba Mendez, "Urban Agriculture—A Necessary Pathway toward Urban Resilience and Global Sustainability?" *Landscape and Urban Planning* 210 (2021).

16. V. Turner, *The Forest of Symbols: Aspects of Ndembu Ritual* (Ithaca, NY: Cornell University Press, 1970).

their 'in-between' nature, situated between what they connect or separate, even though, in most cases, they constitute distinct and autonomous entities.

Liminal space is defined by features such as layering, dissolution, blurring, and ambiguity, and it possesses the capacity to 'transform' the occupant as they move through it. These transitional spaces are particularly relevant in contemporary domestic architecture, positioned between clearly defined functional areas, offering subtle and flexible connections within the spatial layout.

The threshold space thus emerges as a fundamental design device for mediating between opposing needs—privacy and connection, protection and openness, intimacy and sociability. Accordingly, the greenhouse is configured as a paradigmatic model of transitional space, capable of addressing the challenges of climate change through passive environmental control strategies, while simultaneously redefining the spatial and perceptual relationships between interior and exterior environments.

The Evolution of Greenhouse-Building Relationships: From Addition to Integration

The relationship between greenhouse and building has evolved significantly over the past decades, transforming from a simple functional addition to a sophisticated architectural device that challenges traditional boundaries between interior and exterior spaces. This evolution can be traced through four distinct phases, each representing a different approach to the integration of greenhouse technology with residential architecture.

The Greenhouse as Transparent Extension

The first phase represents the greenhouse in its most elemental form: a transparent architectural extension that preserves the distinction between the original building and the new addition.

Rick Mather Architects' Glass House in Hampstead exemplifies this approach, where innovation lies primarily in technical excellence rather than in spatial hybridization.[17] The project demonstrates how contemporary glazing technology can create a completely transparent structure through frameless double-glazed panels supported by laminated glass beams and columns (see Figure 1). A novel system with an invisible conductive film enables heat reflection and electrical conduction, providing radiant heating in winter and reducing solar gain in summer. This transformation allows the greenhouse into a year-round livable space. The intervention thus functions as both a climatic device and a spatial extension, maintaining a clear hierarchy in which the historic structure prevails and the glass addition acts as a technologically refined yet subordinate counterpart.

17. T. Dodd, *Rick Mather Architects: All Glass Extension and House Refurbishment, Hampstead* (2025).

Figure 1. *Architect Rick Mather's Glass Addition to a Georgian Cottage in Hampstead, London (1991/1992), North Facing Elevation (A Transparent addition that extends the living space while maintaining a clear distinction between the original building and the new intervention)*
Source: Dodd 2025.

Bioclimatic Integration

The second phase introduces a more integrated and environmentally responsive conception of the greenhouse. ACC Naturale Architettura's bioclimatic greenhouse in Superga exemplifies this evolution, framing the structure as an environmental mediator in dialogue with both architectural heritage and the landscape context[18].

Inserted within an early 20th-century building on the hill of Villa Sassi Park, the 50 m³ intervention demonstrates how form and orientation can be calibrated for energy efficiency and contextual harmony (see Figure 2). The polygonal plan reconciles solar exposure with the geometric constraints of the existing structure, while the aluminum frames with thermal break, double glazing, and titanium-zinc cladding with pre-patinated lichen-green pigment ensure both technical performance and visual integration. In this phase, the greenhouse transcends its role as an addition to become a bioclimatic device that actively mediates energy exchange and enhances the building's environmental performance.

18. C. Catino, *Capturing Bioclimatic Greenhouse, Superga* (Turin: 2021).

Figure 2. *ACC Naturale Architettura Cristiana Catino, in Superga, Turin (The greenhouse operates as an environmental mediator that harmonizes with both existing architecture and landscape context)*
Source: Catino 2021.

Symbiotic Equivalence

The third phase marks a paradigm shift in which the greenhouse attains architectural equivalence with the dwelling itself. In Lacaton & Vassal's Casa Latapie (Floirac, 1993),[19] industrial greenhouse components become the project's primary structural and spatial elements rather than ancillary additions[1, 2] (Lacaton & Vassal, 2008).[20] The east-facing greenhouse functions as a fully livable extension, its operable façades enabling seasonal adaptability and the modulation of light, intimacy, and ventilation (see Figure 3). This variability allows the domestic space to expand and contract, transforming from a minimal core to an open continuum that merges with the garden in summer. Through the use of inexpensive industrial materials and adaptable structures, the project redefines the dwelling as a flexible, responsive system. The greenhouse thus ceases to be a climatic accessory, becoming instead a generative framework for inhabitation – a co-dependent, symbiotic architecture in which both components share equal status.

19. Lacaton, A., and J.-P. Vassal. "Maison Latapie," in *El Croquis Omnibus: Lacaton & Vassal 1993–2015*, vols. 177-178, Madrid: El Croquis (2017): 48-57.

20. Lacaton, A. And J.-P. Vassal. "Maison Latapie, Floirac" (2008). https://www.lacatonvassal.com/index.php?idp=25 [Accessed 23 Jun 2025].

Figure 3. *Lacaton & Vassal's Casa Latapie in Floirac (1993) (The Greenhouse is no longer subordinated to the building but becomes an equivalent architectural component that shapes the entire dwelling concept)*
Source: Hisao Suzuki, in Lacaton & Vassal 2017.

Greenhouse Primacy

The fourth phase culminates in a complete inversion of the traditional hierarchy, as the greenhouse becomes the primary architectural envelope encompassing the dwelling. In Niederwöhrmeier + Kief's residential project in Nuremberg (2000), the 'house within a greenhouse' typology redefines the relationship between structure and enclosure (Niederwöhrmeier + Kief, 2016). Here, the transparent shell forms the dominant climatic and spatial framework, while the enclosed living units are conceived as inserted volumes within a larger, environmentally controlled space (see Figure 4).

Figure 4. *Niederwöhrmeier + Kief's residential project in Nuremberg (2000) (The greenhouse envelope becomes the primary architectural element that encapsulates and protects the dwelling within)*
Source: Niederwöhrmeier + Kief 2016.

This layered system of boundaries mediates between interior and exterior, optimizing comfort and adaptability. The project exemplifies the greenhouse's evolution from an ancillary addition to an autonomous architectural organism – one in which environmental regulation and transparency become the central generative principles of domestic architecture.

Toward Hybrid Domesticity

This evolutionary trajectory reveals how the greenhouse has transformed from a simple functional addition to a sophisticated architectural device capable of redefining domestic space. Each phase represents not merely a different approach to greenhouse integration, but a different understanding of the relationship between building and environment, between interior and exterior, between protection and exposure. The progression from addition to integration, to symbiosis, and finally to encapsulation demonstrates how contemporary architecture is moving toward increasingly fluid and responsive relationships between built form and environmental systems. The greenhouse, in its various configurations, becomes a testing ground for new forms of domesticity that can respond to changing climate conditions, lifestyle patterns, and spatial needs.

This evolution suggests that the future of domestic architecture lies not in fixed relationships between building components, but in dynamic systems that can adapt and transform according to varying environmental and functional requirements. The greenhouse, as both a technical device and a spatial concept, offers a model for this new architecture of adaptability and environmental responsiveness.

Materials and Methods

This study represents a practical continuation within the broader research framework developed under the INEST – Interconnected Nord-Est Innovation Ecosystem project, funded by the European Union and the Italian Ministry of University and Research as part of the investments envisaged by the National Recovery and Resilience Plan.[21] Specifically, it focuses on strategies for the sustainable regeneration of the existing building stock.

The projects evaluated in the first phase of this research are characterized by modified façade components and transitional architectural elements, designed to adapt dwellings to emerging needs, expand usable space, and reduce environmental impact, thus resulting in new envelope configurations.[22] In addressing the challenges of energy footprint reduction and climate adaptation, technology becomes a key

21. E. Zatta, M. Condotta, R. Revellini, and V. Tatano, "Delivering Sustainability in the Italian N-E Built Environment," *Buildings* 13, no. 12 (2023).

22. P. Limoncin, T. Bisiani, and C. A. Stival, "Façade Additive Strategies to Foster a Wider Concept of Comfort," in *Proceedings of the 4th International Conference on Sustainable Development in Civil, Urban and Transportation Engineering* (ed.) A. Różański et al., 177-187 (Singapore: Springer Nature, 2025).

element of the architectural design process, enabling more effective strategies for retrofitting.

However, beyond technical solutions, it is equally crucial to consider interventions that enhance spatial quality through the reciprocity between people and their environment. In this context, the architectural threshold—understood as a liminal space of transition—offers a powerful design tool. Elements such as passive solar greenhouses exemplify this potential: they serve not only as environmental buffers that improve energy performance, but also as redefined domestic spaces that mediate between interior and exterior, fostering inclusive and transformative spatial experiences.[23]

Sunspace Integration within an Existing Layout

The greenhouse, understood as an architectural threshold device, offers an innovative model for reimagining the domestic entrance in the era of climate change. Through its capacity to mediate between different environmental conditions and to create ambiguous and flexible transitional spaces, the greenhouse represents a design strategy that responds to the evolving needs of contemporary living, increasingly defined by mobility, adaptability, and climate responsiveness.

The design hypothesis outlined here proposes the greenhouse as an architectural device that synthesizes the spatial characteristics of the threshold with the specific environmental and bioclimatic qualities of the glazed structure. This synthesis does not result from a mere juxtaposition of elements, but rather from the generation of a new spatial category, creating an innovative and functional configuration that bridges two traditionally distinct architectural domains.

Moreover, the integration of food production systems within residential building retrofits represents an emerging area of research that is receiving increasing scholarly attention, particularly in the context of urban resilience, self-sufficiency, and the circular economy. The incorporation of productive greenhouses into the domestic realm contributes to environmental performance but also to social and spatial innovation, enhancing the dwelling's capacity to support sustainable lifestyles.

Modelling a Greenhouse

The general objective is to evaluate the potential contribution of the bioclimatic greenhouse and its integrated system in generating three forms of self-sufficiency:

- Energy self-sufficiency, through the reduction of primary energy demand for heating and cooling, due to the seasonal buffer effect of the greenhouse.
- Water self-sufficiency, through the recovery and reuse of rainwater.

23. C. A. Stival, T. Bisiani, and P. Limoncin, "Criteria for Enhancing Comfort and Liveability through Innovative Façade Interventions," *Architecture, Structures and Construction* 5, no. 1 (2025): 14.

- Food self-sufficiency, in terms of supporting domestic micro-horticultural production.

The adopted methodology is based on an integrated approach combining energy and water simulation, initially conducted through the construction of a parametric model in a BIM (Building Information Modeling) environment and supported by a calculation code for evaluating specific contributions in terms of energy and stormwater management.

In the assessment of energy self-sufficiency, the model aims to define the greenhouse contributions on a monthly basis, considering three main scenarios codified with letter 'E':

- Current state "E0", which represents the actual condition of the building, without any intervention;
- Project state "E1", which involves the addition of bioclimatic solar spaces as an integrated architectural extension, positioned on the building façades to promote appropriate passive contributions to the building's useful energy balance;
- Project state "E2", which includes, in addition to the greenhouse, the installation of photovoltaic panels on top of the new bioclimatic solar space, with the objective of introducing energy self-production.

Regarding the introduction of a system for direct use and recovery of stormwater, three possible scenarios – identified with letter "W" – are defined:

- Current state "W0", representing the actual condition of the building with no rainwater recovery; Project state "W1", which considers the collection of meteorological water draining over the new volume of the bioclimatic solar space for indoor irrigation purposes;
- Project state "W2", which considers the collection of meteorological water draining over the new volume of the bioclimatic solar space for indoor and garden irrigation purposes;
- Project state "W3", which considers the collection of meteorological water for both irrigation and domestic uses.

Parameters for Energy Modeling

The energy model, based on monthly calculations, is developed in compliance with ministerial decrees implementing Directive 2023/1791/EU and the technical standards cited to standardize the calculation method (UNI/TS 11300 standard series). The building energy model considers, as significant outputs, the useful thermal energy demand and the primary energy demand: the former is essential for evaluating, in different scenarios, the contribution of the bioclimatic greenhouse to the building's net energy performance; the latter is evaluated to define the contribution of the photovoltaic surface to the same performance.

The model for evaluating the contribution of the bioclimatic greenhouse, in particular, employs the following parameters:

- Climatic data of the location, expressed on a monthly basis: solar radiation on different exposures, mean outdoor air temperature, and outdoor air relative humidity.
- Geometric parameters of the greenhouse: useful surface area and useful volume of the space, surface area of transparent and opaque technical elements facing the outdoor environment, surface area of transparent and opaque technical elements facing the indoor environment (i.e., the existing building).
- Material parameters of the greenhouse: thermal transmittance and solar factor of transparent surfaces, thermal transmittance and thermal capacity of opaque surfaces, both facing outdoors and at the interface with the existing building.
- Thermal exchange parameters for ventilation, between greenhouse and outdoor environment, and between the indoor environment and the greenhouse.

Parameters for Hydrologic Modeling

For the assessment of the contribution related to sustainable water resource management, a daily per capita consumption of 130 liters is assumed for a dwelling within a multi-ownership residential building.[24] This overall value considers both services requiring potable water (personal use, surface cleaning, food production and cooking) and services for which such a water quality level would not be necessary (toilet flush, outdoor irrigation, use of household appliances).

The estimation of the water volume available monthly through precipitation is evaluated according to the following parameters:

- Climatic data of the site: cumulative precipitation per month.
- Geometric and finishing parameters of the greenhouse and existing building: greenhouse roof surface area, existing roof surface area involved in rainwater collection, runoff coefficients of collection surfaces.
- Geometric parameters of dwellings: useful surfaces and volumes, number of users per dwelling, external surface area designated for gardening, surface area designated for greenhouse cultivation.
- Parameters necessary to define the balance between collected water volume and that subject to evapotranspiration phenomena: vegetation water requirements, heat island effect on vegetation, vegetation density, depending on the specific plant species.

The building hydrologic model considers, as consistent outputs, the rainwater harvesting volume made available for irrigation purposes and domestic uses.

24. S. Donatello, M. Cordella, and N. Dodd, *Use-Stage Water Consumption*, 2021.

Moreover, the model allows for the implementation of the effect of a dual system for the collection, storage, and reuse of rainwater, which allocates the stored volume to specific uses for which water quality equivalent to potable water is not required. The YAS (Yield After Spillage) method is employed, which is one of the internationally adopted standards for water resource assessment.[25]

A Remarkable Context for Application: The Panzano District in Monfalcone

The working-class district of Panzano, developed in close relationship with the Monfalcone Shipyard at the northernmost coast of the Adriatic Sea, constitutes an architectural and urban heritage of significant historical and cultural value (see Figure 5).

The industrial settlement – initiated in 1908 by the Cosulich Navigation Company – was conceived as a 'garden city' combining efficiency, hygiene, and technical rationality, providing housing for about 5,000 inhabitants and functioning as an autonomous urban nucleus alongside Monfalcone.[26]

Its development unfolded in three phases: initial spontaneous workers' housing (until 1913), a more structured plan before World War I, and the major expansion between the post-war period and 1927, which completed the residential areas and public facilities. The result was a coherent integration of productive and residential functions, articulated through a hierarchy of dwellings – ranging from modest workers' houses to larger managerial residences (with areas ranging from 40 to 400 m^2) – organized according to social and professional roles.[27]

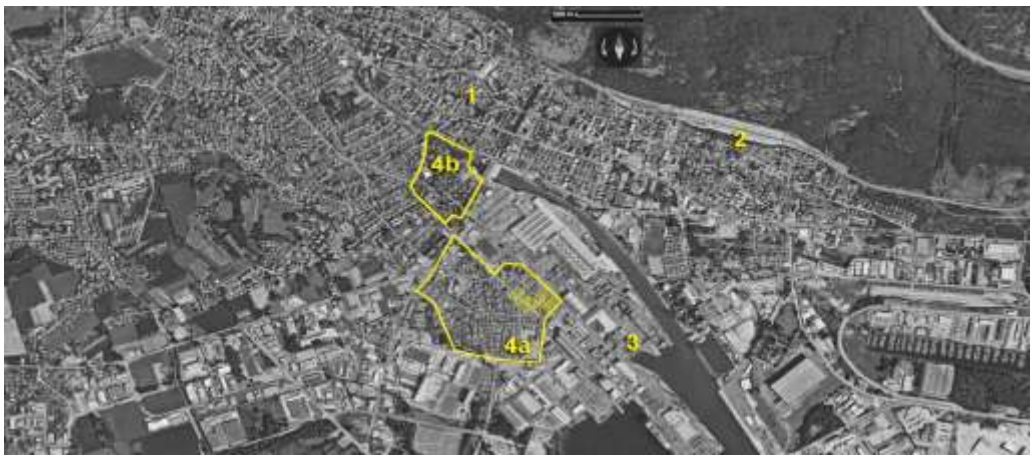

Figure 5. *Location of the Panzano District in Monfalcone: 1) Monfalcone City Center; 2) Railway Station; 3) Naval Shipyard Area; 4a) District Workers' Village; 4b) Employees' and Managers' Houses*
Source: Authors elaboration on current satellite view from Google Maps®.

25. N. S. Muhammad, and M. W. Lin. "Reliability of Rainwater Harvesting Systems Using the Yield-After-Spillage Algorithm," In *Proceedings of the AWAM International Conference on Civil Engineering*, 481-494 (2022).

26. Project Group of Panzano Municipality for the Panzano Recovery Plan, *Panzano Recovery Plan: General Report* (Monfalcone, 2010).

27. E. Valcovich, and F. Gadaleta, *Catalogo Panzano 1950–2017* (Monfalcone: Comune di Monfalcone, 2017).

After World War II, the paternalistic model underpinning Panzano declined, leading to social fragmentation and architectural decay due to the shipyard's disengagement and the lack of coordinated maintenance.[28] Starting in the 1980s, municipal initiatives sought to counter this degradation through a Recovery Plan (1987) and later regional funding (1995) for the preservation of the district's typological features. The Neighborhood Contract launched in 1995 introduced experimental interventions aligned with bio-architecture, energy efficiency, and accessibility principles, aimed at maintaining residents' permanence and restoring social cohesion.[29]

Successive, uncoordinated interventions, however, generated typological heterogeneity, fragmenting the original architectural unity. The 2010 Recovery Plan sought to address these issues by preserving the existing building heritage and regulating building additions – both volumetric (extensions, verandas, garages) and non-volumetric (canopies, pergolas) – to safeguard the district's morphological identity. Architecturally, Panzano remains characterized by diverse housing types, recalling the urbanized countryside model through low-density layouts, individual garden plots, and dwellings designed for potential extensions. These features now offer the potential to reinterpret the workers' village through contemporary notions of comfort, adaptability, and environmental quality.

The 'H-type' Building as a Case Study for Sunspace Integration

Among the various typologies present in the neighborhood, the so-called "building type 1A" or "H-type" deserves particular attention. This consists of articulated block buildings comprising eight dwellings of approximately 54 m2 each, distributed across two levels (four per floor) of 3.00 meters gross height; independent access points and small plots of land are assigned to each unit. In total, 18 buildings of this type were constructed, comprising a complex of 144 dwellings (see Figure 6).

28. D. Barillari, and C. A. Stival, "The Industrial Heritage of the Trieste Shipyard in Monfalcone: Restoring the Garden-City Model in the Residential Typologies of the Panzano District," *Journal of Architectural Conservation* 28, no. 3 (2022): 217-242.

29. Project Group of Panzano Municipality for the Panzano Recovery Plan, *Panzano Recovery Plan: General Report*, 2010.

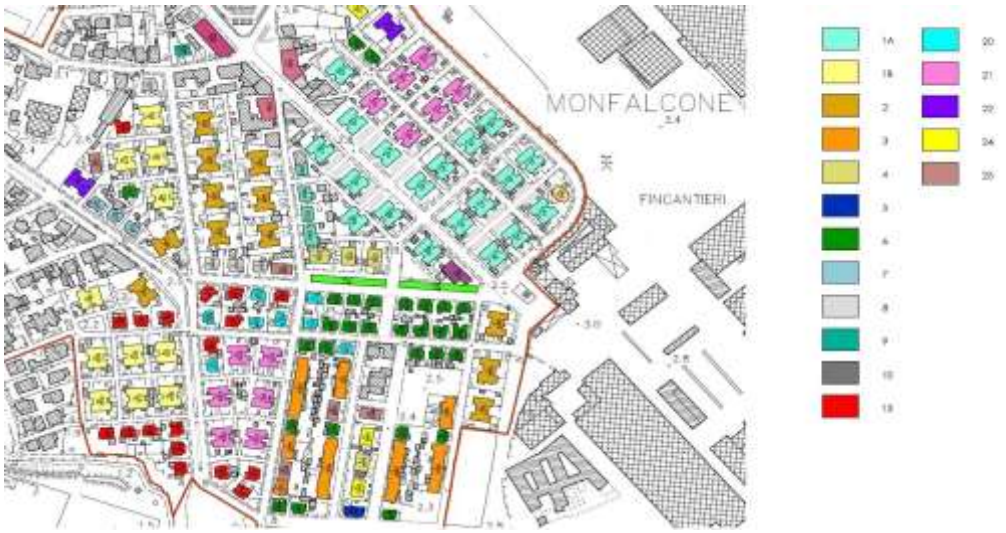

Figure 6. *Situation Plan (2010) of the Building Stock Typologies in the Workers' Village: The Continuous Red Line Borders the Perimeter of the Recovery Plan Scope. In the Key Legend, Codes 1A and 1B Refer to Eight-dwelling Houses with Separate Entrance, which Constitute the Focus of this Study*
Source: Project Group of Panzano Municipality for Panzano Recovery Plan, 2010a.

This typology, initially introduced before the Second World War and reintroduced in 1920-1921, represents the oldest and most widespread residential type in the neighborhood. Each dwelling, directly connected to its own plot, comprises a kitchen, two bedrooms, a bathroom, and circulation spaces, and is completed by a basement level (see Figure 7).

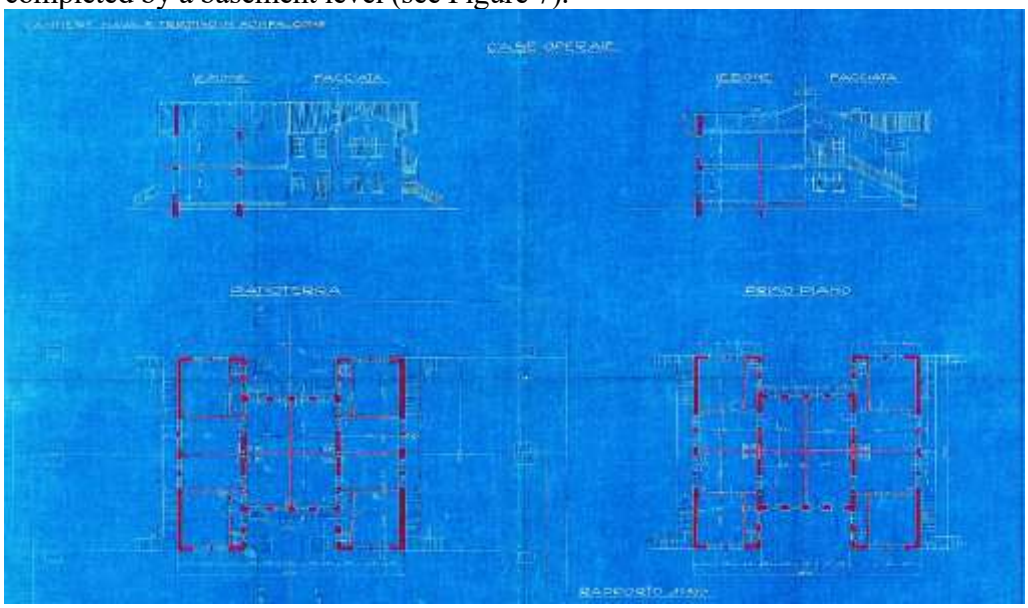

Figure 7. *Drawing for the 'H-type' Housing Project, Typology 1A. Crossed Sections, Main and Lateral Fronts, Ground Floor and First Floor*
Source: Barillari & Stival, 2022, courtesy of Monfalcone Municipality Historical Archive.

The load-bearing structure is constructed with brick masonry on reinforced concrete foundations, while the floors and roof are timber-framed. The building exhibits elements characteristic of rural architecture, such as the deeply projecting roof and external staircases with access balconies to the first floor. Overall, the articulation of entrances and the morphology of the roofing systems remain consistent with the original architectural language.

Over time, numerous uncoordinated interventions—particularly the construction of verandas to protect entrances—have generated a widespread phenomenon of superimposition, partially altering the original typological configuration in several building typologies in the District (see Figures 8-9).

Figure 8. *Views of the 'H-type' Housing in the Workers' Village of Panzano (Recent additions are visible on the ground floor and above the balcony, protecting entrances to dwellings)*
Source: Authors 2023.

Figure 9. *Existing Additions Providing Entrance Protection across Different Building Typologies in Panzano District: The Adopted Protective Systems Vary in both Type and Style*
Source: Authors 2023.

However, these conditions represent an opportunity to redefine the spatial configuration and technical performance of the buildings, updating them according to contemporary concepts of residential well-being. This can be achieved through the insertion of an additional and integrated architectural element capable of introducing self-sufficiency functions to a housing stock currently lacking them. From this perspective, the integration of a bioclimatic solar greenhouse within the eight-dwelling typology represents the focal point of the design proposal. The greenhouse space, conceived as an openable winter garden, is aimed at improving energy performance and achieving forms of self-sufficiency, including water and food production. International experiences confirm the validity of integrating passive-active devices in historic residential contexts, capable of ensuring energy autonomy and comfort while respecting the pre-existing architectural identity.

The analysis focused on residential typology "1A", previously subjected to examination for the identification of preliminary design solutions aimed at enhancing the quality of living spaces. By applying transitional façade systems within the building stock of Northeastern Italy, the research highlights both the architectural adaptability of this typology and the evolution of research methodologies developed within the INEST project. This approach exemplifies how climate-responsive and spatially inclusive strategies can be effectively embedded into broader design frameworks for contemporary retrofitting, beyond issues related to sustainable regeneration.

Characterization of Sunspace Integration on 'H-type' Building

The application of the bioclimatic solar greenhouse to the building typology under investigation involves the integration of new spaces within the setback areas provided by the building volume; consequently, two new volumes are defined with

South-West and North-East orientations. This solution encompasses all the eight dwelling units present in the 'H-type'. The two hypothesized greenhouses are thus configured as double-level volumes, each of which is subdivided into four spaces pertaining to each dwelling unit. Given that access to the dwelling units is independent and occurs within the building setbacks only for ground-floor units (upper-floor units are accessible via balconies), the greenhouse assumes different functions at the two levels. Moreover, the sunspace volume works as a buffer space for North-East orientation, while the sunspace facing South-West works effectively as a passive solar system (see Table 1 and Figures 10-11).

Table 1. *Relevant Climatic Data for the Study of a Solar Greenhouse in Monfalcone*

Month	Outdoor air Temperature [°C]	Average NE Solar Radiation [MJ m^{-2}]	Average SO Solar Radiation [MJ m^{-2}]	Average Horizontal Solar Radiation [MJ m^{-2}]
January	3.4	1.56	6.89	4.40
February	5.4	2.89	8.83	7.30
March	9.2	5.19	11.20	11.80
April	12.9	7.53	11.22	15.20
May	18.5	10.40	11.88	19.30
June	22.2	12.90	13.28	23.50
July	23.5	11.89	12.73	21.70
August	23.1	9.50	12.39	18.40
September	19.3	6.72	11.77	14.20
October	14.6	3.78	9.23	8.80
November	8.7	1.88	6.99	5.00
December	5.5	1.38	6.15	3.80

Source: regulation UNI 10349, parts 1 and 2, 2016.

The greenhouse envelope consists of double glazing with high solar transmittance (g=0.75) in order to balance solar gains during the cold season and thermal losses (U=2.80 W m-2 K-1), mounted on partially openable frames. The greenhouse envelope comprises an independent steel structure with uprights and crossbeams, equipped with its own foundations to avoid affecting the structural behavior of the existing building. The steel structure also allows for the extension of the intermediate floor slab (necessary for the use of the solar space on the upper floor), to be constructed in timber for consistency with the existing floor systems, and for the implementation of the upper closure of the greenhouse, consisting of double glazing with high solar transmittance (design scenario E1) or photovoltaic glazing with amorphous silicon (scenario E2).

The steel structure of the solar greenhouse allows for the integration of a rainwater collection downpipe within the central mullion, positioned at the division between the two floor-level dwelling units, to collect precipitation from the roof surface. The internal cross-section of the central mullion must be subdivided into four equal sectors by means of longitudinal dividing profiles, in order to distribute the rainwater flow made available for the intended uses in the

W1-W2-W3 scenarios from the point of roof collection. This approach ensures uniform flow distribution to the utilities of the different dwelling units.

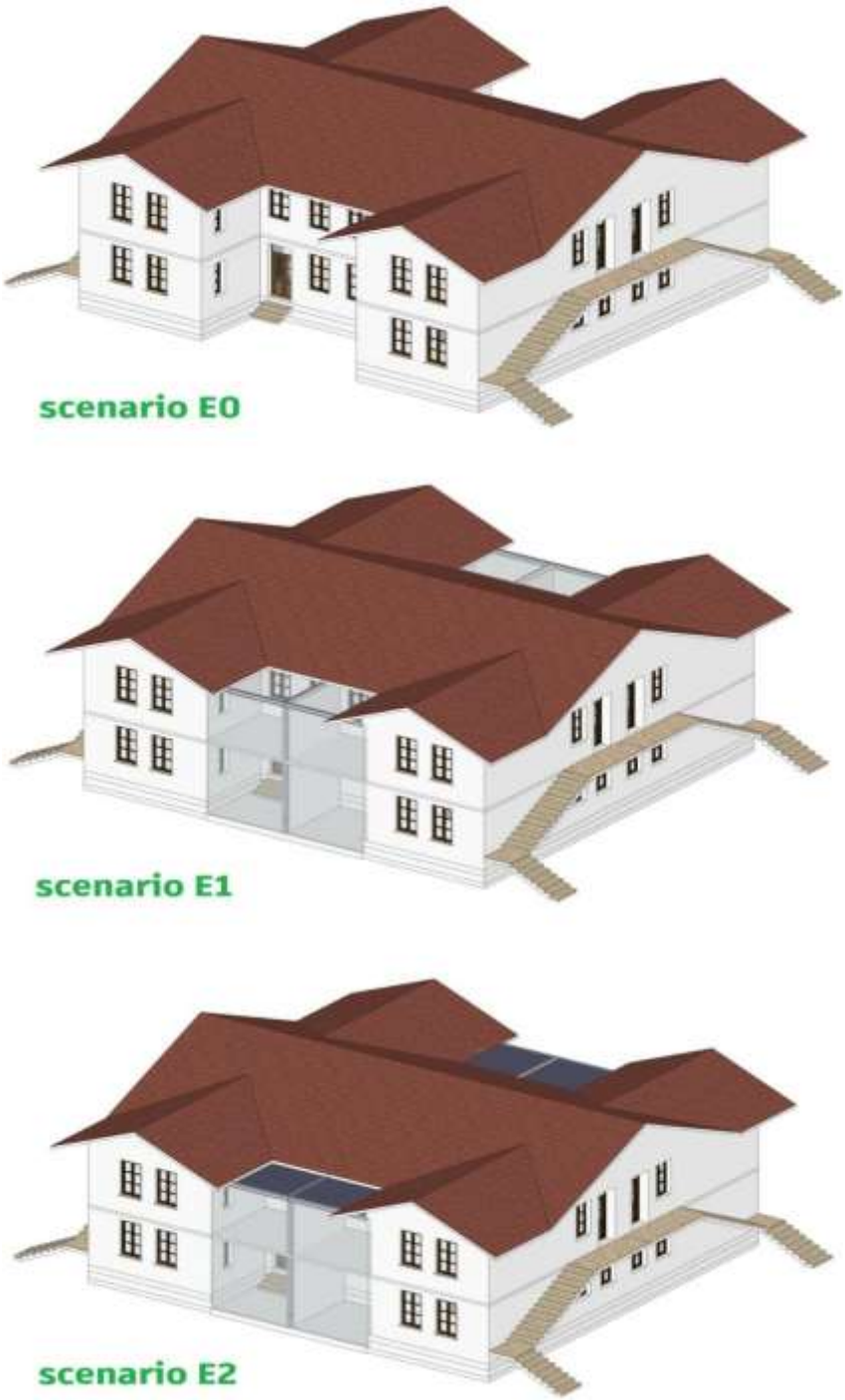

Figure 10. *BIM Model Comparing Scenarios for Different Energy Contributions in the Integration of Greenhouses in Building Type "1A" in Panzano District: From Top to Bottom, State of Fact, Greenhouse Integration, Greenhouse Integration with Solar Photo-voltaic Integration on Rooftop*
Source: Authors 2025.

The proposed interventions on building typology "1A" do not entail invasive effects on the structural behavior of the building type: the façade addition is indeed conceived to operate autonomously and to be potentially removed according to the principle of reversibility of the intervention. From a building services perspective, furthermore, the intervention does not modify the existing internal systems but is limited to introducing passive components with low impact, and active components for electrical energy production in the case of scenario E2.

The catchment surface at the top of each greenhouse, significant in terms of energy balance, in both scenarios E1 and E2 is 12.15 m2, as part of the greenhouse's rooftop is covered by the ridge overhangs of the pitched wooden roof structure, which is characteristic of the original building. In the W1-W2-W3 scenarios, however, a meteorological water collection surface of 94.20 m2 is considered, as this also includes the surface of the existing roof whose slope channels rainwater toward the greenhouse roof. The runoff coefficients are assumed to be 0.80 for the existing roof, with roof tiles as covering, and 0.95 for the greenhouse roof, whose finishing consists of a glass panel.

The original opaque envelope of the building, which constitutes the thermal exchange surface with the greenhouse, features opaque technical elements in solid masonry with thermal transmittance of 1.40 W m^{-2} K^{-1}, and windows with thermal transmittance of 2.80 W m^{-2} K^{-1} that constitute 18% of the surface area of this envelope. Each greenhouse has a gross floor area of 48.40 m^2 distributed over two levels and four dwelling units: each unit therefore has an additional surface area of 12.10 m^2 designated as greenhouse space. The total volume of each greenhouse, equal to approximately 140 m^3, presents thermal storage surfaces determined by the extension of the intermediate horizontal partition and by two new vertical partitions separating the dwelling units having the same level and the same orientation; these technical elements provide a thermal capacity of 4.24 MJ K^{-1}.

To control overheating effects in the greenhouse, it is possible to apply external shading systems to the greenhouse itself, aimed at containing solar gains from April to October, reducing them to 25% during the summer period (June-August).

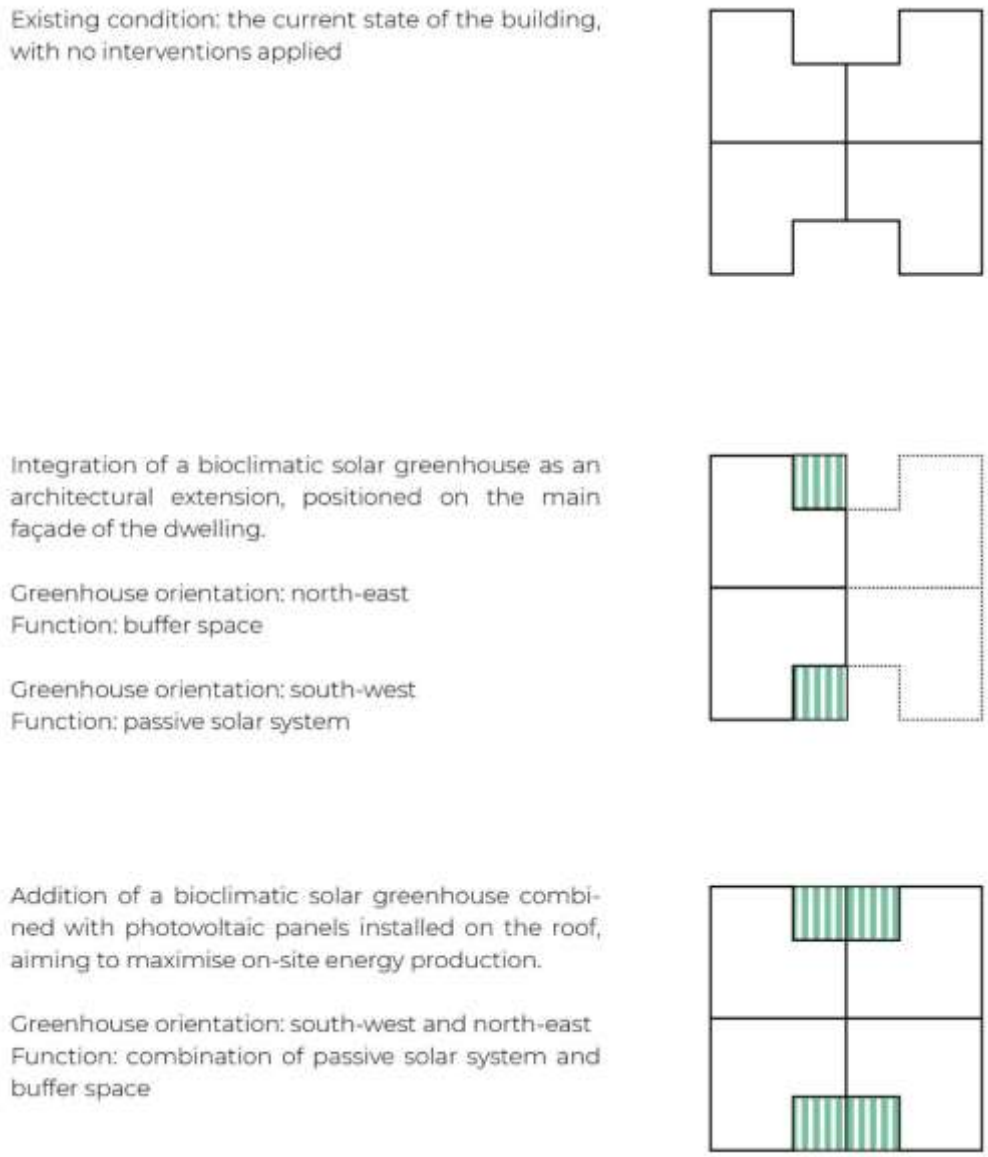

Figure 11. *Comparative Integration Scenarios for Building Type "1A" in Panzano District (The proposed interventions are intentionally non-invasive with respect to the original spatial and typological configuration, ensuring compatibility with the village's conservation constraints while promoting adaptive and incremental regeneration strategies)*
Source: Authors 2025.

With the same objective, differentiated ventilation regimes are applied throughout the year:

- the ventilation rate between the external environment and the greenhouse is assumed to be 0.5 vol h^{-1} during intermediate seasons, and reduced to 0.1 vol h^{-1} during the July-August and November-February periods;

- the ventilation rate between the greenhouse and internal environments is assumed to be 1.0 vol h^{-1} during the winter season, decreasing to 0.1 vol h^{-1} during the summer season.

The hypothesized cultivated area within the greenhouse is 1.75 m^2, a surface area that falls under the category of home-based gardening, recognized as a practice capable of contributing significantly to household food security.[30] This model enables the integration of the family diet with fresh, self-produced vegetables, reducing dependence on external supply sources and promoting greater urban resilience (see Figure 12).

Figure 12. *Comparative Diagram for Assessing the Potential Contribution of the Bioclimatic Greenhouse and the Integrated System in Supporting Three Forms of Self-sufficiency: i) Water, through Rainwater Harvesting and Reuse; ii) Energy, through the Reduction of Energy Demand for Heating and Cooling; Food, by Enabling Small-Scale Domestic Vegetable Production*
Source: Authors 2025.

In accordance with the W1-W2-W3 scenarios, the use of recovered rainwater can be designated exclusively for self-production purposes related to solar greenhouses (W1), or alternatively, additionally supplying toilet flush tanks intended for domestic use (W2). Both scenarios also consider the plot of land associated with each dwelling unit (75 m^2 each) and highlighted in the figure, thus recalling the original purpose that guided the conception and construction of the workers' village (see Figure 13).

Discussion

On the ground floor, the threshold-greenhouse functions as an introductory space to the dwelling, mediating the transition from the public or semi-public realm to the private domain of the individual housing unit. This transition does not occur through an abrupt separation, but rather through a gradual spatial sequence that accompanies the shift from collective behaviors to typically private actions. These transitional spaces are characterized by their capacity to facilitate social interactions between exterior and interior environments, creating opportunities for a range of intermediary activities.

30. A. L. Thebo, P. Drechsel, and E. F. Lambin, "Global Assessment of Urban and Peri-Urban Agriculture," *Environmental Research Letters* 9, no. 11 (2014).

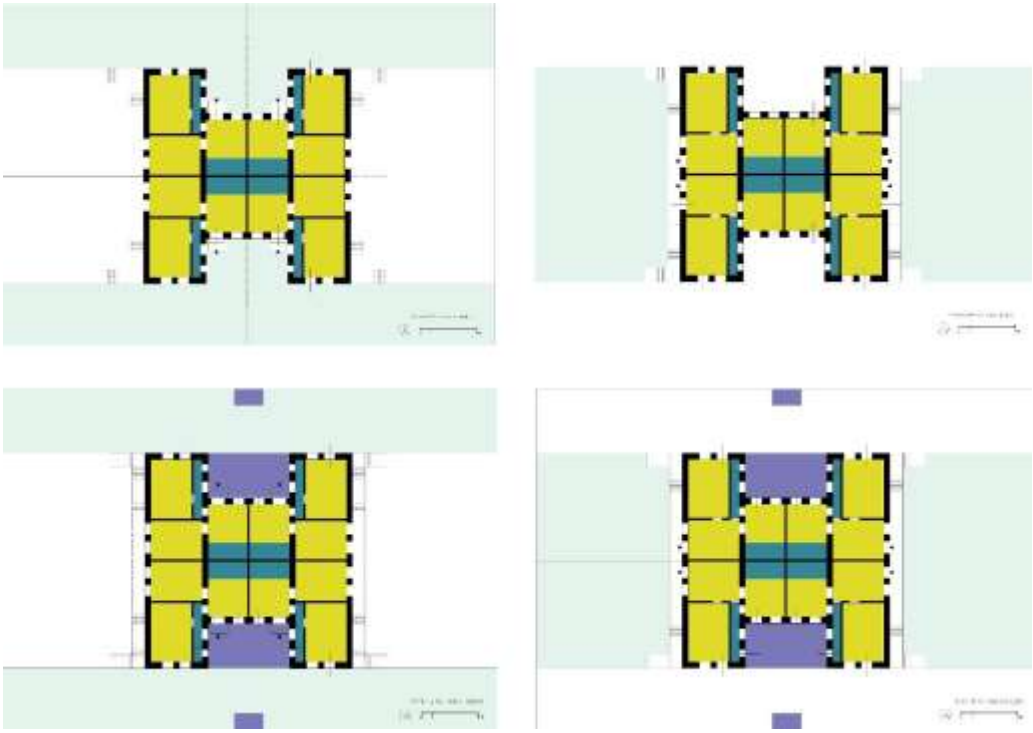

Figure 13. *Plans Identifying the Eight Dwellings—Four on the Ground Floor and Four on the Upper Floor—Across the Design Scenarios for Greenhouse Integration (Primary Spaces are shown in yellow, secondary spaces in blue, the corresponding plot in green and the integrated greenhouse in violet)*
Source: Authors 2025.

On the upper floor, the threshold-greenhouse provides a predominantly transparent space that extends the boundaries of the dwelling, generating a bright and comfortable environment that maintains a controlled connection with the exterior. This configuration challenges the traditional view of the greenhouse as a space solely dedicated to cultivation, transforming it into a versatile setting capable of accommodating various domestic functions.

The transparency of the glazed structure goes beyond ensuring visual continuity – it becomes a means of regulating both privacy and openness toward the outside. Transitional spaces can serve as buffer zones between private and public areas, contributing to passive thermal and acoustic regulation. Elements of environmental and visual control can be selectively calibrated to reinforce a sense of enclosure and protection, or conversely, to enhance the relationship with the urban context, in response to diverse usage needs and the temporal variations of domestic life.

The two solar greenhouses are capable of producing significant solar gains, according to the boundary conditions illustrated in the 'Materials and methods' section. As initially hypothesized, the southwest exposure proves more favorable and operates as a bioclimatic solar greenhouse; the northeast-exposed greenhouse is instead configured primarily as a buffer space protecting the residential spaces in continuous use (see Figure 14).

With reasonable assumptions regarding the shading of the transparent surface (particularly the southwest-facing façade, which experiences the highest solar load) and thermal exchange through ventilation between the outdoor environment and the greenhouse, and between the greenhouse and indoor environments, the temperature remains predominantly below 30°C during the summer season.

It should be emphasized that the southwest-exposed greenhouse exhibits a thermal situation such that it requires no additional mechanical thermal inputs throughout the entire year. The situation differs for the northeast-exposed greenhouse, where thermal exchange through transmission is very high during the winter season (see Figure 15).

The predictive assessment of PMV, according to the EN 7730 standard, demonstrates the acceptability of thermal comfort conditions for three months per year:

- During mid-winter for the southwest-exposed greenhouse.
- At the beginning and at the end of winter for the northeast-exposed greenhouse.

This outcome is consistent with the function of a solar greenhouse, which serves to collect solar radiation and assist in heating the building to which it provides access, ensuring a reduction in energy consumption. The bioclimatic greenhouse, given its essential function of complementing and providing energy savings to the building with which it is integrated, is a technical volume that cannot legitimately be designated for permanent human occupancy.

The impact of the two greenhouses on the overall building performance is significant. In scenario ‘E1’, a reduction of approximately 20% in thermal energy and primary energy requirements is achieved, in the absence of renewable sources intervening in energy generation; approximately 70% of this mitigating effect is attributable to the southwest-exposed greenhouse. In this case, it is therefore predictable that dwellings opening onto the southwest greenhouse are clearly advantaged compared to others.

Less impactful is the implementation of integrated photovoltaic roofing technology on the two greenhouses, which does not directly influence net thermal energy (a typical passive effect), but rather reduces non-renewable primary energy requirements by approximately 12%. The limited effect is due to the small surface dedicated to active energy production; the surface availability for a properly sized photovoltaic installation should consider the existing building rooftop, characterized by a 46% slope and, thus, capable of more efficient power production (see Figure 16).

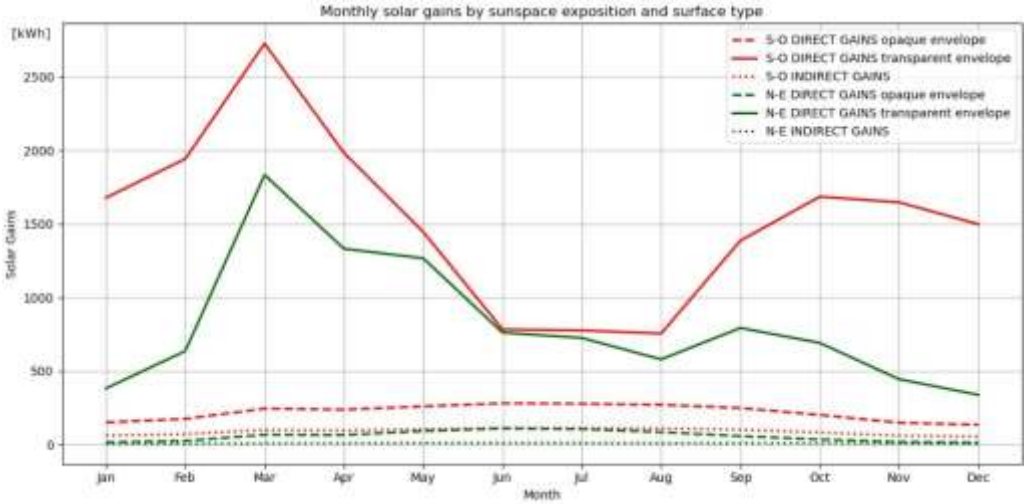

Figure 14. *Monthly Solar Gains Provided by the Sunspaces with S-O and N-E Expositions, in Red and Green Respectively*
Source: Authors 2025.

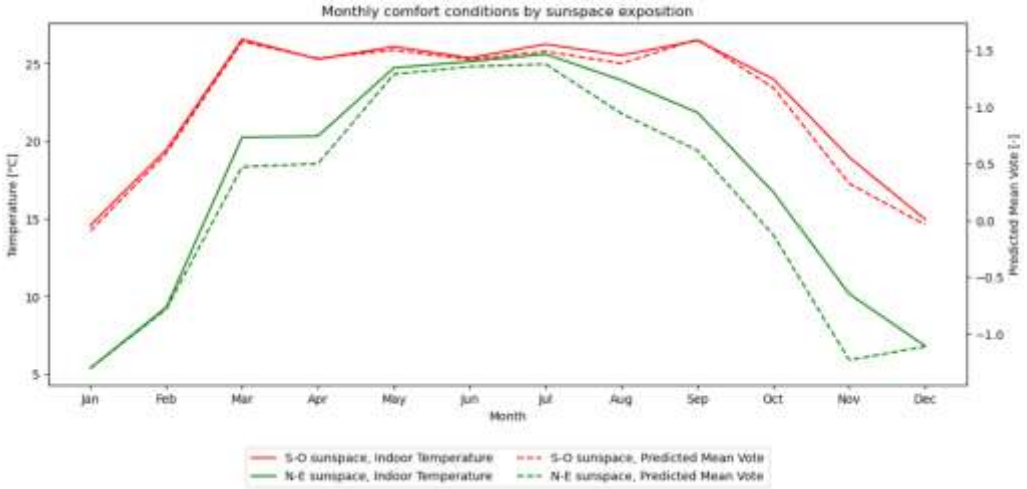

Figure 15. *Monthly Comfort Conditions within the Sunspaces with S-O and N-E Expositions, in Red and Green Respectively*
Source: Authors 2025.

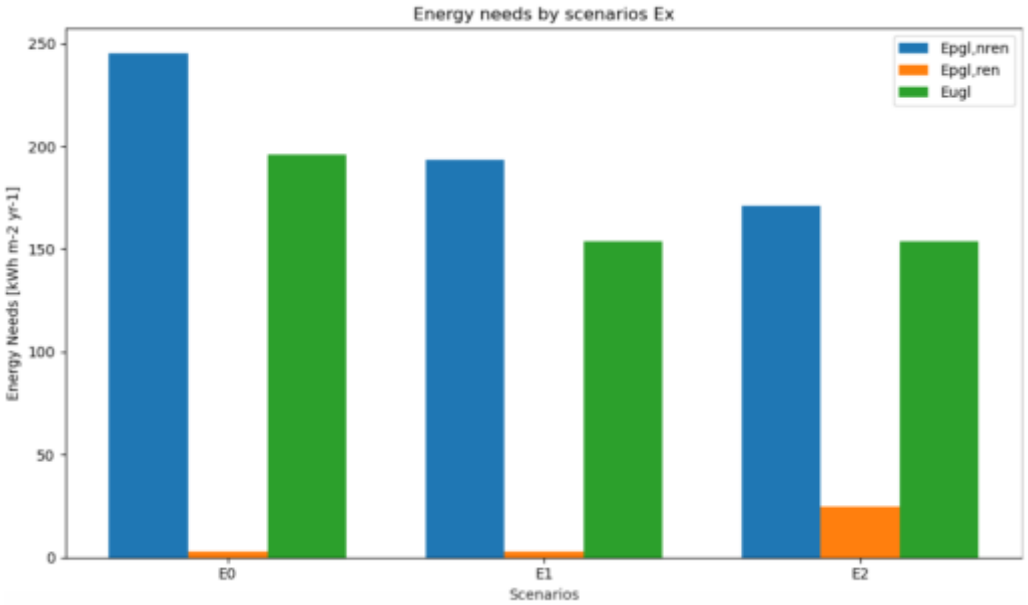

Figure 16. *Energy Needs of "1A" Building Typology according to Ex Scenarios: Non-renewable Primary Energy Performance (blue), Renewable Primary Energy Performance (orange), Net Energy Performance (green) (The indices are evaluated per surface unit and year)*
Source: Authors 2025.

The integration of a stormwater collection system in the solar greenhouse structure shows promising potential. When initially considering scenario W1, a temporal mismatch is evident between periods of highest precipitation (spring and late autumn) and periods of greatest water demand for plant species. Nevertheless, quantitative analysis demonstrates that the volume of collected rainwater is sufficient to satisfy the irrigation requirements of greenhouse crops for eight months; in the remaining months, during the June-September period, minimum coverage equals 30% (in August).

In scenario W2, which additionally considers garden irrigation, complete coverage decreases to six months per year, with minimum coverage slightly exceeding 3% during the three summer months. These minimum values are confirmed in scenario W3, where coverage exceeds 65% from October to March (see Figure 17).

The simulation analysis primarily evaluates the system configuration for the use of recovered rainwater. For scenarios W1 and W2, it is possible to consider a rainwater recovery system devoid of a storage volume, where the water resource is allocated primarily to greenhouse crops (through capillary or drip irrigation systems), and subsequently, for the excess, unused water volume, to the garden associated with each dwelling unit. This solution enables the subsequent design to focus on flow-rate control for cultivated species through an adequate sizing of components and water supply branches, avoiding the need for a dual system that would otherwise be required in scenario W3.

The results also allows us to evaluate approximately 4,000 liters the optimal volume for the potential storage tank of recovered rainwater, whose size is considered compatible with the dimensions of the dwellings and suitable for a non-invasive underground placement in the adjacent gardens.

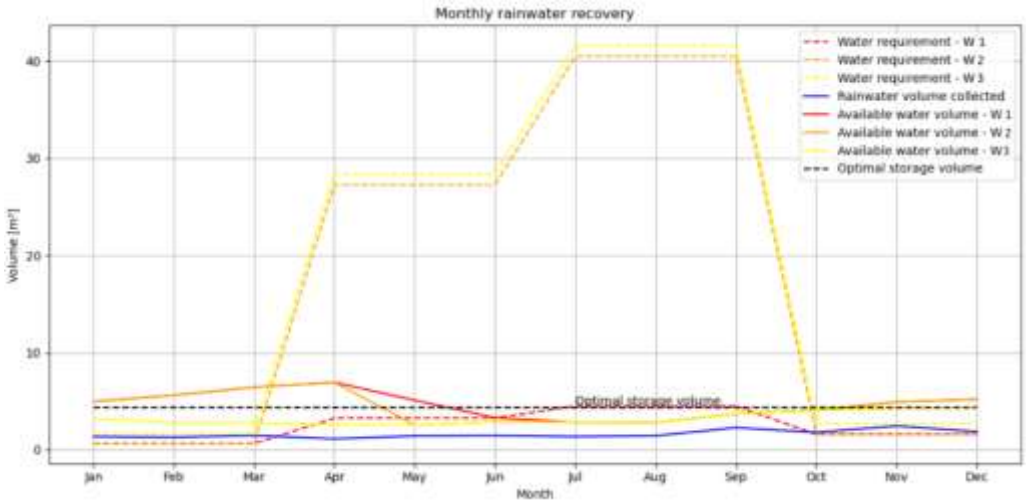

Figure 17. *Water Recovery and Reuse in "1A" Building Typology according to W1-W2-W3 Scenarios (Dashed lines represent the water requirement for uses associated to each scenario; continuous lines the water volume made available month by month that allow to individuate the optimal storage volume)*
Source: Authors 2025.

The environmental parameters of the solar greenhouse present several advantages for intensive cultivation. The internal temperature remains within an optimal range for most horticultural crops throughout the year, never falling below 18°C nor exceeding 34°C. Such stability supports year-round production and eliminates the need for active heating or cooling systems. Water availability is derived entirely from a rainwater harvesting system, with a minimum of 1,500 liters/month reliably accessible and peak availability reaching up to 3,500 liters/month. Estimated irrigation needs for the 1.75 m^2 cultivation area vary seasonally, ranging from approximately 20 liters/day during winter to a maximum of 150 liters/day (or 4,500 liters/month) during peak summer. This means that, while water sufficiency is guaranteed during most of the year, summer conditions might exceed the collection capacity, necessitating either water-saving strategies (e.g., mulching, drip irrigation, cultivar selection) or reduced production intensity.

Given the spatial and resource constraints, crop selection prioritizes species with high yield per square meter, short growth cycles, and compatibility with vertical or tiered systems. The selected crops include leafy greens such as lettuce and spinach, as well as compact fruiting species such as cherry tomatoes and zucchini. Culinary herbs like basil, parsley, and mint are also included for their high density, low resource requirements, and added nutritional and sensory value. Leafy vegetables and microgreens are particularly well-suited for vertical farming applications, which are enabled by the available vertical space. Modular shelving or vertical hydroponic

systems could allow two to three tiers of productive area, effectively tripling the yield potential within the same footprint.

Yield estimations under conventional single-layer cultivation suggest a monthly output of approximately 8–12 kg of fresh produce. Under optimized conditions employing vertical farming techniques, yields could realistically reach 15–20kg/month, especially if microgreens are integrated due to their extremely short growth cycles (10–15 days) and high productivity per unit area.

Dietary recommendations for vegetable intake suggest a minimum of 300 grams of fresh vegetables per person per day. For a two-person household, this equates to roughly 18 kilograms per week, or approximately 75 kilograms per month. Comparing this requirement to the potential yields from the greenhouse, it is evident that a standard single-tier system could provide between 10% and 16% of monthly vegetable needs. In contrast, an optimized multi-tier configuration may cover up to 25–26% of the total demand.

The rainwater harvesting system, offering a base availability of 1,500 liters/month and peak values up to 3,500 liters/month, generally meets the estimated irrigation demands. During winter and spring, water supply is more than sufficient; for instance, an average of 600 liters/month is required in January (at 20 liters/day), representing only 40% of available water. However, during peak summer months, water needs could rise to 4,500 liters/month, exceeding the stored rainwater by up to 2,000 liters. This seasonal imbalance underscores the importance of integrating water-saving technologies and possibly adjusting crop load during high-demand periods.

In conclusion, the bioclimatic greenhouse, despite its seemingly modest 1.75 m2 dedicated cultivation area, possesses significant potential to integrate into the diet of a two-person household. It is projected to cover between 10% and 17% of their annual fresh vegetable requirements, assuming the implementation of optimal and intensive cultivation practices. Beyond the quantifiable output, it is crucial to acknowledge the substantial qualitative benefits of self-production (freshness, reduction in food miles, and individual satisfaction derived from cultivating one's own food).

Conclusions

The research has developed design scenarios that constitute as many validation tests of the potential of the greenhouse-threshold device under different conditions of orientation and functional program. This design experimentation methodology aims to demonstrate the typological versatility of the proposed system and its adaptive capacity to varying conditions at its boundary, confirming the hypothesis of its transversal applicability across configurations of contemporary dwelling.

We structured each design scenario to explore specific architectural variables: alternative spatial configurations, differentiated bioclimatic orientations, diversified functional programs, and variable degrees of permeability between interior and exterior. The comparative methodology

adopted allows the verification of how, regardless of contextual conditions, the greenhouse-threshold device maintains its performance effectiveness and qualitative value, invariably constituting an enriching element of the residential experience.

The proposed project for the Panzano District, in Northeastern Italy, demonstrates how innovation and conservation can be successfully combined, creating an intervention model that respects historical memory while looking toward the future, thus promoting a balance between transformation and protection of the site's cultural value. Crucially, the integration of solar greenhouses in the "type 1A" buildings – already subjected to an initial redevelopment attempt according to sustainability criteria by the Monfalcone Municipality – is not merely a technical solution, but a cultural approach that enhances the neighborhood's identity.

The integration of bioclimatic greenhouses demonstrates a measurable enhancement of the building's overall energy and resource performance. Each greenhouse provides an additional 12.1 m² per dwelling unit, predominantly maintaining internal temperatures between 18 °C and 30 °C throughout the year without mechanical conditioning. The greenhouse results in a 20% reduction in thermal and primary energy demand, approximately 70% of which is attributable to the southwest-oriented greenhouse. The application of photovoltaic roofing contributes an additional 12% reduction in non-renewable primary energy consumption.

The rainwater harvesting system ensures irrigation autonomy for up to eight months per year, with a minimum of 30% coverage in summer and over 65% between October and March. Available volumes (1,500–3,500 liters/month) are generally adequate to satisfy irrigation requirements for the 1.75 m² cultivated area, supporting yields ranging from 8–12 kg/month under the conventional configuration. The research confirms that it is possible to achieve significant energy benefits and improve living comfort without betraying the original architectural language.

However, the true strength of this project lies in its replicability. The intervention model defined herein can be adapted and applied in similar contexts, contributing to sustainable and integrated urban regeneration on a broader scale. Looking ahead, we acknowledge that there are still aspects to be explored further, particularly regarding water self-sufficiency within this specific retrofit context. The increasing adoption of advanced computational optimization techniques and smart materials signals a paradigm shift toward more adaptive and performance-driven solutions.

Importantly, our next phase will focus intensively on the compositional, architectural, and technical aspects of the project. Once the performance parameters have been verified and it has been confirmed that this intervention type offers significant improvements over the current situation, we will now concentrate on the form and architectural detail of the solar greenhouse design. This compositional refinement is crucial, as the success of our intervention depends not only on its technical performance but also on its ability to

harmoniously integrate with the existing architectural language and enhance the overall aesthetic quality of the built environment.

The further development of the research will also address a key aspect of the proposed intervention's sustainability, namely its economic feasibility. It is indeed necessary to verify that the costs associated with the installation and the maintenance of the bioclimatic greenhouses are balanced by the expected energy and water resource contributions provided by the proposed solution, as determined through an assessment of the avoided costs over the life cycle of the new installation. In conclusion, this project underscores that the integration between historical heritage and contemporary sustainability requirements is not only possible but essential for creating resilient communities that honor their past while embracing their future. The next aspect of our research will ensure that this integration is not just functionally successful, but also architecturally compelling and compositionally coherent.

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Revisiting Ronchamp and its Interpretations

*By Levent Kara**

Le Corbusier's Chapel at Ronchamp has been the subject of many interpretations. It is an intriguing building that I come back again and again thinking about architecture as I practice and teach it. Many interpretations implicitly reveal that it is a very difficult building to understand as to how it was conceived yet its experience is so clear. It has been seen as many things from mannerism, playful sculpture, to an expression of archetypal structures of perception. Revisiting some of its interpretations is a study worth undertaking for anyone who practice and / or teach architecture as one finds the building is still a great source of material for what it means to think and interpret architecture. In what follows, I will focus on three particular interpretations of Ronchamp that position themselves in three distinct interpretative frames. One sees Ronchamp as an expression of Le Corbusier's inner metaphysics, one approaches the building from within architectural history of styles and vocabulary, and one that aims at its genealogy and design process. While acknowledging the value of these interpretations as studies in design process and architectural vocabulary, I argue that none of these frames are helpful for us as architects and teachers to understand Ronchamp as a work of architecture that does what it does so clearly in its lived experience.

Introduction

Le Corbusier's Chapel at Ronchamp has been the subject of many interpretations. It is an intriguing building that I come back again and again thinking about architecture as I practice and teach it. Many interpretations implicitly reveal that it is a very difficult building to understand as to how it was conceived yet its experience is so clear. It has been seen as many things from mannerism, playful sculpture, to an expression of archetypal structures of perception. Revisiting some of its interpretations is a study worth undertaking for anyone who practice and / or teach architecture as one finds the building is still a great source of material for what it means to think and interpret architecture.[1]

Prominent art historian Ernst Gombrich muses on Braque's words in seeing Picasso's Les Demoiselles d'Avignon: "it is as if you asked us to drink petrol."[2] His response is that "but art is an acquired taste and I confess that actually I have come to like drinking this petrol -the so-called experiment of cubism, which started with

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1. Interpreting architecture as a disciplinary question is beyond the scope of this study. I rely on first-person lived experience as a highly powerful tool that we all have and use to interpret architecture. "The ability to read architecture - to interpret a building's conceptual resonance - is something we do intuitively as part of our everyday lives as we negotiate the labyrinth of our built environment with the tread of legibility that personal experience provides." Singley P. How *to Read Architecture: An Introduction to Interpreting the Built Environment*. NewYork: Routledge, 2019, 5.

2. Gombrich, E. H. *The Image and the Eye*. Oxford: Phaidon Press, 1982, 242.

this picture."[3] Each encounter with an artwork is to be understood as a new event and each artwork demands from the subject its spontaneous fulfillment; the communicative fulfillment before imposing an interpretative frame on to the work. Kuspit reminds us that thinking the art object within pre-established thought has inherent difficulties. He emphasizes that a critical apparatus formed to analyze particular works may not be adequate for other works and may be an obstacle for the critics, creating an "inability to see the 'otherness' of the work -that is, its distinctness as a product separate from their own systems or ideologies."[4] He points out that evaluative concepts should be drawn from the experience of the work itself, and not from once own attitudes toward art.[5,6]

Mies van der Rohe, in response to a question on what he thinks about Ronchamp, claimed that: "it is a very beautiful thing, but not architecture."[7] Mies's response says more about his own understanding of architectural design than about what Ronchamp offers in its experience. Curtis points out similar responses from architects when they visited Ronchamp:

> "When architects and critics flocked to Ronchamp in the mid-1950s to see the finished building, they returned home with mutterings about 'a new Baroque' or 'a descent into irrationality'. Nikolaus Pevsner, the historian who had written Pioneers of Modern Design, was puzzled by what he took to be a departure from the true way. Stirling wrote of 'the rationale and the initial ideology of the modern movement being mannerised and changed in a conscious imperfectionism. Ronchamp was contrasted with the supposed 'rationalism' of the architect's earlier works and with the mechanistic precision and industrial standardization of American modern architecture of the 1950s, especially that stemming from the example of Mies van der Rohe. These reactions perhaps tell more about the preoccupations of the period than they do about Ronchamp."[8]

These sentiments of an era of modern architects and historians reflect a lack of openness to the plasticity of architectural design, a biased commentary on Ronchamp as an architectural object. Accordingly, Ronchamp is conceived as a break in Le Corbusier's architecture. However, as Curtis underlines: "it had roots in the artist's early paintings, sculptures, buildings and urban schemes, as well as in his analysis of a number of vernacular and monumental structures from the distant past."[9] It is true that Ronchamp is in a sense significantly different from the earlier works of Le Corbusier as to its overall form; nevertheless it is a continuation in his design research in the sense that it exposes similar formal strategies. Ronchamp pursues the same architectural ideas within the same understanding of architecture, albeit in a different sense of plasticity. Colquhoun

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3. Ibid.

4. Kuspit, D. *The Critic is Artist: The Intentionality of Art*. Michigan: UMI Research Press, 1984, 11.

5. Ibid, 8.

6. Similarly, Chee underlines the otherness of the work: "...something 'other' happens if we recount occurrences without embellishment or prior assumptions, trying to make sense of what we encounter but cannot fathom, an sticking to 'only what we *know*', without adding anything, and the satisfaction we are trying to get from the explanation comes of itself." Chee L. *Architecture and Affect: Precarious Spaces*. London: Routledge, 2023, 2.

7. Kortan, E. Mimarlikta Özel Yaklaşimlar-2: Ronchamp Tapinağı. Ankara: METU Press, 1977, 1.

8. Curtis, W. J. R. *Le Corbusier: Ideas and Forms*. London: Phaidon Press, 1995, 178.

9. Ibid.

underlines that, for Le Corbusier, architecture was a matter of creating states of mind and even on the notion of standardization in architecture; his conception was significantly divergent from that of his contemporaries.[10] "For Le Corbusier, the problem was to standardize only certain elements with highly specific functions, falling under the category of 'equipment', and leave the architect free to arrange these elements according to artistic principles and within an envelope that need not be fixed a priori."[11] Le Corbusier himself is very clear on his conception of architecture:

> "The business of Architecture is to establish emotional relationships by means of raw materials. Architecture goes beyond utilitarian needs. Architecture is a plastic thing. You employ stone, wood and concrete, and with these materials you build houses and palaces. That is construction. Ingenuity is at work."[12]
> "But suddenly you touch my heart, you do me good, I am happy and I say: 'This is beautiful.' That is architecture. Art enters in."[13]

The plasticity of Ronchamp as a way of creating and communicating states of mind is not different from that of his early works. Ronchamp is a new experiment in Le Corbusier's continuous design research into creating particular experiences through plastic form making.

Ronchamp as a Symbolic Inscription

> "It is in fact likely to lose sight of the work of art as such and to consider it a record of something more important than the work itself."[14]
> "The question is never once broached whether a psychologically sound Baudelaire would have been able to write The Flowers of Evil, not to mention whether the poems turned out worse because of the neurosis."[15]

Childs, admitting his work belongs to the realm of speculation, sets forth to interpret Ronchamp through a constructed insight into Le Corbusier's cosmological belief system. Scrutinizing various phases of his life, he traces different events to construct a picture of Le Corbusier's individual metaphysics. Mentioning some symbols that he derives from this supposed cosmology, Childs argue that:

> "Nor was his use of spiritual symbolism limited to Le Corbusier's paintings. The Sun and the Moon, numerically represented by the Triad and the Tetrad, figure throughout Ronchamp as their sum, seven, which according to Pythagoras represented the union of man and divinity. If one examines the plan of Ronchamp from south to north, the outline of a human head looking east is discernible, but orient the plan north to south, and the roof line of the southern facade produces the

10. Colquhoun, A. *Modernity and the Classical Tradition*. Cambridge: The MIT Press, 1989, 163.
11. Ibid, 178.
12. Le Corbusier. (1923). *Towards a New Architecture*. Oxford: Butterworth, 1989, 151.
13. Ibid, 153.
14. Hauser, A. (1959). "The Philosophy of Art History". In *Art History and Its Methods: A Critical Anthology.* E. Fernie (Ed.). London: Phaidon Press, 1995, 209.
15. Adorno, T. (1970). *Aesthetic Theory*. London: The Athlone Press, 1997, 8.

> unmistakable horn motif of the Taurus paintings. Perhaps Le Corbusier meant us to discover this for ourselves when he wrote in his commentary on Ronchamp: 'Counterpoint, and fugue -music -grand music, undertake to look at the image upside down, or turn them a quarter angle. You will discover the game.'"[16]

Childs's interpretation seems to be a reader oriented one. Umberto Eco, in *Interpretation and Overinterpretation*, underlines the differences between three kinds of interpretative attitudes: the reader, the author, and the text oriented approaches. And he also underlines the distinction between interpreting and using a text.[17] Eco's discussion focuses on literary texts. However, his notion of 'internal textual coherence' applies to understanding of any hermeneutic unity. "The internal textual coherence controls the otherwise uncontrollable drives of the reader."[18] An architectural object creates this unity in the precise calibrations of its plans, sections, overall volumetry, tectonics, and materiality. The result is the particular first-person phenomenal experience that the architectural object offers.[19]

The plan configuration of Ronchamp, when taken in isolation as pure graphics, may be associated with some cosmic figures as Childs suggests. Those cosmic figures though are not in the architectural experience, they are not part of the consciousness of the subject as she moves through the chapel. The plan, rather than indicating its independent existence as being merely a graphic inscription on the surface of the land, constructs and controls the gestures of the subject: entry, movement, thresholds, sight, light. The plan is the matrix that enables the particular experiences with its control over the other elements of the third dimension and accompanying qualities of light and materiality. And these experiences are not arbitrary to suggest that they may be the result of a totally different generator as when the plan is taken as a cosmic inscription in isolation from the other elements of the chapel. We may even suggest an analogy with playing chess through forms as the basis for the plan decisions, to construct experiences pregnant with particular states of mind. In other words, internal coherence of the architectural text does not indicate a significance of a human head, or another figure as the generator of Ronchamp's plan.

Childs's quotes Le Corbusier as the architect reflects back on Ronchamp in his monograph to support his cosmic reading:

16. Childs, A. "The Fearful Mirror of Apollo". Interstices 4: Journal of Architecture and the Related Arts (1996), 4.

17. Eco, U. *Interpretation and Overinterpretation*. New York: Cambridge University Press, 1992, 67-88.

18. Ibid, 64-65.

19. "Philosophical hermeneutics offers an intellectual ground of great relevance for architecture. At the heart of this study is an understanding of architecture as fundamentally interpretive. Architecture interprets human life or human action. The built work resulting from this interpretation is in turn interpreted in its reception by those who inhibit it." Faulder S. J. *Philosophical Hermeneutics and The Architecture of Alvaro Si*za: *Meaning, Action and Place*. NewYork: Routledge, 2025, 4.

> "Observe the play of shadows, learn the game... Precise shadows, clear cut or dissolving. Projected shadows, sharp. Projected shadows, precisely delineated, but what enchanting arabesques and frets. Counterpoint and fugue. Try to look at the picture upside-down or sideways. You will discover the game."[20]

Written on two pages, these words are printed together with two photographs of Ronchamp. When the part Childs quotes is located in this context, another interpretation is possible, a much more economical one. The photographs are two episodic images with very particular angles, distancing the building as a whole, and framing a gaze, a plasticity that is dominant throughout one's first-person experience of Ronchamp. This interpretation is more economical as it fits the overall structure of Le Corbusier's monogram on Ronchamp. For example the model is photographed before some paintings of Le Corbusier as its background.[21] The emphasis is on form making and plasticity as the medium for exploring particular states of mind: lived experiences that Le Corbusier explored in both painting and architecture.

There are other evidences that weakens Childs's interpretation of the plan of Ronchamp as a figure indicating certain meanings within the frame of Le Corbusier's cosmology. For example, the bull horn as a motif frequently occurs in Le Corbusier's late works. It may have certain metaphysical meanings for the architect which are beyond our access. However, every time he employs the motif, Le Corbusier does it architecturally, transforming the form into an architectural entity that is part of the architectural experience, either enhancing a certain verticality or sectional quality that playfully rethinks volumetry and light. Le Corbusier's symbolism, whatever that may be, operates at the level of lived architectural experience, and is transformed into concrete forms with particular experiences. He is very clear on plans, and dedicates an entire chapter to 'the illusion of plans' in his *Towards A New Architecture*:

> "Arrangement is the gradation of aims, the classification of intentions."
> "Man looks at the creation of architecture with his eyes, which are 5 feet 6 inches from the ground. One can only consider aims which the eye can appreciate and intentions which take into account architectural elements. If there come into play intentions which do not speak the language of architecture, you arrive at the illusion of plans, you transgress the rules of the Plan through an error in conception, or through a leaning towards empty show. "[22]

Ronchamp as 'Mannerism'

James Stirling in his essay *Ronchamp: Le Corbusier's Chapel and The Crisis of Rationalism* gives a very detailed outline of his actual experience of the building not only in terms of the relations between different architectural elements, and

20. Le Corbusier. *The Chapel at Ronchamp*. London: The Architectural Press, 1957, 38-39.
21. Ibid, 104.
22. Le Corbusier. (1923). *Towards a New Architecture*. Oxford: Butterworth, 1989, 177.

materials and techniques of construction, but also of related experiential qualities.[23] His comments demand discussion. For example, he draws a parallel between the Mannerist period of the Renaissance and Ronchamp, and interprets the building as "a derision of modern movement in a state when its vocabulary can no longer be extended."[24] More importantly, he sees a similarity between Ronchamp and Erich Mendelsohn's Einstein Tower. Even though he underlines that "but only inasmuch as the walls and roof are fused into one expression,"[25] together with his other comments, the appearance of Einstein Tower in his reading of Ronchamp indicates an association of the two buildings in their plastic qualities. Stirling sees in Ronchamp a sculptural expression consumed at once without any lingering intrigue:

> "The sensational impact of the chapel on the visitor is significantly not sustained for any great length of time and when the emotions subside there is little to appeal to the intellect, and nothing to analyze or stimulate curiosity. This entirely visual appeal and the lack of intellectual participation demanded from the public may partly account for its easy acceptance by the local population."[26]

Ronchamp and the Einstein Tower are not similar. They don't belong to the same category of plasticity. Every move in Ronchamp, every curve, every angle, etc., is calibrated for human existence from within the architectural form. Rather than being a large scale sculpture, like the Tower, where the forms are generated from and adjusted to a single expression for vision, Ronchamp looks at the occupying human body and not only sight but its spatial and temporal experiences as a whole as the generator of its forms. The Einstein Tower can be seen as mannerism as early as 1920's, a search for formal expression as an end in itself. Ronchamp can only be seen as mannerism within a very narrow definition of modern architecture tied to certain geometries and organizational principles. Beyond this, it is the culmination of a long research on architectural form and design by Le Corbusier as a means of reflection on the human existence. For me, the acceptance of local people testifies to this. Built as a pilgrimage chapel, the building resonates with the pilgrims in ways an architecture of formal structural autonomy, 'the intellectual' architecture of Stirling, cannot grasp.[27]

Other authors highlight the design process of Ronchamp as Le Corbusier immersed himself in books on the rituals of the Catholic religion and gathered information about the tradition of pilgrimage associated with the place.[28] It is clear that Le Corbusier achieved an essential experiential quality for the rituals without falling into a game of symbolism of forms. In response to the question why they

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23. Stirling, J. (1957). "Ronchamp: Le Corbusier's Chapel at Ronchamp and the Crisis of Rationalism", Le Corbusier in

Perspective, P. Serenyi (Ed.). New Jersey: Prentice Hall, 1975: 64-67.

24. Ibid, 65.

25. Ibid.

26. Ibid, 66.

27. "Between transformation and creation, architecture activates the emergence of space-time, enabling us to orient ourselves. In the process of configuring, architecture makes the world, not as some exceptional divine operation that took place at the beginnings of time and thus is forever frozen in place, but as an ever-critical formal notice for human beings to exist." Younes C. *Architectures of Existence: Ethics, Aesthetics, Politics*. NewYork: Routledge, 2024, 1.

28. Baker, G. H. *Le Corbusier: An Analysis of Form*. New York: Van Nostrand Reinhold, 1984, 212.

had chosen Le Corbusier as the architect for the Monastry of La Tourette, a member of the community explains:

> "Why? For the beauty of the monastery to be born of course. But above all for the significance of this beauty. It was necessary to show that prayer and religious life are not bound to conventional forms, and that harmony can be struck between them and the most modern architecture, providing that the latter should be capable of transcending itself."[29]

If we see architecture as a problem of vocabulary, Ronchamp is indeed an epitomization of 'imperfectionism' for 'modern movement'.[30] Its public acceptance on the other hand showcases that the intellectual discussions within architecture about form, elements, etc. may very well miss architecture as a lived phenomenon in the overall texture of culture.[31]

Ronchamp's Origins

> "It stands, so to speak, only for itself and in itself. Now this is decisive for dealing with the question at hand concerning the intention of the author. When it comes to a work of art, it could be said that the intention has, so to speak, "gone into" the work, and can no longer be sought behind it or before it. This sharply limits the value of all biographical insights related to a work of art, as well as those associated with the history of its origins. Works of art are detached from their origins and, just because of this, begin to speak-perhaps surprising even their creators."[32]

Daniele Pauly, in her chapter The Chapel of Ronchamp as an Example of Le Corbusier's Creative Process,[33] sets out to explain Ronchamp through the process of its design, tracing Le Corbusier's references as precursors for its form. Pauly differentiates between implicit and explicit sources that play part in the generation of Ronchamp.[34] The implicit sources are suggested to reveal an unconscious process of association belonging to the incubation period of the project. For instance, Pauly claims that the south wall of Ronchamp with its thickness and the articulation of the openings has its origin in one of the local architectures of northern Africa which Le Corbusier has absorbed into his architectural repository

29. Ibid.

30. Stirling, J. (1957). "Ronchamp: Le Corbusier's Chapel at Ronchamp and the Crisis of Rationalism", Le Corbusier in Perspective, P. Serenyi (Ed.). New Jersey: Prentice Hall, 1975, 65.

31. "Engaging the encounter in discourse without losing its immediacy is germane. The assumption here is that architecture is encountered circuitously, through people and things that are caught in its frame. Such knowing is mediated by peripheral subjects/objects, modes of occupancy and experience which sit outside architecture's disciplinary frame or its orbits of dissemination. Such knowing takes seriously the pull of serendipitous encounters." Chee L. *Architecture and Affect: Precarious Spaces*. London: Routledge, 2023, 4.

32. Gadamer, H. G. (1989). *Dialogue and Deconstruction: The Gadamer – Derrida Encounter*. D. P. Michelfelder, R. Palmer (Eds.). Albany: State University of New York Press, 1989, 123.

33. Pauly, D. *Le Corbusier*. London: Birkhauser, 1989.

34. Ibid, 128-132.

during a trip in 1931.[35] The explicit sources, on the other hand, as Pauly explains, are the ones Le Corbusier himself refers in the design process, such as the Villa Adriana at Tivoli, which provided the solution for light penetration into the side chapels of Ronchamp; the shell of a crab that became its roof; a hydraulic dam whose working mechanisms employed for collecting the rain water; or an airplane wing, which is transformed into the structure of the roof, all of which are employed as sources of solutions for different architectural problems.[36]

Being explicitly referred to or not, these two kinds of sources are not different in kind, and they do not have a place in the final reading of the architectural object. Any source, any memory, any biographical anecdote belong to the psychology of the design process, but they may not explain the end product. All such sources, explicit or implicit, are transformed into the unity of the architectural object. They are synthesized into systemic entities that bear very little if any at all resemblance to their original forms or functions. Tracing the genesis of an architectural object, finding out the precursors of forms and functions, illuminates the creative process and is a study well worth to undertake as a psychological etude. But when it comes to understanding the architectural object as a unified experience in the lived space of culture, such genesis of form, even when available and accurate, bears not much fruit. It makes architecture an autonomous formal endeavor, as if the architectural experience is a function of vocabulary, not different from linguistic experience.

Eco makes a distinction between textual strategy as a linguistic object and the creative process as "the story of the growth of that textual strategy." [37] Internal textual coherence as textual strategy is not its biographical story of growth and coming into being. Any hermeneutic unity, whatever goes into its making, only becomes itself when it transforms its history in its own systemic unity. It is not a historical assimilation of parts or a collection of things, its claim to meaning comes from its own systemicness, its hermeneutic energy. And indeed Ronchamp resists such an analysis for the origins in the sense that the crab shell is not the crab shell anymore but the roof with its unique form; every predecessor has transmuted into something different from its original and has a new meaning in a different system of references that is the irreducible hermeneutic unity that we experience. Neither the crab shell, nor the other precursors mentioned by Le Corbusier himself or suggested by interpreting authors have a place in Ronchamp. They have their places in the creative design process and an analysis of the project's genealogy may be appraised as an attempt to decipher the creative procedure. But they cannot be part of a reading of the work strictly understood as the experience of an architectural object in the concreteness of here and now. When interpreting an architectural work becomes a reading of the genealogy of the object, it bypasses the experiential unity of the new meaning claim of the object and reduces the work to a collection of known things and earlier meanings.

Podro underlines that "in the case of many major works, we have no idea of the immediate sources upon which the artist drew."[38] And giving the example of

35. Ibid, 132.
36. Ibid, 129-131.
37. Eco, U. *Interpretation and Overinterpretation*. New York: Cambridge University Press, 1992, 85.
38. Podro, M. *The Critical Historians of Art*. London: Yale University Press, 1982, 136.

Brunelleschi's augmented column motif, which has numerous anticipations, used in Santo Spirito he suggests: "what concerns us is the way the device is used in the context of Brunellschi's building."[39] These qualities, transmitted through tradition, themselves are transformed into another character within another system of references which is the architectural object.

For example, the south wall of Ronchamp may have its origins somewhere in a local architecture of northern Africa, as suggested by Pauly. There are other authors ascribing different origins.[40] It is true that the south wall carries certain qualities transmitted through the Mediterranean domestic architecture traditions; nevertheless, it also has a unique existence in itself independent of any origins. It is what it actually is in the context of Ronchamp because of its play with the roof structure and its creation of the overall volumetry of the building. Its curve, changing elevational profile, and changing thickness revealed through the aperture system, the unique formation of the apertures with specific carving profiles, all of these create the wall's particular experience. Almost like a hugging arm, or an open invitation to the entry, its movement is unmissable. The character of light it lets in the interior, both spiritual and playful, is unmissable. None of these are explicable through any typological origins. An original reading is required to see what the wall does in its own context.

Discussion

The associations Ronchamp evokes are numerous. Intrigued by its forms, many authors aimed at pinning down the experience of the building in terms of some architectural or spiritual reference:

> "Making a comparison between Ronchamp and a megalithic tomb, (John) Alford argued that the chapel 'can best be understood as a symbolic fortress and tomb', and characterized it as a 'fortress...against death.' He also recognized the chapel visual affinity to a ship, calling it 'a ship of life'."[41]
>
> "Ronchamp may be viewed as the summation of the human predicament, as the ship of life of the transient pilgrim, or as the fortress against death for the weary and the restless- a fortress which inevitably becomes his tomb."[42]
>
> "......- in part Maltese tomb, in part Ischian vernacular, its half-cylindrical side chapels, top lit through spherical cowls and oriented towards the trajectory of the sun, serve to remind one that this Christian site was once the location of a sun temple."[43]
>
> "The whitewashed rendering is applied to the interior as well as to the exterior and the openings scattered apparently at random over the south and north walls splay

39. Ibid.

40. See Providencia P. "Ronchamp, South Wall". *Joelho Revista de Cultura Arquitectonica*. (2022): 21-44 for a thorough study on archetypal origins for example.

41. Serenyi, P. *Le Corbusier in Perspective*. New Jersey: Prentice Hall, 1975, 8.

42. Ibid.

43. Frampton, K. (1980). *Modern Architecture: A Critical History*. New York: Thames and Hudson, 1992, 228.

> either inwards or outwards, similar to the reveals of gun-openings in coastal fortifications."[44]
>
> "The transition into the interior at Ronchamp is dramatic. One enters an otherworldly cave, a catacomb."[45]
>
> "The inside / outside idea is brought to a crescendo which conveys the feeling of an Early Christian gathering in a landscape, while touching on the artist's private agenda of a mystical cult of nature."[46]
>
> "...there is the idea of the 'deep grotto', rendered by the effects of soft, round masses that surround the observer and give a sense of reassurance."[47]

These readings of Ronchamp reveal similar associative processes occasioned through their own experience of the building. It is evident that Ronchamp with its unique form initiates a reaction of associative thinking which consequently leads to a process of ascribing meanings. All these interpretations seem plausible in their associations; moreover, they all belong to Ronchamp as an architectural object for they belong to the individual architectural experiences. These associative explanations for the particular experiences, while exemplifying the architectural experience by multiplying its possible psychological references, may not be sufficient or even necessary in the sense of understanding the particular character of the building. While they may point to possible source experiences, the way the building constructs its unique experience is a synthesis beyond any of those sources. The architectural act is a significant transformation of all of its sources into a new unity. This new unity may reverberate into a 'Netherworld', as Gregotti put it in his essay on design process,[48] and it may play with known or unknown memories. Nevertheless, none of these sources, memories in their singularity is sufficient or even necessary to explain the new unity. The synthesis overrides all the sources in its unique transformations.

The textual/hermeneutic unity of the architectural act can only be understood within its lived experience; and this experience, while it may reverberate into language in terms of various psychological ramifications, nevertheless is indescribable in language in its uniqueness and fullness. Any explanatory framework is bound to fall short of grasping the first person phenomenal experience, as it would be a categorical reduction; placing a particular in its singularity into a domain of similarities - a family of resemblances. It will be reducing an intuition to its closest meaning form, which is nevertheless a conceptual domain.

Cassirer significantly points to a quality in great artists: "in actuality, the particular manner in which the work of art is expressed belongs not only to the technique of construction of the work but also to its very conception; Beethoven's intuition is musical, Phidias's intuition is plastic, Milton's intuition is epic, Goethe's intuition is lyric."[49] Similarly, Le Corbusier's intuition is architectural. The significant effort performed by Le Corbusier through his architecture exemplifies an architectural intuition that transforms not only the knowledge carried through traditions of

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44. Curtis, W. J. R. *Le Corbusier: Ideas and Forms*. London: Phaidon Press, 1995, 65.
45. Ibid, 177.
46. Ibid.
47. Pauly, D. *Le Corbusier*. London: Birkhauser, 1989, 130.
48. Gregotti, V. *Inside Architecture*. London and Cambridge: The MIT Press, 1996, 90-94.
49. Cassirer, E. (1960) *The Logic of the Humanities*. New Haven: Yale University Press, 1966, 205.

architecture but all kinds of objects, from animals and plants to machines and other natural formations in new phenomenological syntheses. His paintings, sculptures, and buildings, all resonate with a keen eye/feel on how form performs in various experiential modalities and this research culminates in his architecture in an occupied spatio temporality. His late architectural work from Ronchamp to La Tourette, to posthumously built Saint-Pierre in Firmini are among the rare great works of architecture that exemplify an unmissable reflection on human existence. Rather than trying to understand these in some biographical metaphysics, as in the case of Childs; or within the narrow vocabularies of histories of architecture, as in the case of Stirling; or through some genealogy, as with Pauly, I believe we need to learn them through their lived experiences. For me, in architecture, the only tool we have to get close to the very intuition of the work is drawing and sketching: reenacting the architectural act while we draw; making sense of the object in the particular temporality of our act of drawing. We need to sit down and sketch, sketch after sketch. We need to redraw and rethink their plans, sections, rerender their materiality, textures, colors, light. We need to listen to them again and again in their unique presences as great works of art without feeling a need to categorically understand them.

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Autonomous Housing for "Co-operative Autonomy"

*By Alioscia Mozzato**

This paper explores the cultural implications of the theoretical and design reflections of North American and European architectural countercultures on the 'autonomy' of domestic living, within the context of the energy crises that characterized the second half of the twentieth century. In an attempt to provide a unified framework for the heterogeneous and fragmented literature on the various experimental "Autonomous House" projects, this study aims to uncover the deeper motivations that link the reconfiguration of architectural space according to a logic of 'self-sufficiency' with the reimagining of post-industrial models of economic development and social organization. Ultimately, it seeks to evaluate the continuing relevance of these ideas, both historically and in light of today's renewed awareness of the fragile relationship between the environmental context and the built environment shaped by architecture.

Introduction

In the long history of energy crises that have characterized the post-war period of the short twentieth century, the 1973 crisis – triggered by the Yom Kippur conflict between the State of Israel and the Arab countries allied with Egypt and Syria – marks the beginning of a profound reflection on the economic and environmental fragility of the previously consolidated models of management and exploitation of the main energy resources in the Western world[80] (see Figure 1).

Above all, in the field of economic and sociological studies, one observes a deep critique, in particular, of centralized systems of production and distribution of the principal fossil energy sources which, on the one hand, fuels a broader political debate on the forms of control over economic models and, by extension, over the social structures of post-industrial capitalism, and, on the other hand, finds expression in the architectural culture of those years as a broader need to rethink the design practice in light of a renewed awareness of the fragile relationship between different environmental contexts and the space shaped by architecture.

This study retraces much of the heterogeneous and fragmentary historiographical documentation on the research developed by architectural culture, especially in the Anglo-Saxon context, starting from the first half of the 20th century, on the concept of "self-sufficiency" in domestic living. By systematizing the contents of the main experimental projects and the literature published on the subject, the aim is, first and foremost, to shed light on a chapter of architectural history that is still insufficiently explored today, in order to indicate possible horizons and potentials for future research. Secondly, it aims to convey the heterodox cultural contribution that these architectural reflections express when situated within the context of the

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80. Francesco Petrini, "La crisi energetica del 1973. Le multinazionali del petrolio e la fine dell'età dell'oro (nero)," Contemporanea, no. 3 (2012): 445-473.

construction of new socio-economic paradigms, in order to understand their criticalities and elements of relevance in the current contemporary debate on the forms that the design of architectural space assumes in relation to the multiple theoretical and operational interpretations connected to the broad semantic horizons of the concept of 'sustainability'.

Pioneering Experiments: the 'Solar Houses'

The austerity policies adopted by Western countries to cope with the oil embargo imposed by the Organization of the Petroleum Exporting Countries (OPEC) – initially directed at Canada, the United States, Japan, Netherlands and the United Kingdom and later extended to Portugal, South Africa, and then Rhodesia, now Zimbabwe[81] – constituted, for architecture and urban studies, a favorable condition for the development of intense experimentation.

In fact, during the 1970s, research was concretely developed – through the construction of prototypes, the publication of books, essays, and manuals – to address the 'energy crisis' by proposing 'alternative solutions', ranging from the use of renewable energy sources, to new systems for energy storage, and even to more radical systems of social and economic management and organization and of exploitation of environmental resources – solutions that had already been initiated, especially in the United States, between the two World Wars.[82]

81. Bruno Marcel and Jacques Taïeb, *Les grandes crises: 1873-1929-1973* (Lassay-les-Châteaux: Armand Colin, 2005).

82. Giovanna Borasi and Mirko Zardini (Eds.), *Sorry, out of gas: architecture's response to the 1973 oil crisis* (Montréal: Canadian Centre for Architecture; Mantova: Corraini, 2007).

Figure 1. *Gianni Berengo Gardin, Campeggio sull'autostrada (Camping on the Highway), Switzerland, 1973. Photograph taken during the days of the oil crisis*
Source: Monika Gisler, "Come la Svizzera ha affrontato la crisi petrolifera del 1973 [How Switzerland addressed the 1973 oil crisis]", in *SWI swissinfo.ch*, 2002 [Online]. Available at: https://www.swissinfo.ch/ita/cultura/come-la-svizzera-ha-affrontato-la-crisi-petrolifera-del-1973/47972416 [Accessed: 9 November 2024].

One of the earliest and most ambitious research projects that fits fully within this historical and cultural framework was initiated in 1938 by Hoyt Clarke Hottel (1903-1998) at the Massachusetts Institute of Technology (MIT),[83] and was dedicated to the development of solar energy technologies for the heating of single-family domestic environments. Between 1939 and 1959, Hottel and his research group built a series of 'solar house' prototypes on the MIT campus, equipped with what was then an innovative system for converting solar radiation into thermal energy. Inside 'water-based' collectors made of transparent glass panels installed on the roof, the fluid contained in small pipes was heated by solar radiation and subsequently stored in tanks, to be later used as a heat transfer fluid to deliver the necessary heat for space heating within the dwelling (see Figure 2).

Research on what are now more commonly referred to as 'solar collectors' continued even after the experimental phase of the 'MIT Laboratory'. George Löf (1913-2009), a professor in the Department of Engineering at the University of Colorado and a student of Hoyt Clarke Hottel at MIT, focused his research on the development of 'air-based' collectors which, unlike the 'water-based' ones, used air as the heat transfer fluid and stone material for the accumulation and storage of heat.[84] In 1957, the technological system developed by Löf and installed in his

83. Pierre-Édouard Latouche, "Solar in the Laboratory", in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 78-83.

84. Ken Butti and John Perlin, *A Golden Thread: 2500 Years of Solar Architecture and Technology* (New York: Van Nostrand Reinhold, 1980).

residence in Boulder, Colorado, was able to meet 23% of the heating energy demand. A few years later, Henry Mathew (1938-2002), a self-taught solar energy enthusiast, independently built in his home in Coos Bay, Oregon, a solar thermal plant consisting of 67 square meters of collectors connected to tanks containing 30.000 liters of water. After some modifications made between 1973 and 1974, the system was capable of producing 85% of the energy required to heat the indoor space of the house.[85]

The house designed by architect Eleanor Raymond (1887-1989)[86] for Amelia Peabody (1890-1984) and built in Dover, Massachusetts, in 1949 represents the first architectural work whose internal heat demand was entirely met by the sole energy contribution of solar radiation. The sophisticated technological system, designed by engineer Maria Telkes (1900-1995), nicknamed the 'Sun Queen' and who was a colleague of Hoyt Clarke Hottel at MIT, was composed of 'air-based' collectors placed in the upper portion of the south-facing façade. These consisted of a double-glazed panel detached from the wall surface – painted black to create an air cavity – within which the air was heated by solar radiation. For thermal energy storage, instead of the traditional stone material, a 'eutectic mixture' (a solution of sodium sulfate salts) – previously tested in the second prototype built by Hottel's research group at MIT in 1947 – was used. This was contained within vertical drums between which the pre-heated air circulated, melting the salts in the mixture to store heat and releasing it into the interior through crystallization when the indoor temperature dropped.[87]

The exploitation of thermal energy produced by solar radiation was also a research theme that saw significant development in Europe. Engineer Félix Trombe (1906-1985), within the framework of research promoted by the *Centre national de la recherche scientifique* (CNRS), designed and built in 1967 in Odeillo, France, two houses equipped with a 'passive' thermal storage system integrated into the external wall, more commonly known as the 'Trombe wall'.

By placing a glass panel a few centimeters from the south-facing wall, a greenhouse effect was produced that heated the air inside the cavity thanks to the heat emitted by the stone wall as a result of solar radiation. During daytime hours, vents located at the top and bottom of the wall allowed the heated air to be transferred indoors by exploiting the convective currents generated within the cavity. At night, the thermal energy stored in the masonry radiated directly into the interior, while the openings were closed to prevent the phenomenon of reverse convection.[88]. In 1969, architect Jacques Michel (1920-2014), a longtime collaborator of Trombe, employed this technology in the design of a house in Chauvency-le-Château, further developing its functioning to enable summer cooling by adding openings at the top

85. Pierre-Édouard Latouche, "Pioneering Experiments", in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 84-85.

86. Doris Cole, *Eleanor Raymond, Architect* (Philadelphia: Art Alliance Press; Toronto: Associated University Press, 1981).

87. Pierre-Édouard Latouche, "A Solar First", in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 86-87.

88. Edward Mazria, *The Solar Passive Energy Book* (Emmaus (PA): Rodale Press, 1979), 43-50.

of the external glass panels, thereby allowing the heated air within the cavity to escape during the summer months.[89]

Figure 2. *MIT Solar House I, Cambridge, Massachusetts, 1939. Installation of 'Solar Collectors' on the Roof of the First 'Solar House' Prototype, developed by the Research Group Led by Hoyt Clarke Hottel on the Campus of the Massachusetts Institute of Technology (MIT)*
Source: Giovanna Borasi and Mirko Zardini (eds), *Sorry, out of gas: architecture's response to the 1973 oil crisis* (Montréal: Canadian Centre for Architecture; Mantova: Corraini, 2007), 78.

More generally, these studies on the development of 'alternative technologies' capable of harnessing the thermal energy produced by solar radiation in the context of domestic living gave rise to the construction of what are better known as the first prototypes of the 'solar house'. These experimental projects represent the theoretical and cultural premises of that more radical reflection on the concepts of 'self-sufficiency' and 'autonomy' which came to characterize the narratives and experiments of the North American–and, to some extent, European – architectural and artistic counterculture beginning in the 1970s, as a consequence of the first energy crisis of 1973.[90]

89. Pierre-Édouard Latouche, "Innovation: The Trombe Wall," in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 110-111.

90. Giovanna Borasi and Mirko Zardini (Eds), Sorry, out of gas: architecture's response to the 1973 oil crisis; see also Lee Stickells, "Exiting the Grid: Autonomous House Design in the 1970s", in *Proceedings of the Society of Architectural Historians, Australia and New Zealand: 32, Architecture, Institutions and Change*, edited by Paul Hogben and Judith O'Callaghan (Sydney: SAHANZ, 2015), 652-662.

A New Paradigm: The 'Autonomous Houses'

As observed by Mirko Zardini,[91] the experimental projects of the American research groups: the Farallones Institute at the University of Berkeley in California,[92] the Centre for Alternative Technology (CAT),[93] Integrated Life Support Systems Laboratories (ILS Labs),[94] the Ouroboros Project,[95] and the New Alchemy Institute,[96] adopting the critiques of development models imposed by the capitalist system, particularly those of Ivan Illich (1926-2002)[97] and Ernst Friedrich Schumacher (1911-1977),[98] developed an architectural reflection on the theme of 'self-sufficiency' oriented toward the construction of new and more radical social and economic models. Within the context of this research, the idea of the autonomy of built space from modern structures and economies of production and distribution is not assumed in a mythological sense, aimed at proposing a return to an Edenic condition associated with the Rousseauian figure of the so-called *bon sauvage*, nor at affirming an unconditional supremacy of individual freedom over the collective dimension of existence.

The content of these theoretical and operational experiments, which, as we shall see, develop around the concept of 'autonomous houses', should rather be referred to the intention to construct new paradigms for the functioning of society and alternative lifestyles through the design of architectures and different models of community, capable of repositioning the issue related to the energy autonomy of buildings within a much broader critical and cultural context, centered on an idea of the cyclicality of environmental resources that extends from food production to water use and as far as processes of waste transformation and recovery.

The expression «Autonomous Houses» was first used by Alexander Pike (1924-1979), director of the Autonomous House Research Programme at the Department of Architecture of the University of Cambridge in Massachusetts,[99] to describe a dwelling equipped with a series of integrated technological devices designed to achieve total autonomy in terms of energy needs and services related to domestic functions.

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91. Mirko Zardini, "Think Different", in *Sorry, out of gas: architecture's response to the 1973 oil crisis,* 40-49.

92. Giovanna Borasi, "Farallones Institute", in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 220-221.

93. Giovanna Borasi, "Centre for Alternative Technology", in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 202-203.

94. Giovanna Borasi, "Integrated Life Support Systems Laboratories", in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 207-209

95. Giovanna Borasi, "The Ouroboros Project", in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 216-219.

96. Adam Bobbette, "New Alchemy Institute", in *Sorry, out of gas: architecture's response to the 1973 oil crisis*, 210-215.

97. Ivan Illich, *Tools for Conviviality* (London: Calder and Boyars, 1973).

98. Ernst Friedrich Schumacher, *Small Is Beautiful: Economics as if People Mattered* (London: Blond and Briggs, 1973).

99. Alexander Pike et al., "The Autonomous Housing Research Program", *Building Science,* Special Supplement: "Energy and Housing" (1975): 119.

The design research and several prototypes developed by the group led by Pike can be understood as an attempt to explore new tools and categories of architectural space design through which to rethink the single-family house as the construction of a completely 'closed system', in which the inflows and outflows of energy, water, and food resources are managed in such a way as to be integrated within a substantially circular operational structure.

What distinguishes Alexander Pike's 'autonomous houses' project from the 'solar house' prototypes developed by Hoyt Clarke Hottel at MIT is the idea of incorporating into architectural space a multifunctional technological infrastructure conceived not only to support the energy needs related to the control of indoor environmental conditions, but above all as a response to the various and multiple levels of self-sufficiency related to domestic functions. It is therefore not merely a technical solution aimed at a more efficient and sustainable use of solar energy, but rather, by exploring new systems of transformation and management of a broader spectrum of renewable resources, including water and food, the concept of the 'autonomous house' represents, on a cultural level, a possible response to the environmental, economic, social, and political issues, then as now urgent, generated by the uncontrolled industrial development of a falsely liberal orientation. This research propose, in fact, a radical paradigm shift toward the self-sufficiency of ways of inhabiting the world, taking as their starting point the foundational element of the built environment: the single-family dwelling.

In March 1976, the Italian magazine *Casabella* (1976)[100] published on its cover the image of *Piece of Nature* [*Stuck Natur*] (1971–1973) (see Figure 3), a work of art by the avant-garde architectural group Haus-Rucker-Co, founded in Vienna in 1967 by Laurids Ortner, Günter Zamp Kelp, and Klaus Pinter, known in the critical literature for the construction of habitable 'bubbles' within urban space, conceived as devices intended to define conditions of existence deliberately separated from physical reality and from the social and collective dimension of the city.

This intention to signify a voluntary detachment from the physical and sociological contexts of urban settlements is expressed in many of Haus-Rucker-Co's projects, for example, in *Environment Transformer* (1968), where transparent helmets are worn by the members of the group to alter optical and acoustic perceptions of the external environment; or in *Oase No. 7* (1972), in which a fragment of nature is reproduced and enclosed within a transparent sphere eight meters in diameter, suspended from the main façade of the Fridericianum in Kassel.

Placed within the context of the research initiated by Alexander Pike on the concept of the 'autonomous house', the image of the house sealed inside a jar may be read as a model of a single-family residence completely isolated from the natural context that conventionally surrounds it, in order to define a fully closed and independent microcosm that reproduces a fragment of nature conceived as a duplication of nature in its entirety.

100. *Casabella*, no. 411 (1976).

Figure 3. *Haus-Rucker-Co (Laurids Ortner, Günter Zamp Kelp and Klaus Pinter), Stuck Natur (Piece of Nature), 1971-1973*
Source: Heinrich Klotz (ed.), *Postmodern Visions: Drawings, Paintings and Models by Contemporary Architects* (New York: Abbeville Press, 1985), 85.

Piece of Nature represents a genuine new paradigm of domestic space conceived to function as a completely synthetic environment through the continuous transformation and regeneration of its own material and energetic resources. To use the words of Lydia Kallipoliti: "The canned domestic cosmos depicts a transformation in the field of

ecology, from the purity of nature as a realm outside the human-made to a technologically mediated science of instrumentation".[101]

The new domestic space circumscribes a fragment of the natural environment within its own boundaries by engineering the functioning of nature. The house is conceived as a perfectly closed system where every transformation takes place internally in order to control its environmental conditions solely by utilizing what is available within its systematic boundaries and operational structures.

Also in 1976, the English magazine *Architectural Design* (1976) published a special issue curated by Martin Spring and Haig Beck, entitled "Autonomous Houses".[102] On the cover, an illustration by Clifford Harper (see Figure 4) – British illustrator and militant anarchist, known for his numerous drawings published in the magazine *Undercurrents* – depicts a rural domestic environment in color, fully equipped with all the technologies necessary to render it autonomous relative to a desolate and gray urban industrial cityscape placed in the background. Inside, the eponymous section curated by Peter Harper (trained as a biologist and later director of the Centre for Alternative Technology in Machynlleth, United Kingdom) gathers some reflections on the political, economic, and cultural implications connected to research on the autonomy of space and residential functions at the scale of the single-family house and the city, a brief review of 'alternative technologies' for its concrete realization, and a collection of nineteen projects of self-sufficient houses,[103] as part of a broader monographic study published the same year entitled *Radical Technology* (1976),[104] written together with Godfrey Boyle (1945-2019) and the editors of *Undercurrents*.

101. Lydia Kallipoliti, *The Architecture of Closed Worlds, or, What is the Power of Shit?* (Zurich: Lars Müller, 2018), 13-14.

102. *Architectural Design*, Special Issue: "Autonomous Houses", no. 1 (1976).

103. Peter Harper, "The Autonomous Houses", *Architectural Design*, Special Issue: "Autonomous Houses", no.1 (1976): 19-49.

104. Peter Harper and Godfrey Boyle, *Radical Technology* (London: Windowood House Limited; New York: Pantheon Books; Melbourne: Penguin Books Australia, 1976).

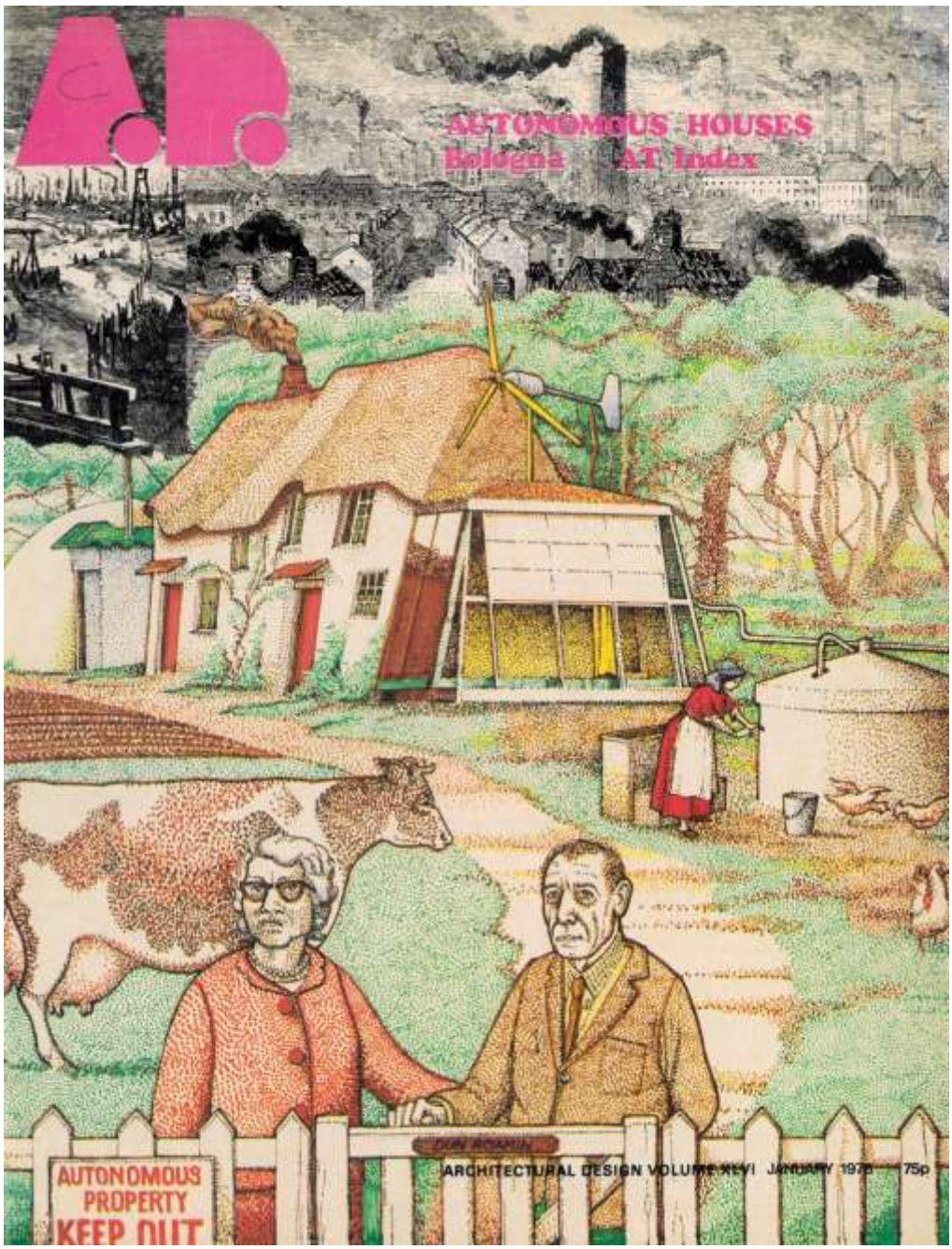

Figure 4. *Clifford Harper, Illustration drawn for the Cover of the Special Issue titled "The Autonomous House", Published in the Journal Architectural Design, no. 1, 1976*

The section curated by Harper in the monographic issue of *Architectural Design* offers a broad overview of research and projects, partly attributable to the experience of the *Alternative Technology* movement that took root in the United Kingdom starting in the 1970s[105] and to some publications by representatives of the American

105. Witold Rybczynski, *Paper Heroes* (New York: Doubleday, 1980).

counterculture released during those years, on the theme of the 'autonomy' of the single-family house.[106]

As in the image of the sealed house *Piece of Nature* by the Austrian collective Haus-Rucker-Co, the archetype of the 'ecological house' proposed by Harper, differently articulated in the prototypes of 'Autonomous Houses' published therein, adopts the concept of 'self-sufficiency' with a fundamentally 'biological' connotation, which finds expression in the design of architectural space as the construction of a technologically 'closed' organic ecosystem, defining a functional structure of domestic life completely independent from the various environmental contexts.

"Some units [Peter Harper writes] are designed for specific locations; others for a specific kind of location (e.g., city or countryside); others for a specific climate. Most of those discussed are intended for temperate climates without any particular location in mind [...]".[107]

For Harper, giving architectural form to the concept of autonomy in dwelling translates operationally into equipping the functional structures of the house with integrated systems of alternative technologies for the exploitation of environmental resources and the recycling of those produced within it. More precisely, the design of the dwelling is oriented exclusively toward the construction of a perfectly functioning technological structure for the transformation of solar radiation into heat, the conversion of wind energy into electricity, the storage and purification of rainwater, and the transformation of organic waste into methane and fertilizers for food cultivation and animal husbandry.

However, manipulating organic and ecological processes in order to construct an artificial space that is closed in itself, in which the design of architectural space sets itself the objective of imitating the functioning of nature in order to reproduce it, implicitly means decreeing the supremacy of technological solutions over the formal questions of architecture. An approach that, paradoxically, effectively nullifies the 'dialectic' that has always existed between the design of architectural space and the historical, geographical, and cultural specificities that distinguish the different places of a territory. A circumstance that, according to Reyner Banham (1922-1988) – a reference already particularly significant in itself – was the primary cause of the interruption of the original and centuries-old relationship between 'architecture' and 'environment'.[108]

106. See Brenda Vale and Robert James Dennis, *The Autonomous House: Design and Planning for Self-Sufficiency* (London: Thames and Hudson, 1975); Alfonso Ortega and Witold Rybczynski (eds.), *The Ecol Operation: Ecology, Building and Common Sense* (Montreal: Minimum Cost Housing McGill University, 1975); Helga Olkowski, William Bill Olkowski, Tom Javits and The Farallones Institute staff, *The Integral Urban House* (San Francisco: Sierra Club Books, 1979); James B. DeKorne, *The Survival Greenhouse: An Eco-System Approach to Home Food Production* (New York, Walden Foundation, 1975).

107. Peter Harper, "The Autonomous Houses", 27.

108. Reyner Banham, *The Architecture of the Well-Tempered Environment* (The Architectural Press, London, 1969).

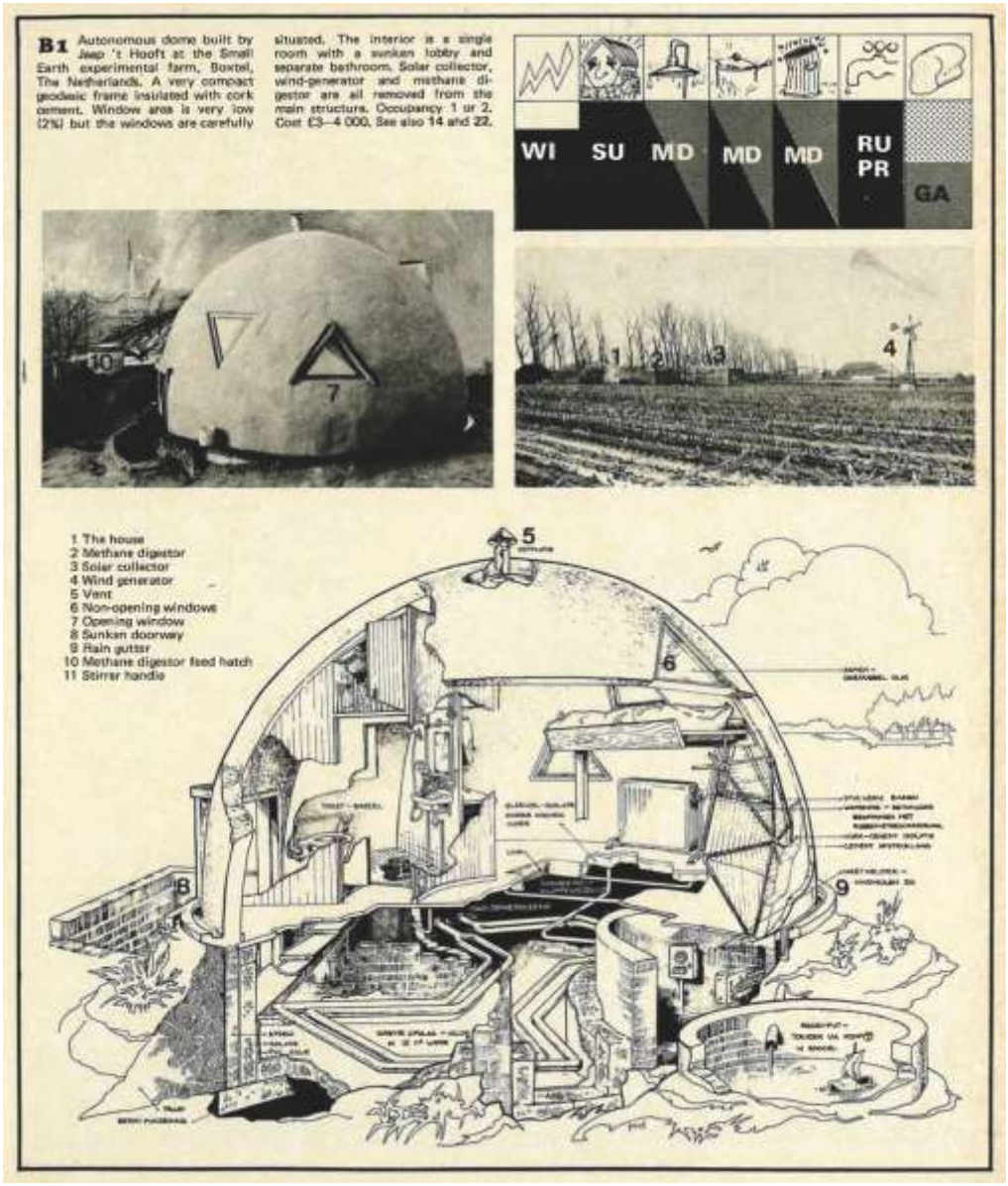

Figure 5. *Jaap't Hooft, "Autonomous Dome" Built at the Experimental Farm Small Earth, Boxtel, the Netherlands, 1975*
Source: Peter Harper, "The Autonomous Houses", *Architectural Design*, Special Issue: "Autonomous Houses", no. 1 (1976): 33.

Conclusions

If one refers to the then-new awareness of the necessity to rethink the relationship between the built space and the social, environmental, and material contexts that the history of energy crises has brought to light since the post-World War II period and which reemerges, updated, even in the contemporary moment, the merit of these research developed, above all by the British and American counterculture, on the self-sufficiency of domestic living has been, in our opinion, to situate

architecture within the ecological question, while adopting a cultural perspective much broader than that confined solely to a critique of the tools and procedures inherent to architectural design.

Reconfiguring the functional structures of architectural space by exploring the intersection between ecological systems and technological innovation within a logic of autonomy meant, for architects, engineers, and intellectuals of the radical counterculture, paradoxically assuming architectural design as a tool for the revision and re-foundation of the social and economic models governing the collective life of a community.

"Autonomy [Peter Harper writes] does not necessarily mean *private*. What we really need is a new model of autonomy/collectivity",[109] further specifying, together with Boyle, that: "For many people, autonomous houses represented the technical realization of the political or existential autonomy that is one of the basic themes of this book: not just having legal or social control over one's destiny but having one's hands directly on the hardware".[110]

The problems of the post-industrial capitalist organization related, above all, to the social context of existence – which still today retain an indisputable character of relevance and urgency – find a possible solution, for Harper and Boyle, by assuming a notion of self-sufficiency understood as a 'dialectic' between 'self-management' and 'sharing'. The realization of a concrete "*co-operative autonomy*"[111] should have allowed, through the design of the smallest element of the built environment: the single-family domestic space, a broader process of 'decentralization' aimed at dismantling the centralized authority of higher institutions by exercising 'bottom-up' control over the systems of production and management of natural resources within a logic of sustainability that is not only environmental but also, and above all, economic and social (see Figure 6).

109. Ibid, 20.
110. Ibid, also in Peter Harper and Godfrey Boyle, *Radical Technology*, 136.
111. Peter Harper, "The Autonomous Houses", 20.

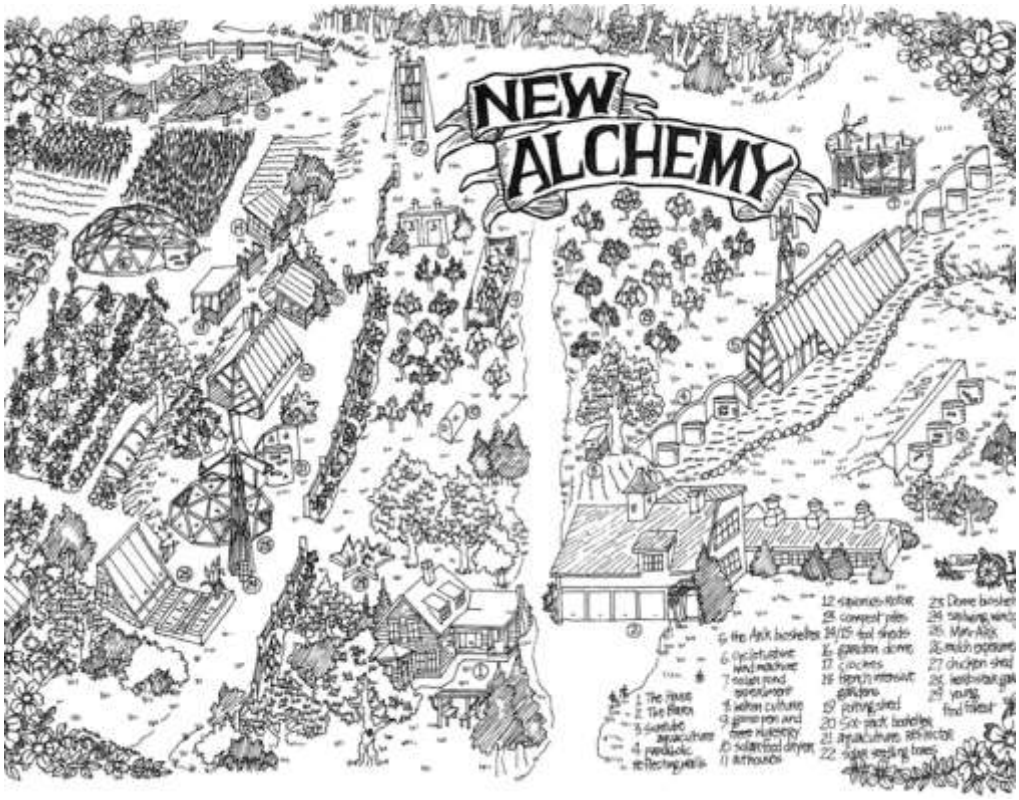

Figure 6. *Drawing of a New Radical Model of Self-sufficient Living Developed by the New Alchemy Institute, Woods Hole, Massachusetts, 1979*
Source: Nancy Jack Todd, "Overview", *The Journal of New Alchemists*, no. 5 (1979): 7.

More precisely, in the chapter of the volume *Radical Technology* (1976) entitled "Autonomy," written by Peter Harper and later republished almost in its entirety in the special issue of *Architectural Design* (1976), the author, referring to the research conducted by Richard Merrill within the New Alchemy Institute, emphasizes the need to rethink the separation imposed by industrial development between the "public production" and "private consumption"[112] of the essential components of dwelling: communication and social services, domestic goods, utility services, and food, assessing their potential for self-production and self-consumption within collectively functioning and self-sufficient social and economic structures called "local communities".[113]

The author distinguishes the 'rural' context from the 'urban' one, recognizing in the countryside more suitable conditions for the construction of newly founded self-sufficient communities, where individual dwellings collaborate in resource production, making them available to the entire community. In cities, instead, interventions should focus primarily on the peripheries, directing the restructuring of pre-existing architecture toward the configuration of self-sufficient housing units, according to a principle of sharing domestic functions within collective

112. Peter Harper, "Autonomy", in Peter Harper and Godfrey Boyle, *Radical Technology*, 136-169.
113. Ibid.

spaces and self-producing energy, water, and food resources through a different use of the dwelling's external areas.

Referring to the experience of the "rural utopian communities",[114] theorized and supported by the Irish economist William Thompson (1775–1833), Peter Harper recognizes the historical failure of these forms of collective dwelling organization as highlighted by Jos Kingston (1948–2007),[115] attributing the cause not so much to the ineffectiveness of the proposed economic and social models, but rather to the backwardness of the technological systems used to implement such projects. Consequently, Harper acknowledges the relevance of the sociological and economic horizon outlined by these 'utopias' in terms of the relationship between self-production and sharing, believing that technological progress, and more specifically the use of 'alternative technologies', now allows their utopian status to take concrete form.

Operationalizing the concept of autonomy in architecture does not mean reconfiguring domestic space with a view to total self-sufficiency, since, as Richard Merrill reminds us, this would constitute a "logical extension of the 'privatization'" that characterizes the logics of capitalist economies.[116] The most authentic meaning of the idea of autonomy proposed by Harper and the British and American counterculture lies in its various social, economic, and political implications, referring to the need to achieve independence from dominant centralized networks through new localized systems of self-production and sharing, built to sustain the original 'dialectic' between the 'public' and 'private' dimensions of existence, without either dimension prevailing over the other.

After all, as Harper writes: "It is a seeming paradox that each extension of the scope of economic and material autonomy, if it is to remain honest and non-exploiting, requires commensurate measures of collective participation. If healthy autonomy can only grow, think of no better moral on which to end".[117]

Excluding the work on the documentation of the main self-sufficient housing prototypes published by Lidia Kallipoliti and her research group in 2018,[118] the special issue of the journal *Architectural Design* (1976) and the volume *Radical Technology* (1976), both edited by Peter Harper – the latter together with Godfrey Boyle – represent the first attempt to systematize research on the theme of autonomy in dwelling, which has not been the subject of subsequent in-depth studies.

In this regard, a more complete and structured reconstruction of the theoretical content and design experiments on this topic can be developed starting from the study of archival materials preserved at the Canadian Centre for Architecture in Montreal, which include experimental projects of prototypes and 'alternative technologies', a wide and significant photographic documentation, and a considerable portion of volumes and major sector journals published in those years, partially organized on the occasion of the exhibition curated by Giovanna Borasi

114. Ibid, 165.

115. Jos Kingston, "It's Been Said Before – and Where Did That Get Us?", in Peter Harper and Godfrey Boyle, *Radical Technology*, 238-248.

116. Peter Harper, "Autonomy", 161.

117. Ibid, 167.

118. Lydia Kallipoliti, The Architecture of Closed Worlds, or, What is the Power of Shit?

and Mirko Zardini in 2007 at the Canadian institute and published in the exhibition catalogue.[119] Considering also the study more specifically dedicated to the theoretical framing of the content of this research, supported by a valuable bibliographic reconstruction, which was carried out by Lee Stickells on the occasion of the *Architecture, Institute and Change* conference held in Sydney in 2015.[120]

Unfortunately, these are still studies that remain too fragmented and distant in time, providing only a partial account of the broad cultural significance of these theoretical reflections and design experiments. However, taken together, they constitute an isolated yet highly valuable scientific contribution in indicating the content and possible directions of a research path aimed at overcoming a significant gap, through the restitution of an important chapter of architectural culture that is still today inadequately integrated and problematized within the main literature dedicated to the history and theory of architecture.

The research and projects developed by architects and engineers: Steve Baer (1938-2024), Edward Mazria, Jacques Michel, Félix Trombe, Michael Jantzen, Michael Reynolds, John Barnard (1932-2021), Malcolm Wells (1926-2009) and by the research groups Underground Space Center, Windworks, Farallones, Ouroboros, Ecol Operation, New Alchemy Institute, ILS Labs, and CAT, deserve recognition for having proposed, for the first time, reflections on 'alternative' models that seek to interrogate the complex meaning and the multiple nuances that the concept of 'sustainability' assumes within the broad disciplinary field of architectural design.

Although, in some cases, an excessive emphasis on the technological dimension can be noted, it is our conviction that the most significant contribution offered to the theory and practice of architecture by these studies and design experiences, beyond the concrete formal outcomes, lies in the construction of a wide and irreplaceable panorama of reflections and experiments. By interrogating the relationships between architectural design and new socio-economic paradigms for the 'dialectical' structuring of the 'individual' and 'collective' dimensions of dwelling, in our opinion, these works reveal their broadest and deepest cultural significance when interpreted in the form, to conclude with the words of Ernst Friedrich Schumacher, "of a repertoire of ideas, with which, thanks to which, and through which, we experiment and interpret the world".[121]

Acknowledgments

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119. Giovanna Borasi and Mirko Zardini (Eds), *Sorry, out of gas: architecture's response to the 1973 oil crisis*.

120. Lee Stickells, "Exiting the Grid: Autonomous House Design in the 1970s".

121. Ernst Friedrich Schumacher, *Small Is Beautiful: Economics as if People Mattered*, 91.

managers: Elena Giacomello, Susanna Pisciella, Gabriele Torelli, Francesco Trovò, with Alioscia Mozzato.

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Logistification and the Typo-Logistic City: Rethinking Infrastructure, Housing and Design in European SEZs

By Adriano Venudo[*] & Vittoria Umani[±]

This paper presents the outcomes of an applied research project currently underway at the Department of Engineering and Architecture, University of Trieste, focused on the design and theorization of Special Economic Zones (SEZ) as spatial and architectural devices. Starting from the cross-border SEZ of Gorizia–Nova Gorica (ITA-SLO), the study proposes a broader critical framework for understanding the ongoing logistification of the European space – a process in which logistics becomes a morphogenetic force shaping infrastructures, territories, and ways of living. Rather than treating SEZ as merely economic or regulatory constructs, the paper explores their potential as inhabited infrastructures and urban laboratories where housing, production, and flows intersect. The concept of highwaying is introduced as a design method to reinterpret road infrastructures as relational and habitable structures. A projective lexicon – "thickness, edge, path, interface" – is deployed to guide the rethinking of infrastructural architecture and urbanism. Through theoretical insight and a multiscalar case study methodology, the paper outlines a vision of SEZ as hybrid territories of architectural experimentation, where spatial quality, logistical performance, and social inclusion are not mutually exclusive, but co-constitutive.

Introduction: "*Logistification* and Infrastructure Space"

Topics and Sites for Operational Research

The research presented in this paper is part of a project developed at the Department of Engineering and Architecture of the University of Trieste and started in 2023 by the CARIGO Foundation. Titled *ZESE GoNGO – Zona Economica Speciale Europea at Gorizia Nova-Gorica*, the project investigates the architectural and territorial potential of Special Economic Zones[1] (SEZ), using as a case study the regeneration of several areas located between Gorizia and Monfalcone. In particular, it focuses on the southern sector of Gorizia, which includes the Duca d'Aosta airport complex, the productive area along the Isonzo River, several residual zones interlocked between two major infrastructures crossing the Gorizia

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1. SEZ (Special Economic Zones) are designated territorial areas where favorable tax, customs, or regulatory regimes are applied with the aim of attracting investment and promoting productive and logistical development. Within the European context, SEZs take on a strategic dimension, functioning as operative interfaces between global networks and local contexts. As in the case study of the cross-border ZESE of Gorizia and Nova Gorica presented here, they are configured as innovation ecosystems capable of integrating logistics, infrastructure, manufacturing, and urban reuse - becoming true devices for urban and infrastructural intensification.

territory (the Trieste - Udine railway line and the Villesse - Ljubljana international highway, which connects to the A4 Trieste - Venice corridor), and multiple zones of the COSEVEG (Consortium for Economic Development of Venezia Giulia). This "diffused" territorial system (sprawltown) is conceived as a new cross-border node for innovation.

The research is configured as an operational laboratory: it engages with a real context while exploring broader questions concerning the transformation of contemporary urban space. In particular, it focuses on the concept of *logistification*, understood as the extension of the logistics paradigm to the built environment, and its ability to redefine settlement forms and modes of inhabitation (Figure 1).

This work continues a line of research initiated between 2019 and 2021 by Adriano Venudo, Claudio Meninno, and Giovanni Fraziano, culminating in the publication *Evoluzione di un territorio. Architettura e infrastruttura*,[2] and now expanded through the involvement of Vittoria Umani and Thomas Bisiani. The new phase of research interprets infrastructure not merely as a technical support, but as a spatial device capable of generating territorial hierarchies and new "working landscapes". Following Keller Easterling's theories, *infrastructure space* is understood as an operational matrix governed by standards and protocols, capable of transforming traditional project logics.

Across Europe, TEN-T corridors, logistics platforms, and SEZ are progressively redrawing productive geographies, giving rise to new forms of centrality that emerge on the margins of compact cities. These hybrid territories – such as the cross-border logistics area of Gorizia and Nova Gorica – demand a revision of theoretical and design tools. The emerging forms – intermodal platforms, container villages, automated centers – are often "architecture without architects" that nonetheless deeply shape the landscape.

The design hypothesis at the core of this research considers the SEZ not only as economic devices, but as a spatial interface between global networks and local contexts. The proposal presented here is based on a multiscalar reading capable of intertwining logistical, residential-settlement, historical, and cultural dimensions. The strategic regeneration of the two aforementioned areas (Gorizia and Monfalcone) fits into a broader vision that brings together logistics, mobility in its larger sense, production, habitation, and innovation, redefining the relationship between design and infrastructure.

The paper is structured into sections that begin with the theoretical framing of *logistification*, followed by its operational applications, and culminating in the analysis of the case study as an experimental and applicative model of territorial transformation across multiple scales.

2. C. Meninno, *Evoluzione di un territorio. Architettura e infrastruttura. Strategie per uno sviluppo territoriale transfrontaliero in ambito europeo.* (Trieste: EUT, 2022), 186.

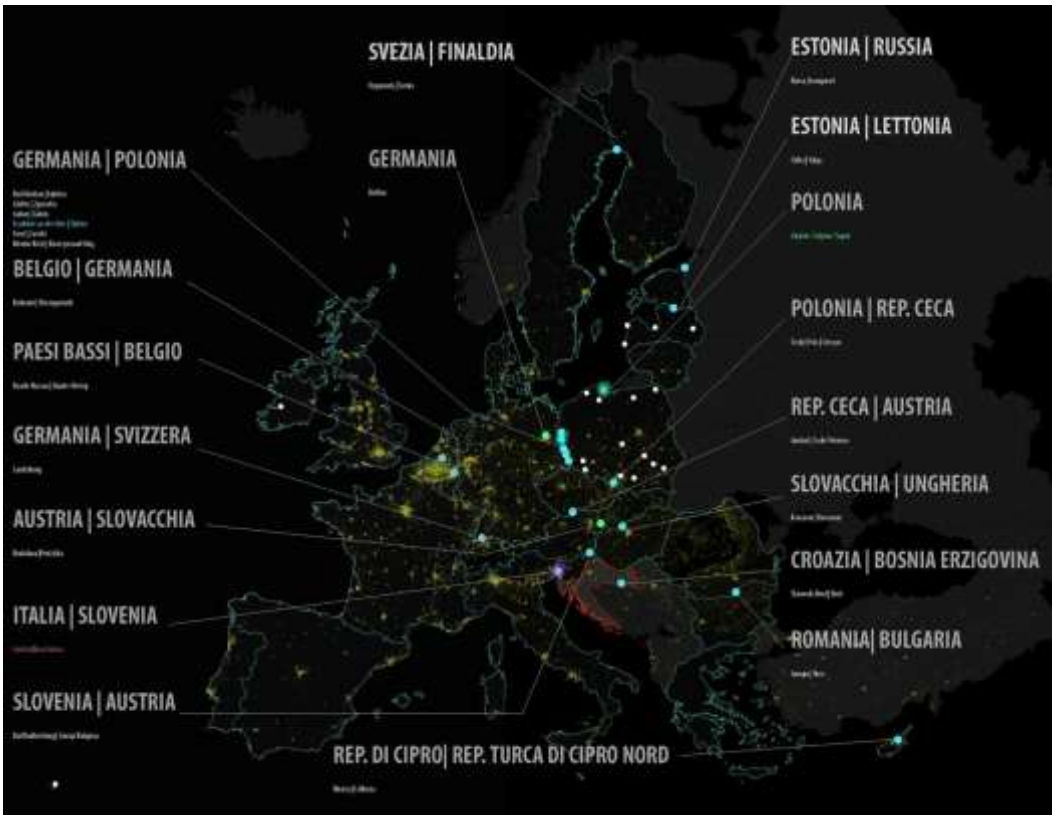

Figure 1. *European Mapping of SEZs Updated to 2022*
Source: Map created by A. Venudo, in Meninno, C., Evoluzione di un territorio. Architettura e infrastruttura. Strategie per uno sviluppo territoriale transfrontaliero in ambito europeo. (Trieste: EUT, 2022).

The Infrastructural City: From Architecture to Geography

The contemporary city has increasingly taken the form of an infrastructural city: a complex system in which logistics networks, transport systems, and productive platforms progressively replace the traditional ordering devices of the twentieth-century European city. TEN-T corridors, SEZ, and intermodal hubs are shaping a new geography that transcends national borders and defines centralities based on selective connectivity and functional proximity to global networks. Within this framework, centrality is no longer determined by position relative to the urban core, but by adherence to the logic of flows. SEZ thus become flexible tools of transformation, capable of operating at both local and continental scales, rewriting settlement rules in light of a new concept of proximity.

This research is based on the hypothesis that infrastructure is not merely a technical support, but an autonomous spatial matrix capable of generating new urban forms and relationships. Following Keller Easterling,[3] *infrastructure space* operates through protocols and standards, transforming territories into "active systems." Stefano Boeri and Rem Koolhaas had already, many years ago, in the

3. K. Easterling, *Extrastatecraft: The Power of Infrastructure Space.* (London-New York: Verso Books, 2014).

Mutations[4] and *USE*[5] projects, anticipated the idea of a "reticular urbanity" or "European sprawl town"[6] in which mobility and logistics form the primary fabric. This perspective is more relevant than ever, as the major European corridors – conceived in the 1980s as axes of linear efficiency – are now revealing limitations and contradictions that demand a critical rethinking of design tools.

From a methodological point of view, the research adopts a transdisciplinary and multiscalar approach. The road, the viaduct, the intermodal hub are no longer considered merely technical infrastructures, but generative devices that hybridize industrial areas, economic zones, functions, uses, and temporalities. Projects such as Koolhaas's *Dolphins*, MVRDV's *Flight Forum*, and NL Architects' *Parkhouse/ Carstadt* have long demonstrated how infrastructural sections can be transformed into dense and habitable urban spaces. These examples show how infrastructure can cease to be a line of division and instead become a site of design - capable of hosting new forms of urbanity, habitability, and everyday proximity.

The case study of the SEZ in Gorizia-Nova Gorica fits precisely within this perspective: not as a functional enclave, but as an open interface connecting transnational networks and local contexts. The methodology integrates cartographic analysis, scenario building, and design tools capable of addressing the logistical dimension as an unstable operational field that hybridizes infrastructure, production, and housing. This approach requires overcoming traditional binaries – inside/outside, ground/building, public/private – in order to conceive the city as a performative and adaptive system, where infrastructure acts as a principle of variation rather than a fixed framework.

The goal is to identify a design lexicon (developed specifically for this research, based on four key terms: "section, path, edge, interface") and strategies capable of combining *highwaying*[7] with productive efficiency and urban quality, transforming SEZ into laboratories for territorial and architectural innovation. In this direction, the "logic of the platform"[8] and the notion of infrastructure as a narrative and relational space become central tools to understand and design the contemporary landscape, forming the foundation of the concept of *logistification* (Figure 2).

4. R. Koolhaas, S. Boeri, S., S. Kwinter, N. Tazi & H.U. Obrist, *Mutations*. (Barcelona: ACTAR; Bordeaux: Arc en Rêve Centre d'Architecture, 2000).

5. Multiplicity (S. Boeri, et al.). *USE: Uncertain States of Europe*. (Milano: Skira, 2003).

6. R. Ingersoll, *Sprawltown*. (Roma: Meltemi, 2004).

7. The term *highwaying* was coined by SMAQ Architects, a Berlin-based practice founded by Andreas Quednau and Sabine Müller, active for many years in projects that hybridize spaces of movement with spaces of dwelling, using infrastructural spaces and structures as potential new domains of inhabitation.

8. Ibid, Easterling, 57.

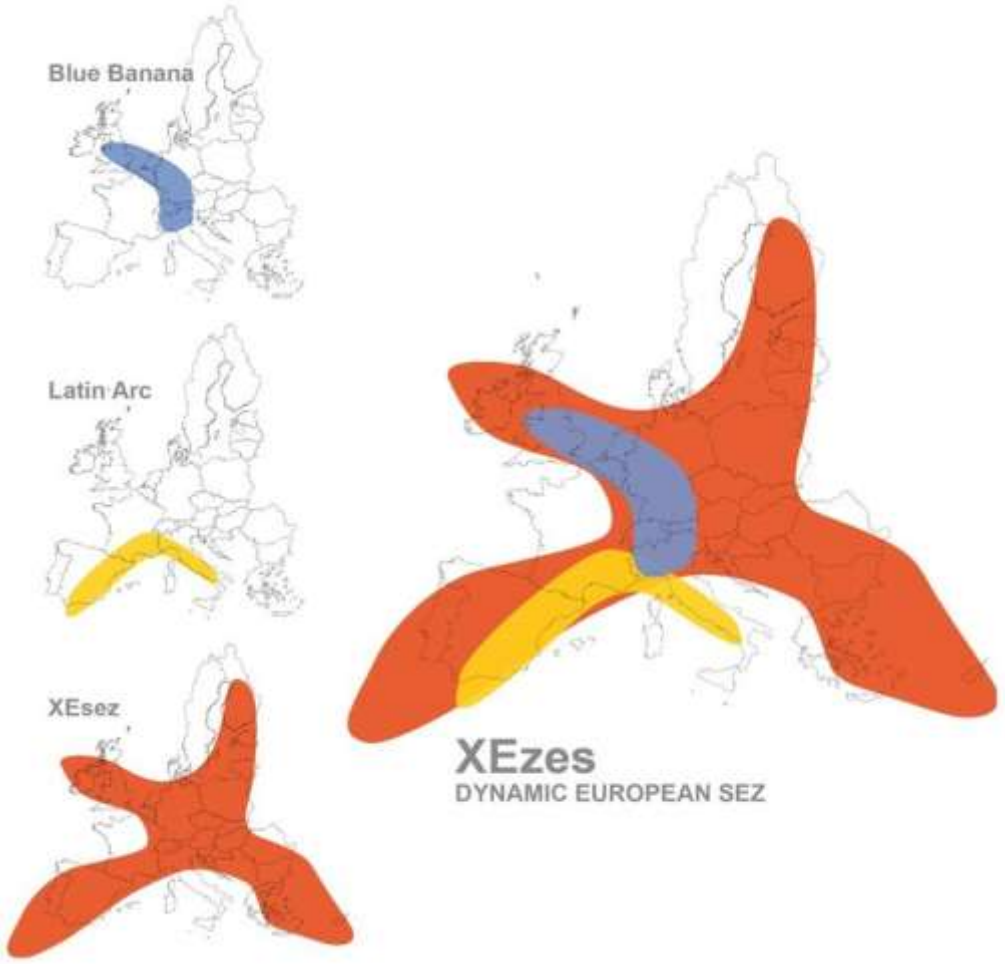

Figure 2. *Continental Urban Systems: Reconstruction of the "Geographical Figures" of the Main Existing European Settlement Systems Compared with the New "XEzes Geographical Figure" Derived from the European Mapping of SEZs, 2022*
Source: Map created by A. Venudo, in Meninno, C., Evoluzione di un territorio. Architettura e infrastruttura. Strategie per uno sviluppo territoriale transfrontaliero in ambito europeo. (Trieste: EUT, 2022).

Literature Review - *Logistification*: Toward a New European Logistics Space

Definition and Theoretical Framework

The term *logistification*, introduced by Jesse LeCavalier,[9] describes the systemic extension of the logistics paradigm from the management of flows to the production of urban and territorial space. LeCavalier highlights how automated environments and infrastructural interfaces have gained operational autonomy, becoming generators of new functional landscapes. Keller Easterling, through the concept of *infrastructure space*, proposes that logistics should be understood as a form of what she defines as "operational urbanism", where rules and protocols replace

9. J. LeCavalier, *The Rule of Logistics: Walmart and the Architecture of Fulfillment.* (Minneapolis: University of Minnesota Press, 2016).

architectural form in determining the spatial order of territory: "the space we move through" is composed more of codes than volumes.

Deborah Cowen[10] emphasizes how logistics constitutes a strategic infrastructure of global capitalism: it does not merely transport goods, but regulates labor, produces inequality, militarizes borders, and defines conditions of inhabitability. In this perspective, Marc Augé's famous *Non-lieu*[11] must be updated: logistics spaces are not just areas of transit, but operational environments governed by their own rules and dedicated to both productive and residential functions, generating a form of deterritorialized urbanity in which efficiency replaces density.

Logistification thus becomes both a critical and design category, one that forces us to rethink the thresholds of the city: infrastructural edges, mobile interfaces, and "abandoned" areas as newly active spaces. As Aureli[12] and Koolhaas[13] observe, this condition requires moving beyond traditional conceptions of urban space, calling architecture to account for its commercial, economic, and political responsibilities. In this framework, SEZ can be understood as operative fields where new design strategies can be tested – capable of intertwining flows, dwelling, and production.

Living in the Logistics Territories

The lack of coordination between production and housing within logistic territories is generating increasing urban and social criticalities. In Friuli Venezia Giulia (Italy), as in the major ports of Northern Europe, the housing demand linked to migrant labor – also affecting our case study – clashes with settlement models incapable of responding to temporary and adaptive needs. These are often seasonal flows, tied to the productive cycles of logistics platforms, which elude conventional planning frameworks.

Renzo Sgolacchia's PhD research[14] demonstrates how in the Netherlands, Belgium, and Denmark, prefabricated container cities have emerged to accommodate logistics workers: low-cost, precarious settlements devoid of integrated services – more tolerated than properly designed. These spaces, conceived as emergency solutions, reinforce marginality by transforming workers into "technical guests" devoid of urban citizenship.

Similar dynamics are evident in Friuli Venezia Giulia region: in Monfalcone, the presence of foreign workers in shipyards has saturated traditional housing supply, generating tensions between the historic center and the operative port

10. D. Cowen, *The deadly life of logistics. Mapping violence in global trade.* (Minneapolis: University of Minnesota Press, 2014).

11. M. Augé, *Non-Lieux. Introduction A Une Anthropologie De La Surmodernite: Introduction à une anthropologie de la surmodernité.* (Paris: Éditions du Seuil, 1992).

12. P. V., Aureli, *The Project of Autonomy: Politics and Architecture Within and Against Capitalism*. (New York: Temple Hoyne Buell Center for the Study of American Architecture & Princeton Architectural Press, 2008).

13. G. Mastrigli (edited, by), *Rem Koolhaas. Junkspace. Per un ripensamento radicale dello spazio urbano*. ((Macerata: Quodlibet, 2006).

14. R. Sgolacchia, *The Logistification of Migrant Workers' Housing: Understanding Flexibility and Scalability of Containerised Boxes*. PhD diss., Università Iuav di Venezia, 2023, XXXV Cycle, International PhD Program "Villard de Honnecourt", Supervisor: prof. Giuseppe Ciorra.

areas. In Trieste, the coexistence of port, free zone, and hinterland logistics hubs produces functional yet fragmented spaces, where production and habitation remain disconnected (Figure 3).

As Claudio Meninno[15] points out, it is precisely in the retroport areas that opportunities arise to experiment with new settlement models capable of integrating productive logics and housing needs. Without such a vision, we risk producing segregated territories, where the city withdraws and infrastructure prevails. Special Economic Zones (SEZ), if interpreted not solely as fiscal tools of deregulation and free-market within the "SEZ system," but as spatial devices, may become a framework for triggering new urban strategies – provided that housing is understood as a constitutive component of the overall design.

This perspective demands a rethinking of settlement policies: logistic dwelling can no longer be a collateral effect but must be foreseen and qualified. The transition from city to platform, if left unplanned, risks generating new operative peripheries and spatial exclusions.

Logistics expansion is reshaping habitation patterns, with informal and semi-regulated settlements emerging near logistics hubs due to proximity needs. This "strategic living" is adaptive and performance-driven, responding to logistics rhythms rather than traditional urban cycles. This condition is evident in several European contexts. In Piacenza, the growth of the IKEA/CEVA hub has transformed areas like Pontenure into sites of residential expansion, where small, often self-built structures emerge in response to irregular work schedules. Similarly, in Verona's Quadrante Europa, flexible and temporary housing clusters are forming at the edges of intermodal zones. In Lyon Saint-Exupéry, the CargoPort platform has generated a dispersed housing infrastructure made up of small, low-density settlements positioned along logistical junctions and roadways, where the relationship between commuting time and living time is particularly tight.

In light of this, the planning of new SEZ projects must confront the challenge of recognizing, interpreting, and engaging with these marginal forms of living. Rather than stigmatizing, planners and designers should see strategic living as both a symptom and a site of potential - spaces where emerging demands for proximity, adaptability, and urban quality begin to take shape.

15. C. Meninno, *Evoluzione di un territorio. Architettura e infrastruttura. Strategie per uno sviluppo territoriale transfrontaliero in ambito europeo*. (Trieste: EUT, 2022), 186.

Figure 3. *Photoplans of the Two Research Study Areas: on the Left, the Port of Monfalcone, and on the Right, the Cross-Border Intermodal Hub (Italy–Slovenia) of Gorizia–Nova Gorica*
Source: Eastern Adriatic Sea Port Authority; SDAG Gorizia, https://www.sdag.it/it/.

The European Expansion of *Logistification*

Logistification is radically reshaping the European landscapes, generating intermodal territories with high flow intensity. These spaces are arranged along the TEN-T corridors and are characterized by an urbanity based more on connectivity than on settlement density. In Friuli Venezia Giulia, Trieste and Monfalcone represent two emblematic cases. Trieste, located at the intersection of the Mediterranean and Baltic-Adriatic corridors, integrates port facilities, a free zone, and logistics platforms, under increasing residential pressure. The port of Trieste, ranked first in Italy for cargo traffic, handled 57.6 million tons in 2022, while the newly established regional Simplified Logistics Zone (ZLS) connects ports and freight terminals to promote a more integrated production system.

Monfalcone reveals a different aspect: the tension between industrial development and unplanned residential demand. Here, the presence of migrant labor, particularly from Bangladesh, has created housing needs that fall outside traditional urban models, resulting in precarious urban margins. The logistics platform of Friuli Venezia Giulia spans 26 municipalities and covers more than 1,400 hectares, with the goal of streamlining procedures and attracting investment. However, this production-focused logic risks generating fragmented, infrastructure-dominated territories in the absence of an urban plan that includes housing as a strategic component.

As highlighted by the research of Meninno and Cowen, the integration of logistics and urban space requires design tools capable of reconciling economic efficiency, settlement quality, and social cohesion. Without this, logistics risks transforming territories into functional platforms disconnected from their context. For this reason, planning must overcome the divide between productive and residential areas, embracing hybridity as a guiding principle.

These reflections are grounded in the studies of Easterling (*Extrastatecraft*), Cowen (*The Deadly Life of Logistics*), Boeri and Koolhaas (*Mutations*), Aureli (*The Project of Autonomy*), and in the experiences documented in *ZES. Spazi, strategie, progetti*, curated by Meninno.

Methodology and Case Studies: SEZ and New European Geographies

The XZES as a Continental City: Infrastructures and Spatial Visions

The XZES project – *eXtended ZES System*[16] – proposes an interpretation of Europe as an infrastructural, reticular, and discontinuous continental city. This is both a theoretical and operational figure, linking well-known geographical models (Blue Banana, Green Belt, Atlantic Arc) to a new logistics geography, and ultimately leading to definitions of architectural and urban layouts where spatial and functional intensity prevails over administrative continuity. Historic cities are progressively emptied of centrality, while peripheral areas reorganize around flows, generating asynchronous networks of productive and logistics clusters. These dynamic challenges the twentieth-century nation-state model, giving rise to so-called "functional regionalisms," interpreted as an "expanded new Middle Ages" in which special zones and logistics interfaces replace former capitals.

The methodology adopted in this research includes an updated screening of European SEZ (38 cases across 25 countries), analyzed according to functional and transcalar criteria; the creation of thematic maps at the continental scale (TEN-T corridors, multimodal platforms), the regional scale (Alpe-Adria), and the local scale (Friuli Venezia Giulia); the construction of morphological and flow maps based on freight transport data, intermodality, and settlement systems; and a cartographic visualization process inspired by the historic infrastructural mapping of Friuli Venezia Giulia.[17] To this is added a design phase for the cross-border SEZ of the Isonzo area, with architectural and urban projects currently being finalized between Gorizia and Monfalcone, aimed at creating a hybrid model that integrates infrastructure, logistics, and habitation.

Corridors, Logistics Platforms, and New Regionalisms: Approach and Tools

The methodology adopted investigates European *logistification* through the lens of TEN-T infrastructure programs, Green Corridors, and Simplified Logistics Zones (ZLS/SEZ). These infrastructures – such as the Baltic-Adriatic and Rhine-Alpine corridors – constitute supranational functional spaces governed by specific rules and differentiated fiscal regimes. The research explores how such platforms can integrate logistical efficiency with ecosystemic value, particularly by engaging with existing territorial figures such as the European Green Belt (the reactivated former Iron Curtain).

SEZ are analyzed as both spatial and regulatory tools capable of attracting investment and concentrating activities in marginal territories, while also offering design opportunities to reactivate disused areas and obsolete infrastructures. Through a multiscalar reading, they are interpreted as reticular governance platforms of a post-state nature, based on multi-level negotiation mechanisms.

16. A. Venudo, *Scenari XZes e riconfigurazione tra nodi e archi per la città continente*, in Ibid, Meninno, 106.

17. L. Di Sopra, *La struttura urbanistica friulana. Analisi e prospettive*. (Udine: Del Bianco Editore, 1967).

In summary, from a design perspective, the research focuses on the need to integrate logistics platforms into existing landscapes by mitigating their environmental impacts and restoring urban quality to infrastructural spaces, while developing the architectural theme of proximity. Following James Wines' concept of "Green Architecture", SEZ are reimagined as large-scale hybrid environmental architectures that combine technology, ecology, and a sense of place. This methodological approach aims to define operative tools for conscious design, capable of transforming logistics infrastructures from purely technical spaces into genuine "urban and environmental devices".

The "Moving Border" and the Alpe-Adria Macroregion: Methodology for the Applied Field

The research proposes the concept of the "moving border" as a methodological device for analyzing and designing the cross-border SEZ. Derived and adapted from the reflections of Marco Ferrari,[18] the "moving border" is interpreted here as a dynamic threshold – a space of territorial and design transition that goes beyond the administrative line to become a spatial and logistical device.

The Alpe-Adria macroregion (including Friuli Venezia Giulia, Carinthia, Western Slovenia, Croatia, and Hungary), originally formed as a zone of economic and social cooperation after the Cold War, today becomes a natural laboratory for testing new settlement models related to logistics and productive infrastructures. In this context, the overlap between infrastructural networks (TEN-T corridors), historical memory, and geopolitical dynamics generates an intermediate space that, from the peripheral, assumes a central role. In particular, the cross-border area of Gorizia-Nova Gorica-Šempeter Vrtojba represents the concrete application case of the research – an emblematic territory of connection and friction between different urban systems. Studies on the eastern border[19] highlight how this territory, historically shaped by infrastructures and institutional transformations, functions as a true "spatial engine."

The ZES project developed here therefore adopts the "moving border" as both an operative and design tool, as well as the testing ground for the research. The goal is to overcome the logic of administrative enclaves by creating flexible, open, and connected territorial devices that operate at the intersection of infrastructure, inhabitation, and logistics.

Multiscalarity and the Mutation of Centralities: SEZ as "Trigger Devices" in FVG

Friuli Venezia Giulia, a strategic hub between the Northern Adriatic and Central-Eastern European markets, is crossed by the Baltic-Adriatic and Mediterranean TEN-T corridors. The region is characterized by major intermodal logistics infrastructures (the ports of Trieste, Monfalcone, and S. Nogaro; the freight villages of Cervignano, Fernetti, and Gorizia SDAG; and the Trieste-Ronchi airport), connecting maritime,

18. M. Ferrari et. al., *A moving border. Alpine cartographies of climate change*. (New York: Columbia University Press, 2018).

19. S. Basso, *Nel confine: riletture del territorio transfrontaliero italo-sloveno*. (Trieste: EUT, 2010).

road, and rail traffic (Figure 4). These facilities make the region a testing ground for experimenting with innovative models of territorial transformation through Special Economic Zones (SEZ), conceived as "systemic shocks" and "trigger devices." These targeted and multiscalar interventions stimulate processes of urban and infrastructural reconversion in marginal territories, operating simultaneously at architectural, infrastructural, and territorial scales.

Cross-border SEZ (such as Gorizia-Nova Gorica-Šempeter Vrtojba) thus become adaptive tools for testing new relationships among flows, goods, infrastructures, and settlement configurations – promoting logistics platforms integrated with housing, flexible forms of inhabitation, and goods flows that combine operational efficiency, urban quality, and environmental sustainability.

The overall methodology of the research is therefore based on an integrated and multiscalar approach, employing tools such as the *moving border*, adaptive design, and infrastructure regeneration/conversion. The study has developed thematic and morphological maps, comparative analyses of data and flows, and design strategies – thus going beyond the purely productive or fiscal logic of SEZ, and transforming them into opportunities for urban and environmental design.

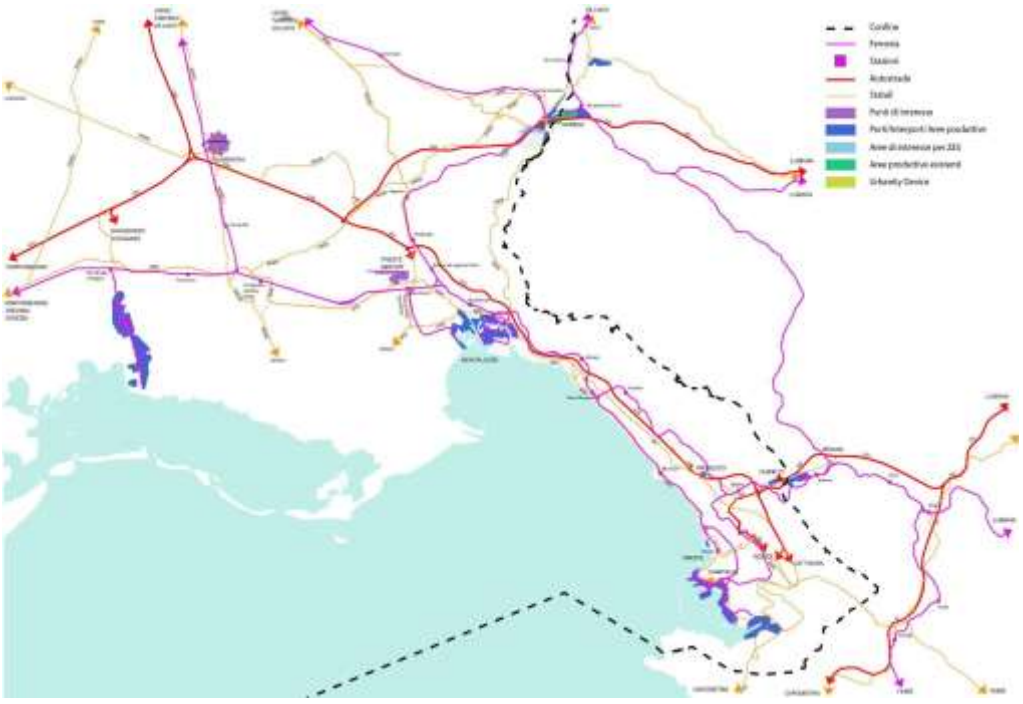

Figure 4. *Logistic System of Friuli Venezia Giulia (FVG) Supporting the Research Project for the FVG SEZ, 2025*

Source: Map created by V. Umani, UNITS Research for the CARIGO Foundation. Research title: *ZESE GoNGO – Zona Economica Speciale Europea at Gorizia Nova-Gorica, 2025-26 UNITS.*

Results

Infrastructure Architecture and Street Space

The divide between infrastructure and architecture is fading, giving rise to hybrids responding to densification, sustainable mobility, and user flexibility. Examples include inhabited viaducts and infrastructure parks, such as London's speculative Living Bridges or Paris's Promenade Plantée, which transform infrastructure into public, habitable spaces.

Urban intersections and nodes in projects like Paris's Rive de Seine and Madrid Río convert highly infrastructural zones into vibrant social and environmental platforms. These interventions reveal the street as architectural matter, a "deep surface" incorporating flows, territorial policies, and ecology. A clear principle emerges: intentionally designed coexistence between different (urban and non-urban) flows is no longer a problem to avoid but a resource to activate. Streets, once spaces separating uses, become dynamic fields where diverse speeds, modes, and functions interact to create new architectural forms.

This "urbanity of friction", where overlapping rhythms and uses coexist, isn't new: historical European boulevards and promenades show functional layering. What's changed is the deliberate design to orchestrate these differences, not for control but to foster spatial complexity and new architectural forms.

Unlike modern zoning that separated functions, contemporary *typo-logistic* design embraces friction between uses, walking alongside traffic, inhabiting transit spaces, to turn conflict into a compositional opportunity.

Visionaries like Lawrence Halprin[20] and Bernard Tschumi[21] saw urban space as dynamic choreography, where overlapping activities generate meaning and urban experience. Contemporary examples like Barcelona's Superilla and the Hans Monderman designed spaces in the Netherlands demonstrate how designing friction enhances spatial quality.

Thickness, Edge, Path, Interface: A Design Lexicon for Street Space

If *infrastructure space* is now recognized as a key category in urban design, we must also adopt tools to read and shape the street as active architecture, equipped with form, function, aesthetics, and social value.

Building on Adriano Venudo's[22] work, which updates insights from Kevin Lynch[23] and Venturi, Scott Brown and Izenour,[24] he identifies four key categories for understanding the street as habitable infrastructure: thickness, edge, path, and interface.

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20. L. Halprin, *Cities*. (Cambridge, MA: MIT Press, 1972).

21. B. Tschumi, *Manhattan Transcripts*. (London: Academy Editions, 1994).

22. A. Venudo, *Scritto sulla strada. Dall'infrastruttura allo spazio aperto. Teorie, tecniche e strumenti*. (Gorizia: GOtoECO, 2010).

23. K. Lynch, *The Image of the City*. (Cambridge, MA: MIT Press, 1960).

24. R. Venturi, D. Scott Brown and S. Izenour, *Learning from Las Vegas*. (Cambridge, MA: MIT Press, 1972).

Thickness refers to the street's spatial depth, not just a flat surface, but a layered, three-dimensional structure hosting mobility, commerce, greenery, and utilities.

Edge is the transitional zone between infrastructure and urban fabric, where movement meets pause, and logistics meets urbanity. Its quality defines how the street integrates with the city.

Path acts as the morphogenetic spine, shaping direction, curvature, and sequence, serving both spatial and symbolic functions.

Interface includes all mediating devices, physical or digital, that make the street legible and accessible: crossings, signage, sound buffers, transit stops, and more.

This lexicon reframes the street as not just a technical artifact, but as a formal, ecological, and political opportunity. It supports an understanding of infrastructure as lived space, where logistics and everyday life intersect and evolve.

In the context of the SEZ and of the transformations induced by logistics, the lexicon of the space-street becomes an instrument to critically redefine the material conditions of the SEZ and as an operational tool in the development of the Gorizia-Nova Gorica/Monfalcone SEZ as an urban project.

Architecture-Infrastructure

The following projects consolidate the increasingly blurred boundary between infrastructure and architecture: streets and circulation systems do not merely connect functions, but become habitable devices, landscapes, and urban form. In these *typo-logistic* hybrid typologies, architecture and logistics co-constitute one another, reflecting the spatial consequences of Europe's evolving production geographies. What these projects have in common is not only their scale, but a paradigm shift: design is no longer organized around a stable "front" and "back", nor around a pedestrian, frontal experience. Instead, built form is generated by continuous flow and by a cinematic, mobile perception—architecture is conceived from the viewpoint of the driver, and its measures depend on design speed, turning radii, visibility, and dynamic perception.

A useful conceptual frame comes from the idea of the "volume of street space" and from the street/interface as an operative artifact mediating public and private domains. In the essay's "Pionieri tra i pionieri. Coliseum Center Shopping Mall"[25] reconstruction of the IAUS "Project Streets" research (Eisenman), the street is not a neutral line but a spatial field whose interfaces can increase permeability and generate complexity.

Within logistification, this field becomes explicitly operational: movement, access, loading, and parking act as generative forces, turning infrastructure into a design material and a morphological driver.

The first set of example projects exemplify how infrastructure and urban design merge, how the logics of circulation and street design contribute to the definition of new urban forms.

25. A. Venudo, *Pionieri tra i pionieri. Coliseum Center Shopping Mall*, in C. Meninno, V. Rodani, The shopping center as/is a meeting place. (Trieste: EUT, 2020), 54-67.

MVRDV's Flight Forum[26] in Eindhoven integrates airport logistics with urban functions, using streets as organizing elements that define form and flow. The geometries of the buildings answer to the logic of operative time, to movement visibility and the efficiency of the circulation layout.

MVRDV's Flight Forum (1998-2005) is an industrial and business park next to Eindhoven Airport, developed on parts of an abandoned air-force base. Its strategy is explicitly spatial: rather than isolated objects in a dispersed landscape, buildings are organized wall-to-wall in clusters, producing conglomerates surrounded by continuous lots for loading and parking. This is crucial for the architecture-infrastructure argument: the project is not composed through a primary façade addressing an urban street, but through a continuous operational perimeter where logistics and circulation define edges and exposures. The "street" is not a residual in-between; it is the organizing system that stabilizes flows, legibility, and access, and thereby shapes built form. In typo-logistic terms, *edge* and *interface* emerge as operational thresholds - spaces where the logistics landscape becomes readable and usable through design.

MVRDV frames the internal road network as a continuous-flow system: curving lanes and looped access are conceived to keep vehicles moving, making speed, visibility, and turning radii explicit design parameters rather than constraints.

NL Architects' Parkhouse/Carstadt[27] in Amsterdam treats a parking structure as a "habitable road," combining transport with living and commercial spaces. This "continuous micro-city" allows cars to move on its roof and is planned as an infrastructural section, where every floor is at the same time, technical surface and livable space. The unbuilt Parkhouse/Carstadt project radicalizes the same principle by transforming parking and circulation into architecture. Several sources describe it as a large sloping parking surface that rises to multiple storeys and ramps down again, with program nested underneath - cars become, in effect, "roof ornament and program", while the ramp is the main urban figure. A detailed reconstruction highlights its 1 km extension, a horseshoe trajectory, and the way the carriageway folds within site limits to knot different parking levels while carving voids into the mass below. This is exactly the "continuous flow" logic: the building is an infrastructural ring/loop that allows movement to remain uninterrupted, while commercial, residential and service programs are inserted "between the folds" of the ramped section. Conceived as a folded 1 km-long road, its 19-meter-wide ramp climbs at about 3.5–5% (max 6%) up to the 30 m height limit, so that "roof" and "road" coincide and the building is experienced as a single cinematic trajectory.

Here the architectural paradigm is explicitly cinematic: the project is conceived to be experienced in motion, calibrated through speed, curvature, and visibility. Here, urban measure is recalibrated around the automobile. Speed and curvature govern dimensions and form, while visibility and dynamic perception shape how space is read in movement; parking surfaces, kerbs, ramps and glazed envelopes become the operative thresholds of this mobile public realm.

In the lexicon proposed by this paper, Parkhouse/Carstadt becomes an exemplary device of path (as built trajectory), thickness (as sectional depth where

26. MVRDV, *Flight Forum, Eindhoven*, in *KM3: Excursions on Capacities*. (Barcelona: Actar, 2005).

27. NL Architects, *Parkhouse Carstadt, Amsterdam*, in *BasketBar and Other Projects*. (Barcelona: Actar, 2005).

technical and habitable layers overlap), and interface (as continuous mediation between vehicle circulation and inhabitable programs).

Other examples include the unbuilt project for Ponte Parodi in Genova by UNStudio[28] that proposed a radical integration between land, roads and commercial architecture following the logic of a "built infrastructural landscape". Ponte Parodi pushes the hybridization of land, infrastructural access, and mixed-use programming. The project is conceived as a three-dimensional piazza and public attractor integrating retail, leisure, a cruise terminal, cultural programs, and a rooftop public park, within a layered organization of circulation typologies. Descriptions stress that the juxtaposition of circulation systems is not secondary but *formative*: it organizes program and optimizes flows through and on top the building. This makes Ponte Parodi a clear typo-logistic case: not a building next to infrastructure, but an infrastructural-morphological device where *edge* and *interface* are spatialized as public continuity, and where the project's urbanity is generated by the orchestration of multiple mobilities (pedestrian, service, tourist, port-related). Conceived as a built infrastructural landscape, it superimposes public topography, parking decks, and circulation gradients to produce a waterfront architecture readable in motion from the surrounding road and harbor infrastructures.

And Zaha Hadid's CMA CGM Tower[29] in Marseille, is an unexpected example of how *logistification* can profoundly affect the architectural morphology of a vertical building. While departing from the more common horizontal developments associated with this typology, the tower stands within a "no man's land", compressed between two elevated highway ribbons, in an urban landscape marked by vehicular flows and transit infrastructure. The space below the highway, typically hostile and residual, is here rearticulated as a threshold: a transition zone where the pylons and the green and pedestrian surfaces surrounding the building interact as one. Traveling along the highway, the tower appears as a soaring blade that divides the two infrastructural arteries. This second set of examples are more specific to production platforms and operational spaces, but they follow the same "borrowing" principles. By merging shapes, methodologies and flows, these operational/production projects create new aesthetics along with new architectural and urban forms. Rem Koolhaas anticipates the idea of an urban space dominated by fluxes, efficiency systems and logics in his *The Harvard Guide to Shopping*[30] and the more recent *Countryside: The Future*.[31] Architecture loses its formal primacy to become a component of "larger systems", like those of logistics and algorithmic governance.

Also, projects like Port City Futures[32] or Logistics Landscape,[33] are contributing to a new interpretation of the European territory as a diffused infrastructural system,

28. UNStudio, *Project for Ponte Parodi, Genoa (2001)*, in *Designing the User Experience*. (Amsterdam: Frame Publishers, 2016).

29. Z. Hadid Architects, *CMA CGM Headquart*ers. Retrieved from: https://www.zaha-hadid.com/architecture/cma-cgm-headquarters/ [Accessed July 2025].

30. R. Koolhaas et al., *Project on the City 2: The Harvard Guide to Shopping*. (Cologne: Taschen, 2001).

31. R. Koolhaas, *The Countryside: The Future*. (New York: Guggenheim Museum, 2020).

32. PortCityFutures, TU Delft. Retrieved from: https://www.portcityfutures.nl [Accessed July 2025].

where ports, SEZ, multimodal corridors and productive architectures give birth to new labor landscapes, in those areas often considered marginal or peri-urban.

Taken together, these cases clarify why "highwaying" is not only a matter of scale but of architectural epistemology. The shift is from frontal composition to flow-based morphogenesis: volumes are drawn by trajectories; fronts and backs dissolve into continuous operational envelopes; and spatial quality depends on how design governs speed, curvature, visibility, and thresholds. In these typo-logistic hybrids, the driver (the human-in-vehicle) becomes the implicit design subject.

What appears is a public space "of movement", with uncertain boundaries where edges, parking fields, ramps and glazed fronts act as threshold-spaces. In this sense, typo-logistic hybrids are not simply new morphologies, but a redefinition of architectural agency. Architecture becomes a component of larger systems (logistics, mobility governance, operational time), yet precisely through this dependency it can re-open questions of urbanity - by designing thickness, edges, paths, and interfaces as inhabitable infrastructural space. In this sense, the *typo-logistic* is not just a new morphologic category, but a new paradigm of the architecture project and it implies rethinking of the classic categories of the city, productive and public spaces. *Path* becomes built trajectory, *thickness* becomes section-as-infrastructure, *edge* becomes operational perimeter, and *interface* becomes the mediating device that can intensify permeability between public and private domains.

Discussion

The SEZ Urban Space as a "Logistic Interface"

In this hybrid context, administrative borders are replaced by performance-based logics: spatial values arise from a site's capacity to absorb, transform, and distribute flows, materials, information, and humans.

Keller Easterling[34] reinforces this by identifying SEZ as a key instance of *infrastructure space*, seemingly neutral zones that, through protocols and connections, silently structure globalization. Their design lies not in local masterplans but in flow patterns and network dynamics, making SEZ both logistical platforms and spatial actors that shape behavior and landscape on an international scale.

European examples like Teesworks (UK), Katowice and Łódź (Poland), and the currently under definition Gorizia-Nova Gorica/Monfalcone SEZ reveal new hybrid models. Particularly in FVG, the SEZ assumes a polycentric form: a mesh of production, logistics, and housing hubs that create a distributed regional interface, integrated into broader transnational networks, from ports like Trieste, Monfalcone and San Giorgio di Nogaro, to the inner lands like Gorizia and Nova Gorica. Their value stems from access to multimodal corridors and their adaptability to evolving industrial needs. In this sense the very idea of proximity is flipped, it is not just physical, but also an intangible infrastructure made up of

33. Logistics Landscapes Research Group, ETH Zurich. Retrieved from: https://logisticslandscapes.arch.ethz.ch [Accessed July 2025].

34. Ibid, Easterling.

flows, relationships, and shared visions. The challenge is to imagine forms of infrastructural urbanity capable of leveraging the territory's unique morphology, transforming constraints into resources and fragmentation into a driver of design and regeneration.

This challenges the notion of SEZ as "non-places," proposing instead that they be reimagined as urban devices blending habitability, work spaces, and mobility, offering opportunities for integrated, sustainable coexistence between people, facilities, and fluxes. To engage with SEZ as emergent urban forms means crafting new design vocabularies and infrastructure aesthetics that reflect their political and operational complexities. SEZ create sharp divides between regulated internal zones and informal external settlements. These adjacent zones often lack urban qualities, forming thresholds shaped by logistics but disconnected from city life.

The border-space of the SEZ then becomes an opportunity to develop a further "urbanity device", a hybrid architectural-infrastructural intervention at the SEZ edge, able to provide services and social interfaces for workers living around the Gorizia-Nova Gorica/ Monfalcone territory. Rather than porous in the traditional sense, this structure operates as a contact zone, where the need for stability, identity, and belonging meets the pressures of economic efficiency. Its form and function can reflect local cultures and uses, addressing context-specific needs without replicating the rigidity of formal planning, but utilizing the *typo-logistic* principles and aesthetics.

This building-device should aim to intercept vulnerability without institutionalizing it, offering forms of support without consolidating precariousness.

Seen through this lens, the edge of the SEZ is not just a boundary for goods or customs, but an architectural and urban laboratory, a place where tensions are made visible, and where new spatial and social experiments can take shape. SEZs, then, are not just physical realizations of policies, they are spaces to be designed, inhabited, and reinterpreted.

Friuli Venezia Giulia: Scattered SEZ, Housing Regeneration, and New Proximities

As a historic borderland and current strategic hub in the Euro-Adriatic logistics network, the Friuli Venezia Giulia region presents a striking paradox: a rising demand for labor linked to logistics and production hubs, and at the same time, a widespread underuse of existing housing, particularly in small towns and historic centers affected by depopulation and deindustrialization.

ISTAT data[35] indicates tens of thousands of empty or disused housing units in the region, mostly in internal areas. Meanwhile, commuting is a defining feature of daily life: 71.6% of residents commute for work, among the highest rates in Italy,[36] and regional train use is steadily increasing, with daily passengers rising from 21,232 to 29,000 between recent years, according to Legambiente's Pendolaria

35. Trieste Prima, "Immobili vuoti a Trieste: colpa della crisi demografica." Retrieved from: https://www.triesteprima.it/attualita/immobili-vuoti-trieste-colpa-crisi-demografica.html [Accessed July 2025].

36. ISTAT, "Gli spostamenti per motivi di studio o lavoro nel 2019." Retrieved from: https://www.istat.it/comunicato-stampa/gli-spostamenti-per-motivi-di-studio-o-lavoro-nel-2019-secondo-il-censimento-permanente-della-popolazione/ [Accessed July 2025].

report.[37] This pattern highlights the urgent need for integrated policies that address production, logistics, mobility and housing in a coordinated way.

The SEZ concept here could evolve into a scattered, polycentric system of intermodal nodes and specialized districts, linked to underutilized housing in historic centers like in Gorizia for example. Reactivating existing homes rather than building anew would foster sustainable, flexible living tied to logistic rhythms.

This model redefines proximity as systemic and adaptable, embedding urbanity within logistical flows. It offers a spatial strategy that counters the "non-place" stigma, advancing territorial cohesion, logistical innovation, and urban quality through housing regeneration and distributed SEZ design.

In FVG, where marginality is both a condition and a resource, a scattered trans-national SEZ model between Gorizia, Nova Gorica and Monfalcone, coupled with the reuse of strategic housing in neglected historic centers, could form the basis for an integrated spatial policy that links territorial cohesion, logistical innovation, and a renewed quality of urban life.

Conclusions

Traffic Architecture as Architecture of Contemporaneity

The contemporary urban project is increasingly shaped by flows, infrastructures, and logistical systems. In this context, Lawrence Halprin's 1966 concept of Traffic Architecture[38] becomes newly relevant. Halprin proposed an aesthetic and functional approach to mobility infrastructure, envisioning roads and interchanges as spatial systems integrated into the landscape, capable of supporting perceptive continuity and urban coherence. Revisiting Halprin's vision through contemporary examples in the Netherlands, France, Italy, shows how infrastructure is used to hybridize architecture, densify cities, and mediate between different speeds of life. Roads, viaducts, and intermodal hubs become active urban components, accommodating residential, productive, and social functions.

For Halprin, the aesthetics of infrastructure were not secondary but central: an attempt to create a coherent visual grammar for the landscapes in motion, both for those crossing highways and for those living along their margins. This legacy prompts a key question today: Is an aesthetic of logistics still possible?

Special Economic Zones, as contemporary infrastructural and territorial devices, embody a global-local paradox. While built for maximum efficiency in global supply chains, they inevitably anchor themselves in local contexts, impacting space, form, and social relations. This tension gives rise to two distinct yet interrelated aesthetics.

The first is internal to logistics itself: a standardized, highly legible architectural language of efficiency, repeatability, and neutrality. This "network aesthetic" functions as a transnational identity, aligning European SEZ into a recognizable system. Clean

37. Legambiente, *Pendolaria 2023*. Retrieved from: https://www.legambiente.it/wp-content/uploads/2021/11/Pendolaria-2023.pdf [Accessed July 2025].

38. L. Halprin, *Freeways*. (New York: Reinhold, 1966).

lines, prefabrication, and functional detachment signal this system-wide coherence, echoing Halprin's vision of visual continuity across the USA's interstate highway system.

The second aesthetic emerges at the margins: a language of mediation and interface. This is where the hybrid border-architecture devices previously mentioned are placed. They could support logistics workers and adjacent communities, offering services like canteens, rest areas, laundries, and spaces for socialization. While not formally part of the SEZ, they could constitute a vital social infrastructure. Unlike the standardized core, these interface-architectures can adopt a localized, context-aware language, using materials, forms, and spatial strategies rooted in place. Here, aesthetics is inseparable from function: they generate belonging, improve quality of life, and reframe the margins as meaningful urban spaces.

Rather than opposing these two aesthetics, the challenge lies in navigating their tension. The SEZ's global functionality coexists with local impact, requiring design strategies that integrate, mitigate, and relate. Recognizing this duality grants logistics an architectural and civic responsibility. It counters the functionalist view that sees infrastructure as neutral, emphasizing instead that even the most technical systems have form, visibility, and social consequence.

In Friuli Venezia Giulia, this aesthetic duality is already visible. Standardized logistics typologies are being juxtaposed with context-sensitive interventions, such as in Monfalcone, where interface architectures use local materials, hybrid programs, or adaptive reuse to create new forms of spatial engagement. These projects hint at a possible future in which logistics is not just efficient, but also legible, livable, and urban.

When dealing with the aesthetics of infrastructure however, perhaps a third one needs to be mentioned: *highwaying* (Figures 5-6). Naturally *highwaying* does not exclusively refer to the aesthetic category but it cannot be separated by it. If Lawrence Halprin's traffic architecture laid the groundwork for an aesthetic of movement and infrastructure integrated into the landscape and the city, the concept of *highwaying* proposed by SMAQ Architects[39] introduces an even more radical reflection: the highway is no longer just a functional element to be crossed or mitigated but becomes the backbone around which a new type of settlement is structured. In the *Highway...ing* project in Stuttgart (Figure 6), a high-speed road is reprogrammed to integrate itself into a larger system of housing, services, and leisure spaces, generating a form of urbanization that literally arose from vehicular flow.

The highway, normally perceived as an element of separation and fracture, is reinterpreted as an "elastic and mutable strand" of spatial possibilities. The authors even produced an animation, alongside other more traditional forms of representation, in order to break down the experience into sequences of movement-driving, slowing down, stopping, transition-transforming the flow into a design grammar. In this scenario, logistics is not just a background, but a formal and functional matrix, capable of generating new housing and spatial typologies.

This kind of approach opens up the possibility for a new *typo-logistic* aesthetic, in which mobility infrastructures are no longer elements to be masked or denied but supporting structures of the architectural imaginary. *Highwaying*, in this

39. SMAQ Architects, "Highway…ing – Stuttgart, Germany." Retrieved from: https://www.smaq.net/2003/01/highway%e2%80%a6ing-stuttgart-deutschland/?lang=en [Accessed July 2025].

sense, becomes a methodology: a way to read, interpret and transform the territories crossed by flows into habitable devices that combine production, accessibility, protection and environmental integration.

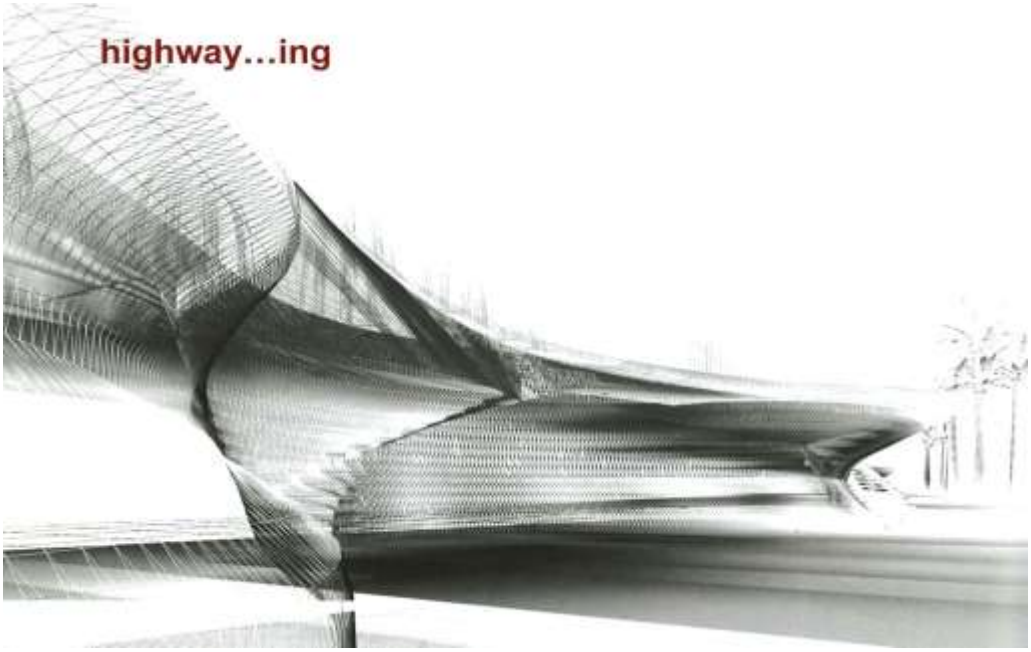

Figure 5. *Drawing of a Fragment of the Waterfront Project in Benidorm by C. Ferrater and X. Martì, Particularly Illustrative of the Concept of Highway…ing (Hybridization Between Spaces of Movement and Spaces of Dwelling). Project 2009–2014*
Source: OAB Office website, https://ferrater.com/project/benidorm-west-beach-promenade/.

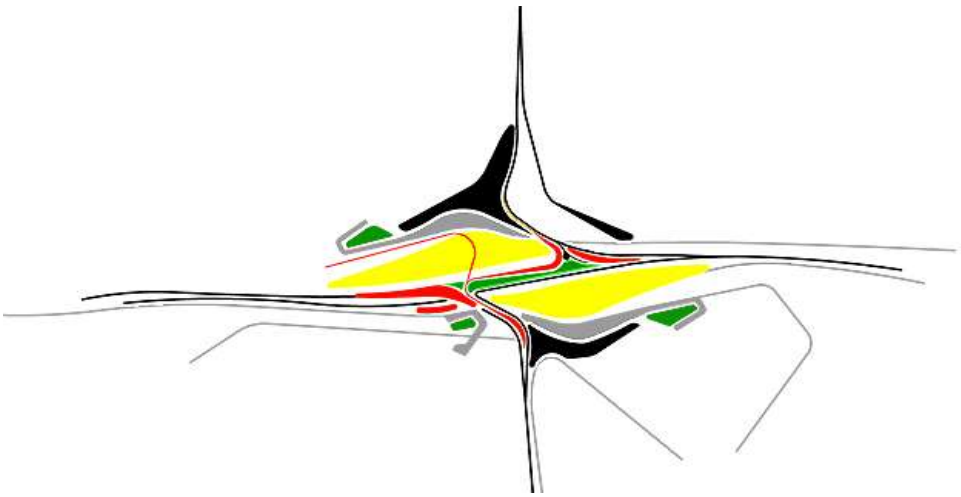

Figure 6. *Drawing of a Site Plan Study for Highway … ing Stuttgart by Andreas Quednau and Sabine Muller SMAQ Architects, Particularly Illustrative of the Concept of Highway…ing (Hybridization Between Spaces of Movement and Spaces of Dwelling). Project 2003*
Source: SMAQ Architects Office website, https://www.smaq.net/2003/01/highway%e2%80%a6ing-stuttgart-deutschland/.

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Emancipation by Living: A Typological Reflection - From Political Control towards Designing for Equality

*By Arianna Scaioli**

In his essay Enjoy the Silence, Aureli traces the conceptual origins of a typological discourse in the ritual and ritualisation of inhabiting space. Architectural design has determined and contributed to the spatialisation of gender roles and power hierarchies within the domestic environment. The design of the house, within the modern strategy, has contributed to the translation of a social and political vision in its formal, use-related, symbolic and perceptual dimensions. Positioning itself within a materialist feminist critique of architecture, the contribution reflects on the design of housing spaces, between the dwelling and the neighborhood, as a cultural act of spatial transformation where architecture becomes the object and tool of emancipation. Looking back to the past, to a female and feminist legacy, the contribution reflects on the contemporary instances of the spatialisation of rights, equality and care, considering them as design paradigms capable of modifying not only the way of inhabiting a space, but also that of designing it, influencing a typological discourse. The contribution presents three case studies – Temporary residential centre for homeless women by Vivas Arquitectos, Entrepatios las Carolinas by SAtt Arquitectura, and 85 Social Housing in Cornellà by Peris+Toral – by dissecting them in spatial elements the interest is to understand the spatial domain of empowerment.

Introduction: Beyond Housing

In the contemporary scenario, the theme of *housing* has returned to the centre of design debates as a catalyst for rights, from the right to housing to the right to the city. The discussion has shifted away from the specific issue of housing and dwelling toward a more general notion of *inhabiting*. This leads to a reflection on the meaning of *inhabiting* in today's context, considering whose bodies, voices, and needs are taken into consideration. This need is especially urgent today, in a historical moment marked by profound urban and social conflicts[1] that have heightened dissatisfaction with ways of living that no longer respond to contemporary needs.[2] While in the past this was an issue rooted within the discipline, today we are faced with an explosion and fragmentation of the theme, permeated by ecological, social, and political concerns. It is, therefore, not just a question of reorienting political choices and cultural models, but of

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1. Sassen, S (2014) *Expulsions: Brutality and Complexity in the Global Economy*. Cambridge (MA): The Belknap Press of Harvard University Press.

2. This reflection is developed also within the Viennese Pavilion, Agency for better living, at the Biennale di Architettura in Venice, 2025. The pavilion fosters a comparative reflection between Vienna and Rome on collective forms of living and how they promote empowerment and well-being in response to contemporary needs.

reconceptualising the theme of inhabiting, starting with a questioning of traditional typologies.

Discrimination by Design

Within this disciplinary renewal, social and gender-based discrimination is prompting a repositioning of design practices, with an understanding of the project's agency in shaping "altering futures"[3] and in spatialising rights. The central question guiding this exploratory research is: "What effect does gender inequality have on Architecture? And reversing it: what can Architecture do to tackle gender inequalities?" Space is not neutral but materialises power dynamics: Control,[4] Moralisation and Domestication,[5] revealing the intrinsic conflicts.[6] These dynamics operate on different levels:

> The hardware or physical dimension: the materiality of spaces.
> The software: the use of space and the experience of architecture.
> The symbolic dimension: visibility and representation.
> The perceptual dimension: thermal comfort, psychological and physical well-being, and sense of belonging to space.

The four categories, which will be used to describe the projects critically, dissect how spaces both reflect and reinforce gendered power dynamics (Figure 1).

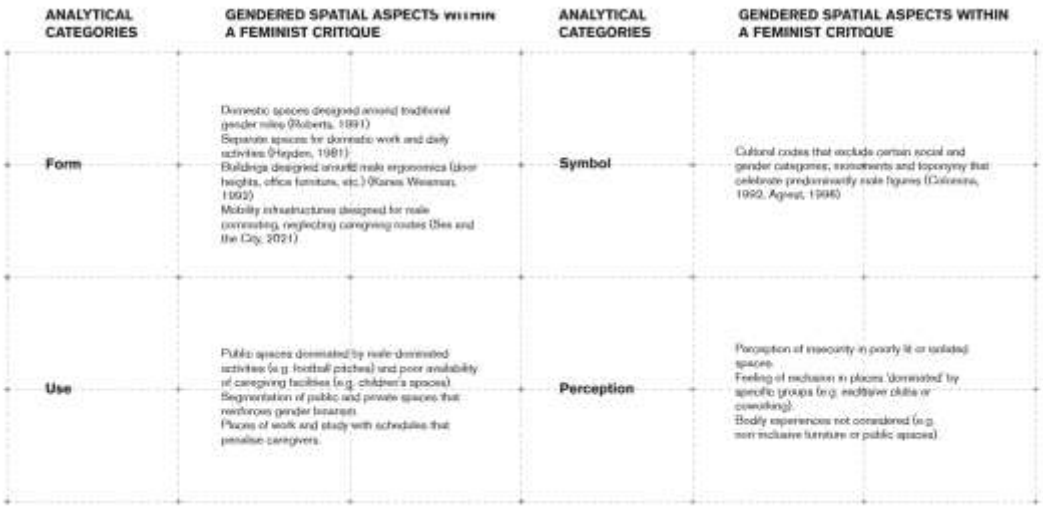


Figure 1. *Gendered Spatial Aspects*
Source: Drawing by the Author, 2025.

3. Petrescu, D (2007) *Altering Practices*. London: Routledge.
4. Foucault, M (1975) *Discipline and Punish*. New York: Vintage Books.
5. Teyssot, G (1986) "Figure di interni," in *Il progetto domestico. La casa dell'uomo: archetipi e prototipi*. Milano: Electa.
6. Sassen, S (2014) *Expulsions: Brutality and Complexity in the Global Economy*. Cambridge (MA): The Belknap Press of Harvard University Press.

The acknowledgment of how these discriminatory forms occur in a situated context and intersect with existing forms of spatial vulnerability, thereby exacerbating conditions of marginalisation, has highlighted the spatial dimension as a fundamental component to be explored in efforts to counter forms of violence, accessibility difficulties, and the lack of visibility and recognition. In some contexts, where fundamental rights are not guaranteed, including Afghanistan, Iran and beyond, the phenomenon of gender apartheid translates into regulatory and design measures that render women's bodies invisible. This is not just a matter of denying access to certain places, but of changing their layout: regulations prohibiting windows in women's communal spaces and the bricking up of existing openings confine kitchens and women's collective rooms to closed environments, producing spatial segregation that normalises gender exclusion. The theme of visibility is central to many feminist reflections, taking on different connotations:

- Making visible and bringing back to light the biographies and works of female architects who have been erased from history.[7] Here, care is developed through the act of curating these stories.[8]
- Making visible the needs, desires and aspirations of non-normative bodies by rethinking forms of living and design;[9] This involves openness to co-design, experimentation, and prototyping, as well as reformulating the relationship between design and process.
- Making visible the different forms of discrimination, violence, and spatial inaccessibility, but also manifesting hidden and invisible care work.[10]

7. Friedman, A. (1998) *Women and the making of the modern house: a social and architectural history*. New York: Abrams; Harriss, H., House, N., Parrinder, M., & Ravenscroft, T. (2024) *100 women: architects in practic*e. RIBA Publishing; Lorenz, C. (1990) *Women in Architecture: A Contemporary perspective*. New York: Rizzoli. Mattogno, C. (2025) Schwitalla, U. (2021) *Women in architecture: past, present, and future*. Hatje Cantz Verlag; Singha, S. (2018) Women in Architecture. London: Routledge.

8. Krasny, E., & Perry, L. (2023) *Curating with Care*. London, UK - New York, USA: Routledge.

9. Schalk, M., Kristiansson T. & Mazé, R. (2017) *Feminist Futures of Spatial Practice: Materialisms, Activisms, Dialogues, Pedagogies, Projections*. Baunach: AADR – Art Architecture Design Research; Brown, L. (2016) *Feminist Practices: Interdisciplinary Approaches To Women In Architecture*. New York: Routledge;

10. Federici, S. (1975) *Wages Against Housework*. Bristol: Power of Women Collective and Falling Wall Press; Federici, S. (2012) "Feminism and the Politics of the Commons". In *The Wealth of the Commons*, Edited by David Bollier, and Silke Helfrich. Amherst: The Commons Strategies Group, [Available online]: http://wealthofthecommons.org/essay/feminism-and-politics-commons.; Krasny, Elke. 2022. *Scales of Care: Affective Ecologies and Reproductive Urbanism*. Montevideo Architecture Public School Online Seminar, 6 aprile 2022. Disponibile su: https://www.elkekrasny.at/archives/3200; Fitz, A., Krasny, E. & Architekturzentrum Wien. (2022) Critical Care: Architecture and Urbanism for a Broken Planet. Cambridge, MA - London, England: MIT PRESS.

Critical Positioning

The contribution reflects on contemporary instances of the spatialisation of rights, equality, and care, treating them as design paradigms capable of modifying not only how we inhabit a space but also how we design it, thereby influencing a typological discourse. Starting from the provocation launched in the ARCH+ issue *Vienna – The End of Housing (as a Typology)*,[11] this contribution questions whether the hybrid and open nature of contemporary living signals the *death* of housing typology as we know it, or rather its transformation into new spatial imaginaries grounded in care, collectivity, and gender equality. A challenge to typological conventions seems to emerge, with buildings that are increasingly hybrid between work, caring activities, collective spaces, and home, conceptually moving towards new typologies, as seen in the project Gleis 21 by Einszueins Architektur (2019) in Vienna, which develops the idea of a neighbourhood-building (*Quartierhaus*). The rejection of traditional floor plans characterises this line of questioning; the ground floor is not a generic space left to the market to be acquired. Still, it becomes the threshold between the house and the neighbourhood. This flow between the private, public, and collective recomposes the modern movement's zoning. Moreover, the vanishing of the separation between day and night areas, the de-hierarchization of rooms (i.e., no main bedroom of 14 sqm and a child's room of 9 sqm), and a reduction in room size, favouring collective areas, contribute to this reformulation of traditional types. These subversions open up a rethinking of living space based on subjectivity rather than predefined roles. Building on these premises, this paper investigates how these issues translate into concrete design practices through case studies that, in different ways, embody a typological and processual transformation oriented toward gender equality.

The research proposes a methodological approach that, by dissecting space into its elements, reinterprets them through a feminist lens. It discusses how architecture becomes both the object and tool of, and for, emancipation through the process of thinking and building. The thesis guiding this contribution is that housing typology, far from being a neutral or purely functional form, is a political and cultural tool capable of conveying – or counteracting – gender inequalities. In this sense, women's empowerment can also be read as a process of typological transformation, in which the home becomes a space for negotiation, resistance and imagination.

Structure and Objectives

The paper is structured into the following sections. Section 2 introduces gender equality as a design issue, relating to architecture, type, and the politics of space. Section 3 outlines the research methodology, framing the criteria used to present the case studies. Section 4 presents three case studies located in the Spanish context to define a cultural and spatial unit. The Spanish context was chosen because there is a strong convergence between political ideology and

11. Arch+ (2024) *Vienna – The End of Housing (as a Typology)*. Spector Books.

typological experiments linked to new forms of living,[12] with a robust tradition of social housing and typological studies[13] on collective living. Yet, these remain underexplored from a feminist perspective. These projects explore the theme of female/feminist housing in different ways: the first, Temporary residential centre for homeless women by Vivas Arquitectos in Barcelona (2023), is a women-centred housing project, while the second, Entrepatios las Carolinas by SAtt Arquitectura in Madrid (2020), is designed with explicit reference to gender criteria, working on the idea of a care infrastructure and a democratic space beyond the traditional family, the third, 85 Social Housing in Cornellà de Llobregat by Peris+Toral (2021) explores the theme of the total de-hierarchisation of space to eliminate gender roles and spatial stereotypes, promoting forms of equality. Section 5 critically discusses the projects in relation to broader challenges, and Section 6 concludes and outlines potential research directions.

Gender (In)Equalities in Space: Architecture, Type and the Politics of Care

"Architectural types do not emerge from a natural evolution or from some universal and timeless principle […] Type is the nexus of all the factors that contribute to the production of architecture: norms, budget, class, gender, space […] they are devices that spatialize the way people relate to each other."[14]

From this perspective, the architectural project faces a crucial challenge: whether and how these experimental prototypes of living can serve as a typological reflection on gender equality, care, and women's empowerment as design paradigms. The typological theme re-emerges not as abstract cataloguing but as a tool for design and negotiation. Typology, in this perspective, becomes an opportunity for disciplinary renewal. The dimension of use of space is linked to the activities performed within it, where everyday life becomes a field for developing forms of freedom and empowerment. Specifically, according to the Gender Equality Index 2024,[15] in the domain of time, care work (encompassing housework, childcare, and family care) remains predominantly a female task. Gender roles have an impact on which spaces are used in everyday life, with constraints in accessing local infrastructures and services (childcare, health centres, public transport), in higher rates of poverty, especially in female-led households, and subsequent difficulties affording decent housing, as well as unemployment, barriers to education and experiences of violence and street harassment. The argument is that we should begin this reflection by

12. Novella, A., Sánchez de Madariaga, I. (2024) *Designing Daily Life Spaces. Gender Criteria for Housing Design and Public Procurement*; Ajuntament de Barcelona, Institut Municipal de l'Habitatge i Rehabilitació. (2019) Flexibilidad e igualdad de género en la vivienda colectiva (Qüestions d'Habitatge, n. 22).

13. Cánovas Alcaraz, A., Espegel, C., De Lapuerta, J. M., Martínez Arroyo, C., & Pemjean, R. (2016) Vivienda colectiva en España: 1992–2015. Valencia: General de Ediciones de Arquitectura; Cánovas, A., Espegel, C., De Lapuerta, J. M., Martínez Arroyo, C., & Pemjean, R. (2013). Vivienda colectiva en España. Siglo XX (1929–1992). Valencia: General de Ediciones de Arquitectura.

14. Aureli PV (2024) Enjoy the silence. The case for typological design. *In Burning Farm* 10: 1-14.

15. European Institution for Gender Equality. 2025. Gender Equality Index 2024. Available at: https://eige.europa.eu/gender-equality-index/2024.

examining how women have historically, and continue, to perform caring activities "not to naturalise housework as a female vocation [and the author adds: nor feminism as a women's issue]. It is refusing to obliterate the collective experiences, the knowledge and the struggles that women have accumulated concerning reproductive work, whose history has been an essential part of our resistance to capitalism. Reconnecting with this history is a crucial step for women and men today both to undo the gendered architecture of our lives and to reconstruct our homes and lives as commons."[16]

One of the critical aspects that emerges from reading Federici's work, a feminist philosopher and activist, is how the re-collectivisation of care work can be used as a strategy to promote gender equality and empower women, particularly in the context of addressing female poverty and building new "communities based on quality relations, principles of cooperation and responsibility to each other and the earth, the forests, the seas, the animals."[17] It is precisely this cross-cutting perspective that is the key to interpreting a discourse that begins by observing women's lived experiences to understand how to challenge the norm in the contemporaneity. This canon has traditionally been male. Starting from women's lived experiences serves as a methodological lever because it highlights structural dynamics that are often invisible in traditional typologies: the distribution of care work, the fragmentation of time, spatial insecurities, and a lack of everyday services. These dynamics are not essential properties of a single group, but rather manifestations of spatial vulnerability that cut across age, disability, socioeconomic conditions, and gender orientation. Using a feminist perspective, therefore, means starting from cases where these dynamics are most visible to derive design principles that can be transferred to other bodies and contexts, beyond the norm, the standard, and the habit.

From Power to Empowerment

This condition calls for a reconceptualisation of domestic space and its role in the distribution of care, moving beyond traditional family structures and proposing more collective and cooperative alternatives. In his essay *Enjoy the Silence* (2024), Aureli traces the conceptual origins of a typological discourse in the ritual and ritualisation of inhabiting space. However, through rites and the subsequent organisation and composition of domestic environments, architectural design has helped shape and reinforce the spatialisation of gender roles and power hierarchies. When we consider architecture and rights in the context of critical and design thinking, we are also reflecting on architectural and political praxis. These two concepts are not separate entities; instead, they are interconnected: the political is embodied and operates through architecture, from the design utopias of Ledoux and Boullé (18th Century), who imagined new types of buildings that would bring about a social reorganisation according to egalitarian ideals, to the utopian communities

16. Federici, S. (2019) Re-Enchanting the World Feminism and the Politics of the Commons. Oakland, Canada: PM Press, 165.

17. Federici, S. (2012) "Feminism and the Politics of the Commons." In *The Wealth of the Commons*, edited by D. Bollier and S. Helfrich. Amherst, Available at: https://wealthofthecommons.org/essay/feminis m-and-politics-commons.

promoted by Fourier (18th Century), which were able to spread across the Atlantic and inspire new forms of living in collectivity such as New Harmony and the cooperative colony of Topolobampo, to the avant-garde architecture of the Soviet revolution. However, regarding form, it is essential to recognise that it is not merely a physical form independent of social, economic, and contextual values. This relates to Ernesto Nathan Rogers's understanding of form as a socially constructed entity.

Over the centuries, a process of domestication of social life and moralisation of the population, especially women and poorer groups, has developed through the organisation of the home and its various forms. Notable in this sense are Henry Roberts' model houses (1851) in England, which serve as the basis for the modern housing project, in which each room is linked to a specific function, promoting the segregation of the sexes through spatial division and introducing the concept of privacy. Through his houses and the multiplication of functional rooms, he sought to reduce and counter what the bourgeois saw as sexual immorality and depravity of working-class people living together in overcrowded dwellings. This critique builds on Tafuri's position in *Theories and History of Architecture* (1968) on the "typological critique", which emphasises the necessity of acknowledging the historicity of the type and the ideological contingencies behind it, thereby offering a more comprehensive interpretation than a formalist reading. It also explores how a specific form can (or cannot) influence the way we build, think about, and inhabit a space. Within this condition, women have sought to construct and carve out a space for themselves within the home and expand into the city, paraphrasing Virginia Woolf, taking the form of a room of one's own or a book. In this place, they can think and build their own architecture and cities, even if only imagined through words.[18] This process can be observed both in the writings of Catherine Beecher and the housing typologies designed for single working women in the 1920s-1930s in Vienna by Margarete Schütte-Lihotzky, the so-called Donna "Tipo Tre"[19] (Type Three Woman: not a wife or mother, nor the object of pleasure, but an independent, modern woman) by Notari (1929), attributing to the project an emancipatory connotation. These cases highlight the need to rethink housing units to ensure autonomy and to provide accessible, safe communal care spaces. Tracing the genealogy of a typological discourse from the perspective of women inhabiting space reveals how women's emancipation, through the search for a *Habitat au Féminin*,[20] has sparked a series of typological experiments at various scales, thereby becoming a transnational movement that has entered contemporary discussions. The themes that emerge are therefore: the rationalisation of the house, the liberation from care work, the production of safe places for physical and psychological support, and the

18. Bernege, Paulette. 1928. *Si les femmes faisaient les maisons*. Paris: Mon chez moi; Frederick, Christine. 1914. *The new housekeeping. Efficiency studies in home management*.

19. Notari U (1929) *La donna tipo tre*. La Vita Felice, Milano, 2013.

20. Paravicini U (1990) *Habitat au féminin*. Lausanne: Presses Polytechniques et Universitaires Romandes. The term habitat au féminin refers to an idea of space that stems from the awareness of the need to seek forms of living that meet the needs of women at different stages of their lives, whether single, in a couple, with or without children, or divorced. An individual space of independence and freedom.

development of cooperative forms of living. Beguinages,[21] Kitchenless house,[22] Boarding House,[23] Maternity and Childcare Village,[24] Cooperative housing,[25] Single Mother's house,[26] Women's center[27] Anti-violence center[28] are typologies that reformulate the relationship between body-space and space-rights working on the concept of a care infrastructure that takes the notion of everyday needs and use of space at the centre. This idea of care infrastructure is central to the project Manzanas del Cuidado (Care Blocks) in Bogotá. "Who takes care of those who care?" It is an attempt to create a support network for caregivers (especially women) in marginalised conditions. These are spaces where women spend time in job training, doing sports, or studying, and staff members take care of their family members who may need it. On the one hand, the theme is that of building forms of mutualism and support through the definition of different ways of living, with the case of Canadian feminist housing cooperatives in the 1970s and 1980s, which gave rise to a national phenomenon,[29] up to contemporary experiments in Barcelona and Zurich, with the projects La Borda (2018), La Morada (2025) by Lacol (Barcelona), Kalkbreite (2014) by Müller Sigrist Architekten, and Mehr als Wohnen (2016) by Schneider Studer Primas (Zurich). On the other hand, the theme of protection, support, and the reconstruction of economic and social independence involves projects that integrate aspects of short-term housing, but also spaces of learning, as in Sharon Davis' Women's Opportunity Center (2013) in Rwanda or Yasmeen Lari's Women's Center (2011) in Pakistan,[30] as a safe place even in conditions of environmental disaster (Figure 2).

21. A city within a city, with workspaces and accommodation. Places where women could choose not to marry and find a form of freedom and emancipation based on their own subjectivity.

22. Precursors of contemporary cohousing, with centralized communal kitchens and rational accommodation. Of particular interest is Schutte Lihotzky's project for a single working woman. Through collective care services (nurseries, laundries, etc.), the project itself contributed to building a community, anticipating practices of sharing and domestic cooperation.

23. A type of regulated accommodation for working women: private rooms with shared facilities, designed for mobility and economic independence but often governed by rules of cohabitation linked to morality or religion.

24. Residential cluster that integrates housing with childcare services and healthcare facilities; a project that aims to support young mothers abandoned by their families.

25. Collectively owned and managed housing: private units flanked by adaptable common spaces, a device for self-management, mutualism, and the reorganization of care practices.

26. Housing designed for single mothers that combines protection, privacy, and shared support spaces; a project that addresses single-parent living as an opportunity for networking rather than isolation.

27. Non-residential multifunctional center for training, counseling, and meeting; spatial hub for symbolic production, empowerment, and collective political practices.

28. Protected shelter with temporary housing and legal and social support services; combines spatial discretion and pathways to housing autonomy.

29. Scaioli, A (2024) "Her Space: Women's Collective living as a form of emancipation." In *Athens Journal of Architecture*, Volume 10, Issue 4, October 2024, 407-438.

30. Scaioli, A (2024) Empowering Women through Architecture. The humanistic approach of Yasmeen Lari. In Rosa Tamborrino (Ed.) "Città che si adattano? Adaptive Cities?" Book 4 - Strategie di adattamento e patrimonio critico. Adaptive Strategies and Critical Heritage. Series: Insight, AISU International, Torino, 295-308.

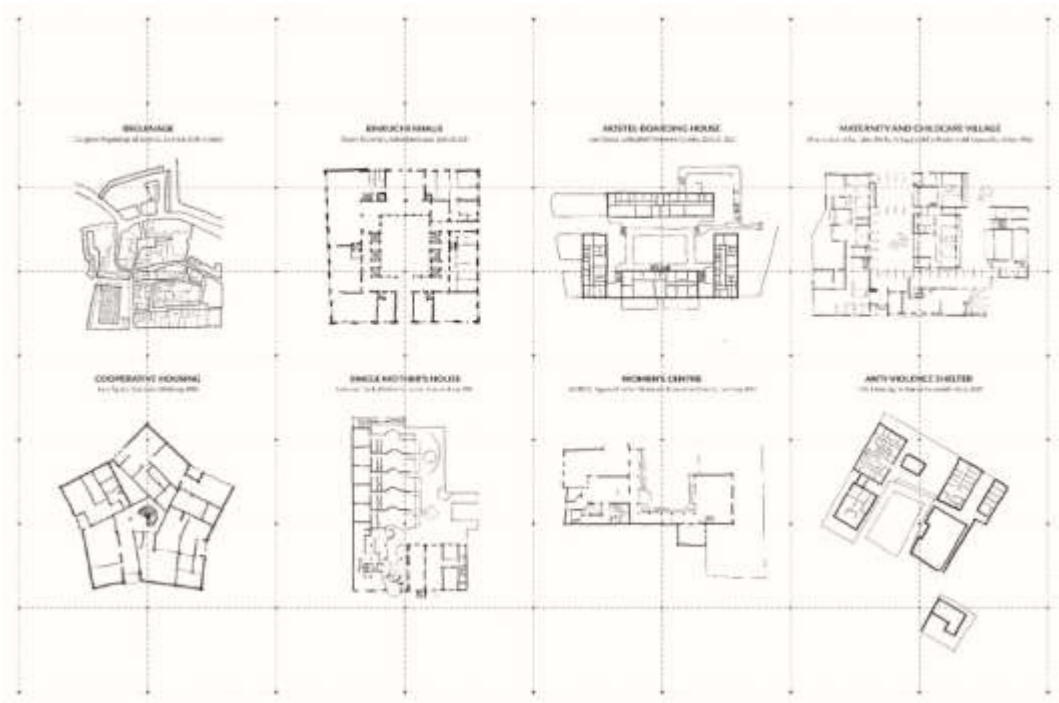


Figure 2. *Female and Feminist Forms of Living. Typological Experimentations*
Source: Drawing by the Author, 2025.

This attitude prompts reflection on forms of living that accommodate families of varying geometries, whether expanded or contracted, as well as on what could support and revolve around the house, where care and gender equality could generate forms of emancipation through the project itself. *Emancipation by and through design* was at the core of Myra Warhaftig's reflections in the 1980s later materialised in the *Emanzipatorische Wohnung* for the IBA in Berlin (1984), which broke with traditional typological schematics and introduced spatial de-hierarchization. The kitchen is repositioned at the center as the hub of care: no longer a closed and hidden space, or the "Camera della Donna - Woman's Room" as it was called in the Casa Elettrica by Bottoni (1930), but the permeable and open heart of the home, connected visually and physically. This configuration allows considerable organisational flexibility and the remodelling of interior spaces in response to the variable number of inhabitants. This idea was revisited in contemporary exploration. Looking at Sophie Delhay's Unité(s) projects (2019), Summacumfacher's San Riemo (2020), or 85 Social Housing in Cornellà by Peris+Toral (2021), the relationship between the entrance, kitchen, and distribution in its sequences and hierarchies takes on comparable typological characteristics (Figure 3).

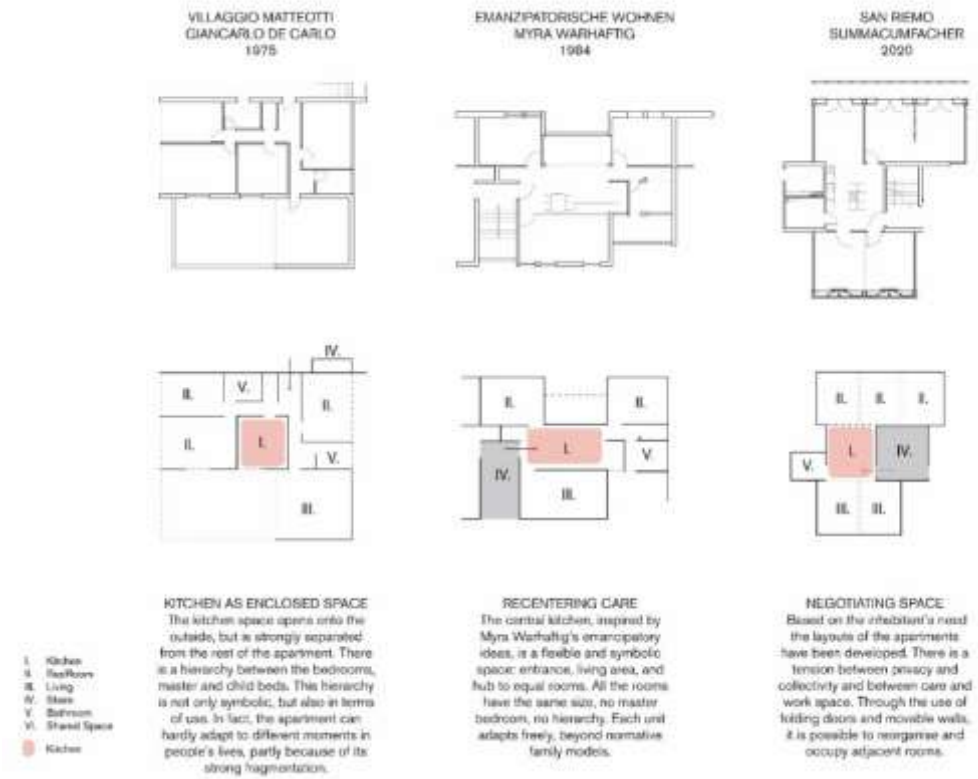


Figure 3. *The Progressive De-hierarchisation of the Domestic Space*
Source: Drawing by the Author, 2025.

Methodology

This work was conceived within the Milanese framework and engages with a cultural and historical background rooted in morphological and typological studies.[31] Specific attention is given to the form of space, character, materials and environment, as defined by Rogers (1955) as *ambiente*. This ongoing research project aims to look from the "margins to the centre", in the words of bell hooks, and to understand how issues derived from feminist philosophy, sociology, geography, and politics can inform the poetics of space. Currently, feminist conceptualisations focus on reappropriation through temporary practices and actions, such as walks, pavilions, and critical mapping. However, there is a need for reflection on the project of inhabiting by working on the form, use, symbolism, and perception of space in synchrony. The paper's originality lies in its attempt to bridge gaps between spatial justice, feminist theory, and architectural design, reframing typologies within a feminist matrix. Within the framework developed in this thesis, the corpus of the work draws on various methods that lie at the intersection of theoretical and design-

31. The paper is based on reflections carried out as part of the doctoral research project: *Spaces of Care and Equality: A feminist design reflection between morphology and process* at the Politecnico di Milano supervised by Prof. Ilaria Valente and Prof. Emilia Corradi.

driven approaches,[32] including a literature review, redesign of the projects, and critical diagrams, which seek to interconnect different disciplines, thereby substantiating this reflection. This concept is intended to be interpreted in multiple ways, aligned with the various moments of the research, which comprise a review of the state of the art, case study research and analysis, and the definition of design strategies. The methodology adopted is based on a design matrix that intersects spatial categories and thematic dimensions to decode how feminist principles are embedded in architectural choices. The matrix is not prescriptive or evaluative, but deconstructive: it reveals the tensions and strategies that shape each project, between individuality and collectivity, from the apartment to the commons. The contribution assumes the need to consider in a systemic and cross-cutting way the issue of how gender influences not only the perception of space (the perception of safety, appropriateness, etc.) and how a space is used (different activities, different patterns of use, etc.) but also how it influences, in a more subtle way, the symbolic aspect (spatial hierarchies, *hidden* care spaces and activities, standardized dimensional aspects referring to a universal user etc.) and how all this affects the morphological and material element of the design. This method allows us to observe spatial elements and understand their potential for aggregation in sequences that promote equality, care and empowerment. Typology, understood as a synthesis of transcalar and thematic relationships, is configured as a relational device that brings form, subjectivity and power into dialogue. Spatial matrices transform typological exercise into a process of action research, in which each diagram serves both as an operational tool and a lens of investigation. The projects have been selected within the Western context, following the collection of more than 30 design experiences across Europe (Figure 4).

Figure 4. *An Atlas of Shared Practices*
Source: Drawing by the Author, 2025.

32. Fraser M (2013) *Design research in architecture: an overview*. Ashgate, Farnham; Roggema R (2017) Research by design: proposition for a methodological approach. *In Urban Science* 1(1): 2; Schoonderbeek M (2017) A theory of "design by research"; mapping experimentation in architecture and architectural design. *In Ardeth* 1: 62-79.

The case studies selected for this contribution are all located in Spain, in peripheral areas, where the spatial challenges to gender equality are analogous. While these three cases are not the only ones to contain traces of feminist design, they stand out for their ability to make these traces legible, discursive and analysable. Their selection enables us to develop a broader, more nuanced analytical narrative that challenges the role of architecture. The categorisation of the case studies builds on the one proposed within the doctoral research. The thesis, following the analysis of case studies, identifies three major strands concerning how these projects interpret, translate, and encapsulate gender equality, care, and women's empowerment. These are as follows: women-centred housing, gender-sensitive housing, and emancipatory housing. This categorisation is not intended to be rigid; rather, it is a method for identifying analogies and potential interpretations of how the themes of gender equality, care, and women's empowerment are manifested in the current design landscape, integrating an intersectional perspective. The first project is temporary housing for homeless women; the second is collaborative housing for non-normative families; and the third is multifamily housing for individuals from diverse backgrounds.

Case Study 1 / Women-Centred Housing: Temporary Residential Centre for Homeless Women by Vivas Arquitectos in Barcelona, 2023

Women-centred housing projects prioritise the housing needs of women at various life stages, including single women, divorced women, women with children, and older women. These projects address diverse requirements, such as affordability, marginalisation and the need for a safe space due to domestic violence, as well as the desire to live in a like-minded community. These projects, predominantly initiated by feminists, provide living spaces where women can explore new forms of cohabitation. These interventions include autonomous projects promoted by self-organised groups seeking architects capable of translating their values, demands for emancipation, and need for care into spaces and architecture. The Temporary Residential Centre for Homeless Women project by Vivas Arquitectos in Barcelona is located in the Sarrià-Sant Gervasi neighbourhood, where another shelter already existed. The project aims to establish a space that provides more than just an emergency shelter. It seeks to promote emancipatory housing practices for the approximately 100 women living there. This commitment is reflected in three key actions articulated within the project's typological reflection: defining a safe space for women in need, promoting socialisation and co-creation and offering a welcoming, accessible environment. Homeless women often find it difficult to access safe accommodation in shelters, as they are frequently victims of gender-based and sexual violence at the hands of other residents. The theme of dignified, safe, and welcoming housing is reflected in the design, which employs several design solutions to achieve each objective. The building has been designed as a linear structure, with a communal ground floor intended as a place of care. All the services related to supporting, reintegrating and emancipating residents are located here. A range of support services, including psychological counselling, communal meetings, and socialisation rooms, is available to assist women throughout various social,

work, educational, and medical stages. These services are designed to support women in rebuilding an independent life. These spaces overlook a private garden, and the transition between interior and exterior occurs through an open yet covered space. The metal sheet façade features a regular rhythm, clearly demonstrating the intention to ensure transparency and natural light in the spaces, while simultaneously promoting a strongly introverted character. Here, excavations, loggias, and gardens do not break the unity of the façade but remain discreetly behind it. Focusing on the public-collective-private relationship, the project redefines how spaces are used, with a focus on the in-between and the theme of thresholds to break down forms of isolation within living units. These spaces include terraces, corridors, loggias, and covered passageways. These spaces can be transformed into areas where potential encounters may occur as "habitable spaces between things" (Figures 5-6).

Figure 5. *Vivas Arquitectos. Shelter for Homeless Women*
Source: Collage by the Author of photos by José Hevia. Redrawings by the Author.

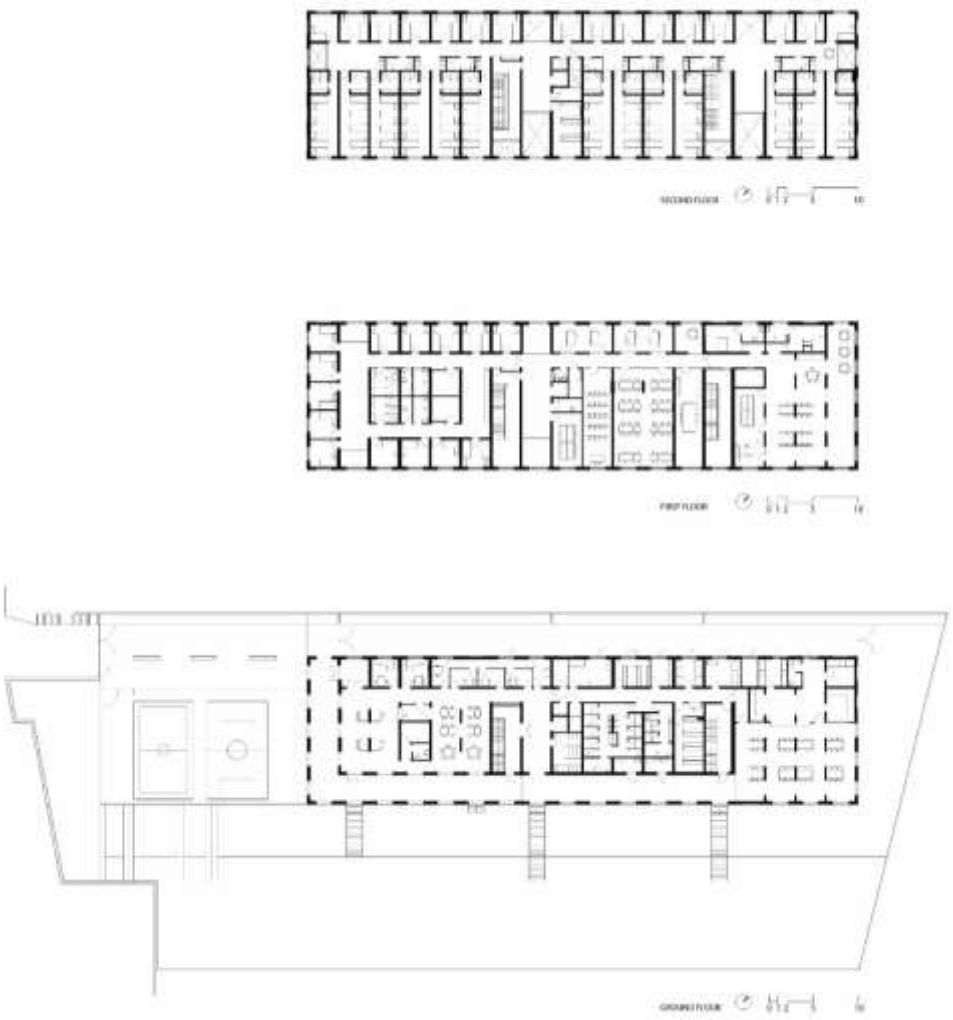


Figure 6. *Vivas Arquitectos. Shelter for Homeless Women*
Source: Redrawings by the Author.

There are different types of accommodation, including shared rooms with four beds and private bathrooms, as well as rooms with two beds and shared bathrooms. This diversity of housing typologies is designed to address the diverse requirements of women in care. It acknowledges that each woman faces unique and complex circumstances and that a one-size-fits-all approach to achieving independence is not feasible. The project, therefore, offers not only a haven but also a reflection on the typological approach, displaying how flexibility and care can foster democratic and empowering relationships. In this sense, the centre is more than just a temporary location; it is a spatial device that accompanies and supports the emancipation process.

Case Study 2/Gender-Sensitive Housing: Entrepatios las Carolinas by SAtt Arquitectura in Madrid, 2020

Gender-oriented housing projects are designed to address the specific needs of women, children, older adults, and individuals with disabilities. They propose new forms of housing that reflect the diverse needs, aspirations and lifestyles of these groups. By challenging traditional stereotypes and hierarchical forms of housing, gender-oriented housing projects aim to create more inclusive and equitable living spaces. Unlike women-centred projects, which promote gender equality by focusing on the emancipation of women throughout the entire process, from conception to realisation, maintenance and ownership, these projects aim to create the material conditions that enable men and women to thrive and enjoy equal living opportunities. In this regard, criteria stemming from gender mainstreaming are introduced throughout the project process. Furthermore, despite focusing on the central themes of safety and accessibility, these projects promote greater openness towards the neighbourhood, addressing scales of living and care that extend beyond housing and individual buildings. Entrepatios Las Carolinas, located in the Usera neighbourhood of Madrid, is a pioneering example of ecological collaborative housing. Since its establishment in 2018, it has operated under a right-of-use regime. A significant proportion of the neighbourhood comprises small, unstable homes constructed during the initial waves of migration in the 1950s and 1970s. These are in addition to unoccupied land and dilapidated workshops. The result is a neighbourhood in transition, currently marked by socioeconomic inequality and mistrust between old and new residents, stemming from the expulsion of the first inhabitants in favour of precarious communities displaced from other areas. The absence of high-quality public spaces and a strong community fabric, which can help reduce social distance and build ties among residents, has led to a fragmented neighbourhood. In this complex context, Entrepatios aims to establish shared, inclusive spaces and situations that will contribute to the creation of a more equitable community fabric.

This project was designed by sAtt Arquitectura and developed through a co-design approach with the Entrepatios Cooperative, involving fifteen workshops. This project integrates a gender and feminist perspective into its design process and outcomes, focusing on material and immaterial aspects related to a symbolic dimension. Specifically, the incorporation of gender considerations was pivotal in reshaping traditional residential architecture, while also emphasising reproductive and productive activities, making them explicit through design, and acknowledging the diversity of household patterns and residential needs over time. The architectural design integrates spaces for habitation, care and work, with an emphasis on accessibility and integration with the surrounding community. The objective is to establish "comunidades de comunidades de vecinos": a transformation that extends from our homes to our city, encompassing our buildings (Entrepatios).

The project adopts a comprehensive sustainability strategy, emphasising care as a vital component of safety, accessibility, and a sense of belonging. It integrates social, environmental and economic dimensions to deliver a democratic, inclusive, non-hierarchical, climate-sensitive and economically accessible intervention. The project comprises seventeen flexible apartments, with a focus on shared spaces.

These spaces, located in key areas of the building and the surrounding neighbourhood, extend the available living areas. The complex's residential architecture is characterised by its permeable, visible, and accessible design, featuring workshops, communal laundry facilities, a rooftop vegetable garden, a spacious common room with a kitchen, and various open spaces. These elements are intentionally designed to be integrated into the overall community space, rather than confined to individual dimensions or used to host activities that should remain private. These communal areas function as thresholds, hosting activities from both the neighbourhood and the community, thereby extending the notion of inhabitation outward. This approach aligns with the concept of 'eyes on the street,' contributing to a heightened sense of security in immediate urban surroundings. The reimagined entrances, including the space adjacent to the main entrance, which is accessible from both the communal courtyard and the street, foster greater permeability (Figures 7-8).

Figure 7. *SAtt Arquitectura. Entrepatios las Carolinas*
Source: Collage by the Author of photos by SAtt. Redrawings by the Author.

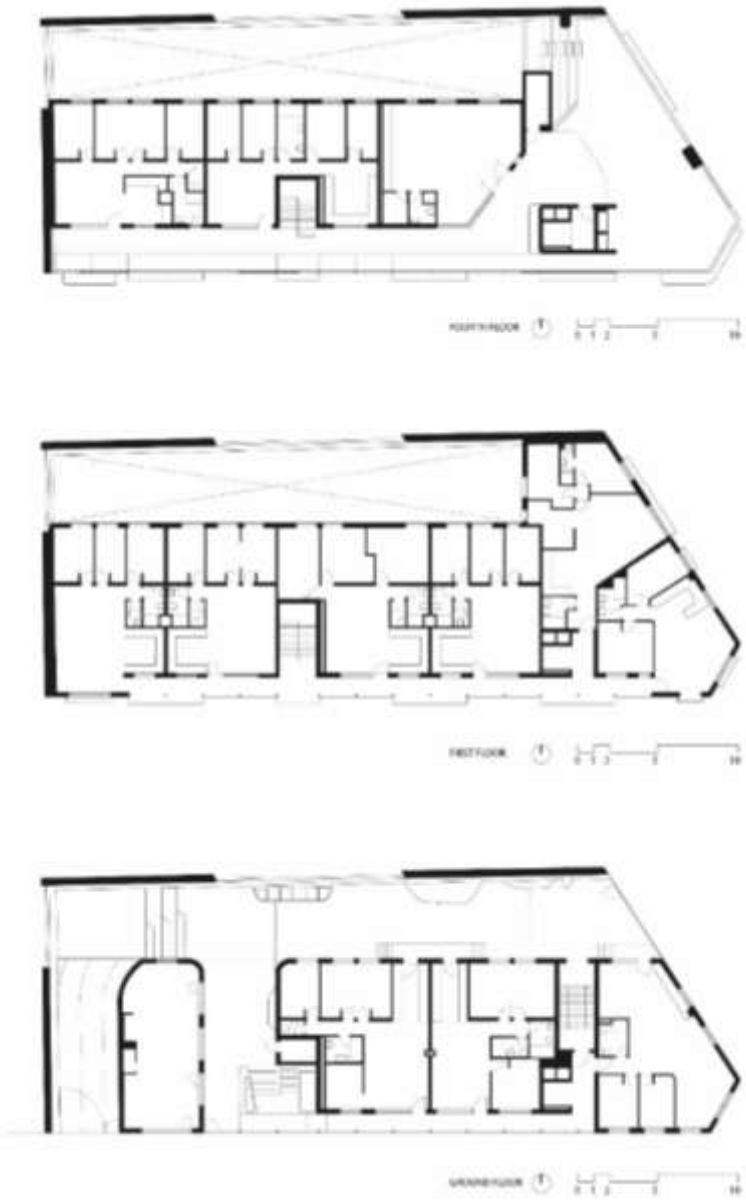


Figure 8. *SAtt Arquitectura. Entrepatios las Carolinas*
Source: Redrawings by the Author.

Case Study 3/Emancipatory Housing: 85 Social Housing in Cornellà de Llobregat by Peris+Toral, 2021

Emancipatory housing projects promote gender equality, care and women's empowerment. Although they do not explicitly introduce a gender perspective, these projects nevertheless have a positive impact on gender relations. Concepts such as democratic living, equity-focused design and the right to live are promoted through spatial organisation, as is the breaking down of hierarchies within dwellings. This concept encapsulates the spatial and compositional essence of

these projects, which are realised at different scales. Within these projects, the theme of hierarchies is reinterpreted in an emancipatory way, in which the equality of spaces across both dimensions and relationships is intended to support gender equality and the equitable use of space, without prioritising certain activities over others. The project, located in Cornellà de Llobregat, was developed by the Catalan studio Peris+Toral and comprises 85 social housing units across five floors. It creates the courtyard building typology based on a repeated 3.6 m x 3.6 m structural module. Initially, the tatami module generates a matrix of communicating rooms, arranged around a collective courtyard. By using this repeated module, typological innovations are introduced in relation to the theme of de-hierarchization of space. The project embodies typological flexibility, non-hierarchical living, and adaptability to diverse lifestyles, thereby transcending the traditional model of the nuclear family. This is achieved through the implementation of a timber construction system, comprising beams and columns, which also serves as a poetic and architectural element of the project. The building is organised around a patio that articulates a sequence of intermediate spaces that function as commons. On the ground floor, an open but covered space opens towards the city, mediating the relationship between the public space and the neighbourhood patio, which becomes a small square for the community. The four vertical cores are located at the four corners of the courtyard, allowing all neighbours to converge in the square, thereby creating a safe space from a gender perspective through the concept of "eyes on the street". The dwellings are accessed through the core and the private terraces that form the outer ring overlooking the patio (Figures 9-10).

Figure 9. *Peris+Toral. 85 Social Housing in Cornellà*
Source: Collage by the Author of photos by José Hevia. Redrawings by the Author.

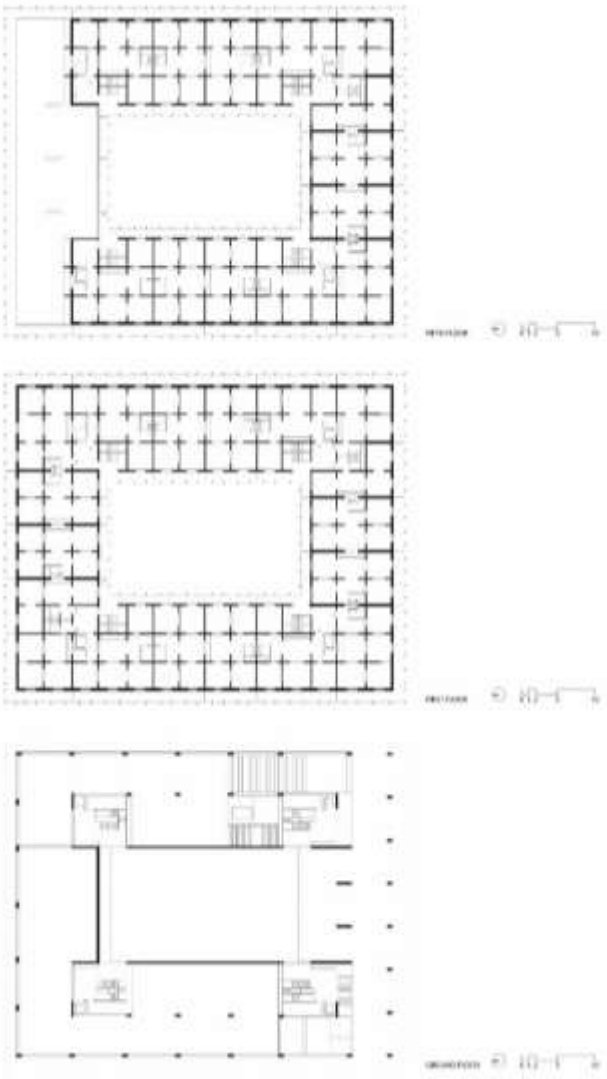


Figure 10. *Peris+Toral. 85 Social Housing in Cornellà*
Source: Redrawings by the Author.

The houses consist of five, six or seven modules, depending on whether they have two or three rooms. The open and inclusive kitchen is situated in the central room, serving as a distribution point that replaces corridors, making domestic work visible and challenging traditional gender roles. This recalls the typological experiment conducted by Myra Warhaftig with Emanzipatorische Wohnung, in which the kitchen became the heart of the home, assuming a central role both spatially and symbolically. The size of the rooms, in addition to offering flexibility based on the ambiguity of use, thanks to the repetition of the module, allows the layout of the homes to be freely modified according to the needs of the inhabitants. In this sense, the Cornellà project exemplifies how spatial design can become a tool for emancipation, even in the absence of an explicitly feminist agenda. By rethinking domestic hierarchies, promoting flexibility, and placing care at the centre of the spatial narrative, the project contributes to a broader redefinition of housing as a

democratic and inclusive infrastructure. It demonstrates that typological innovation can be a quiet but powerful agent of social transformation, capable of fostering more equitable and caring ways of living together.

Comparative Reading of the Three Projects

This reflection takes as its starting point the need to codify a shared feminist spatial theory, building a design culture that systematises spatial practices and morphological reflections, consciously assuming a political and cultural position on the architectural project. In this sense, the contribution proposes a reflection on the design of collective forms of living conceived as catalysers of inclusive and democratic practices that can foster gender equality through design. These forms of collective living extend beyond the traditional notion of housing, permeating the space between buildings and their context, with new forms of domesticity, care, and equality, with the intention of *making common space*. In this context, the housing project becomes a field of negotiation. In a scenario in which gender equality, women's emancipation, and care are considered design issues, it is essential to reestablish the project's necessity. This involves redefining its cultural values and reframing the relationship between a political and poetic approach. But can these spaces, informed by a feminist standpoint, highlight inequalities and foster more equitable forms of living? How should they be designed? Through the construction of a legacy of female and feminist living, the contribution has identified several aspects which, in their forms, use-related, symbolic and perceptive dimensions, are present within the selected case studies:

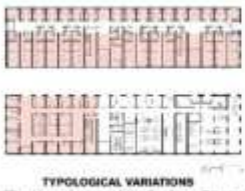
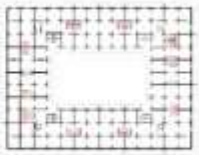
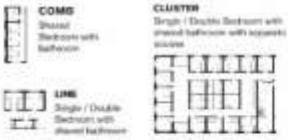
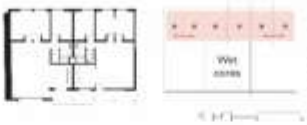
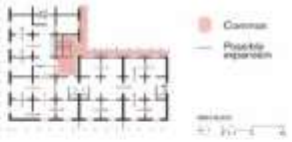
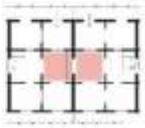
> Safety, spatial configuration can offer protection from violence and promote psychological safety.
> Accessibility, design allows access regardless of physical ability, age, or social status.
> Affordability is key to sustainable housing solutions for women in precarious situations or with a single income.
> Diversity, organisation of space accommodates heterogeneous family compositions and practices.
> Commons promote mutual support, collective care, and non-commodified forms of life.
> No-Hierarchies allows a spatial distribution that avoids rigid separations and enables fluid, egalitarian use of domestic environments.
> A room of one's own, design guarantees autonomy, privacy, and the possibility of intellectual or creative retreat.
> Adaptability, typology can evolve according to changing needs, life stages, and forms of cohabitation.

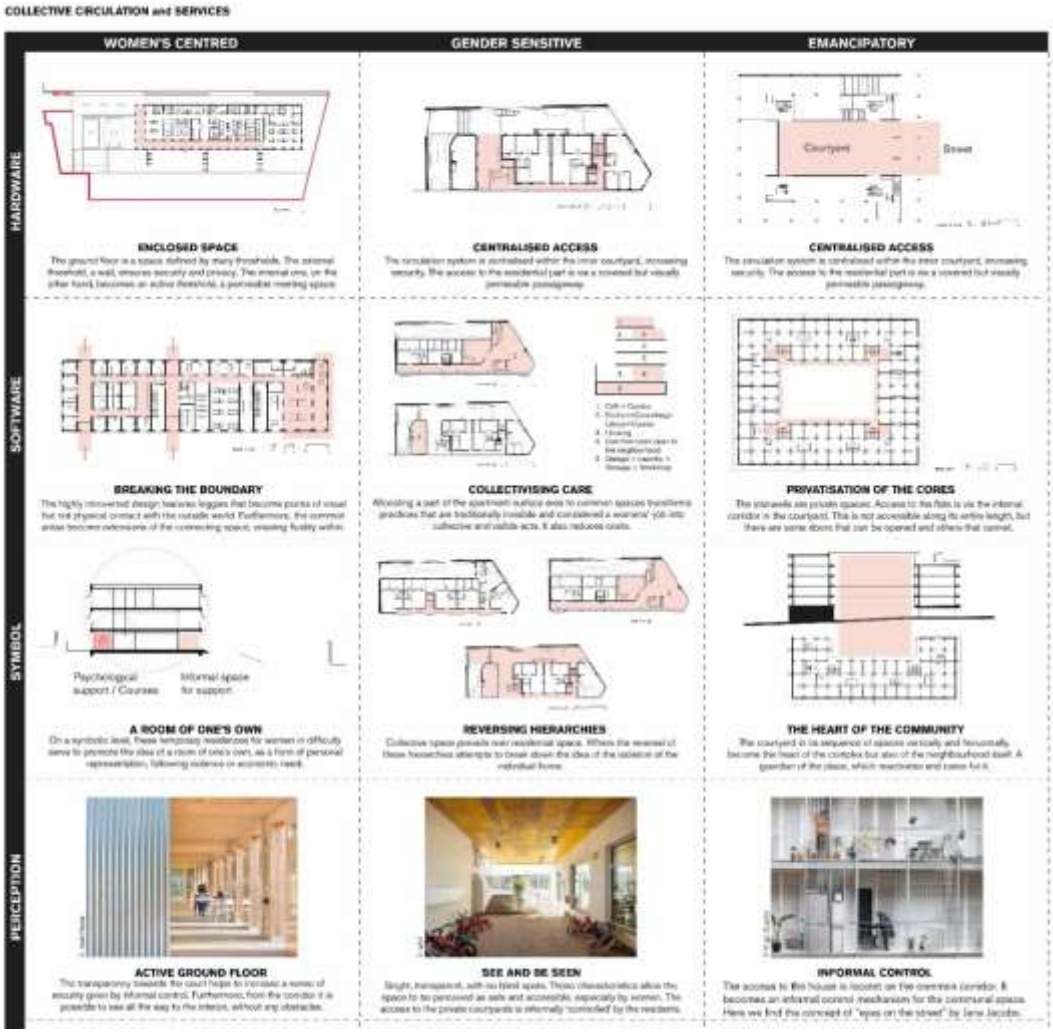
To further articulate these reflections, the following table synthesises the key characteristics of the three case studies, highlighting how each project interprets and translates the themes of gender equality, care, and empowerment through typological and spatial strategies (Table 1).

Tables 1-3. *Comparative Analysis of Three Housing Projects, Temporary Residential Centre (Barcelona), Entrepatios Las Carolinas (Madrid), and 85 Social Housing in Cornellà (Cornellà de Llobregat), Highlighting their Respective Approaches to Gender Equality, Care, and Typological Innovation*

	WOMEN'S CENTRED	GENDER SENSITIVE	EMANCIPATORY
TARGET	Homeless women, women victims of violence, women in vulnerable situations	Non-normative households	Diverse users: families, elderly, women, children
THEMES	Safety Accessibility Affordability Room of one's own Diversity	Safety Accessibility Affordability Room of one's own Diversity Co-Design No-Hierarchies Commons	Safety Accessibility Affordability Diversity No-Hierarchies
APPROACHES	Top Down approach with support system (psychological, physical, economic)	Bottom up cooperative model with participatory design workshops	Top-Down model of Collective Housing
FRAME	Explicitly Feminist: focused on women's empowerment through a caring perspective	Non-speculative gender oriented design: considers non-standard bodies	Implicitly equity focused: de-hierarchisation of space breaks down traditional gender roles

FIREPLACE

	WOMEN'S CENTRED	GENDER SENSITIVE	EMANCIPATORY
HARDWARE	 **TYPOLOGICAL VARIATIONS**	 **DOMESTIC GROUND FLOOR**	 **OPEN INFRASTRUCTURE**
SOFTWARE	 **DEGREES OF INTIMACY**	 **ADAPTING TO LIFE CYCLES**	 **NEGOTIATING SPACE**
SYMBOL	 **A ROOM OF ONE'S OWN**	 **RECONCILE CARE AND WORK**	 **RECENTERING CARE**
PERCEPTION	 **PRIVACY WITHIN COMMUNALITY**	 **EYE ON THE COURT**	 **FLUID SPACE**



Source: Elaboration by the Author.

The table synthesises key design strategies, spatial devices, and feminist dimensions, illustrating a spectrum of engagement from explicitly women-centred to implicitly emancipatory models of housing.

This comparative reading reveals a spectrum of feminist engagement, from overtly women-centred design to more implicit forms of spatial emancipation. While the Barcelona project prioritises protection and support, the Madrid cooperative fosters openness and integration, and the Cornellà housing model promotes flexibility and equality. What unites them is a shared commitment to rethinking the domestic realm as a site of care, collectivity, and transformation.

Discussion

This contribution analyses projects that demonstrate how architecture can act as a political and cultural tool, challenging spatial hierarchies and promoting gender equality. Rather than being neutral or merely functional, housing typologies

emerge as devices of negotiation, in which the organisation of everyday spaces becomes a contested and transformative arena. Thus, the architectural project is not merely a response to needs, but an intentional and situated act that reflects values, ideologies, and power structures. Reflecting on typologies becomes a space of resistance in which new, more inclusive, flexible, and caring forms of living can be imagined and constructed. In the face of increasingly diverse forms of living and evolving social needs, existing housing models have proven to be inadequate. At the same time, feminist discourse on housing has often focused on use, management, and process, rarely addressing typological and morphological questions. The *death* of housing typology, then, becomes a productive provocation: is it truly obsolete, or simply in need of radical redefinition?

This paper argues for the latter. Typological thinking must be reinvigorated with new design paradigms, such as gender equality, care, and women's empowerment, that can transform not only how we inhabit space but also how we conceive and design it. This aligns with a militant, materialist feminist critique that reinterprets the idea of "a room of one's own" as a starting point for imagining expanded, fluid, and collective forms of domesticity. These new configurations accommodate variable household structures and challenge the gendered division of labour through the collectivisation of care. The three case studies contribute to a transcalar reflection that spans from the housing unit to the neighbourhood, exploring how care and empowerment can be spatialised. They navigate the tension between "a room of one's own" - as a space of safety, identity, and rights - and "a room to the city," where the breakdown of the nuclear family and the hybridisation of domestic forms open up new possibilities for shared living. This tension is materialised through spatial sequences, atmospheric variations, and the reconstitution of the modernist dichotomy between public and private. Heir to a materialist feminist critique of gender from the 1970s, which was built on the demands and experiments of the early 1900s, the research starts from Hayden's provocative question, "What would a non-sexist city be like?", to reflect on the spatial, symbolic, and perceptual dimensions of living space as a place for claiming rights. A work of reconstruction of a design and designerly legacy carried out through literary writings (Perkins Gilman, 1915), manuals (Beecher, 1841), and utopian works (Bernège, 1928), but also linked to a historiographical (Torre, 1971) and critical (Matrix, 1984) exploration.

The matrices presented are not only a product of research, but also a tool for reading and designing. In fact, breaking down the various projects into spatial elements (fireplace, circulation, service, open space) and observing them in terms of their formal, functional, symbolic and perceptual dimensions allows us to outline some of the themes and issues at the heart of a feminist approach to housing design. Possible lines of action are then identified:

> Deconstruction of spatial and social hierarchies: The deconstruction of spatial and social hierarchies aims to redesign built environments to reduce disparities. The goal is to create environments that do not reproduce pre-existing power and gender roles.
> Activation of common spaces and the ground floor: The activation of ground floors and common spaces often transforms otherwise passive areas into places

for socialising and daily care. This increases perceived and real safety, strengthens mutual aid networks, and makes urban space more welcoming for everyone.

> Modularity, adaptability, and typological diversification: Designing with modularity and adaptability means offering solutions that evolve with users' needs over time. Flexible housing types and spaces enable reconfiguration for different families, domestic work, and care services. Typological diversification avoids standardisation that excludes specific needs.

> Visibility, orientation, and informal control: Promoting visibility and orientation means making spaces easily readable and informally monitorable by the community. Clear paths, active views, adequate lighting, and natural observation points enhance positive social control, discourage dangerous behaviour, and increase perceived well-being.

The matrix is conceived as a conversational instrument that extends beyond prescriptive norms. Existing reports propose gender-aware design through new standards for sidewalk widths, building separations, and the provision and sizing of care spaces. There is the underlying danger of reproducing formal outcomes without considering the motivations behind design choices or how to translate those motivations into the physical fabric of places. For this reason, the research argues for stepping back to create a matrix that integrates design and compositional strategies that express principles of gender equality, care, and women's empowerment across formal, use-related, symbolic, and perceptual dimensions, and at multiple scales, from the body to the neighbourhood. Such a tool is valuable not only as a platform for community dialogue and comparison but also as a resource for practitioners and educators. It functions as both an operational instrument and a framework for generating and analysing projects. The thesis, therefore, proposes a methodological approach to develop a tool that can guide design decisions across diverse contexts. The condensed information in the matrix facilitates mediation of interactions among the various stakeholders involved in a project. Positioned between a manifesto and a practical instrument, the matrix is useful during conceptual development as well as in analytical and interpretive phases.

The three selected projects are representative of a European cultural and design context. They are chosen to address the typological issue and the challenges of gender discrimination in a coherent manner. The methodological approach to interpretation and design proposed in this research is grounded in the idea of its applicability to other contexts. In fact, although the matrix begins with projects located in specific contexts, it abstracts their character, defining design actions that can then be translated in particular ways.

Returning to Dolores Hayden's reflection, what emerges is the need to understand housing not as an isolated unit but as part of a transcalar project of care, in which "the household should be extended to the world."[33] This perspective invites us to blur the boundaries between the public and private, the individual and the collective, and to consider thresholds as spaces of empowerment, justice, and dignity. In this context, collective forms of living become catalysts for inclusive and

33. Hayden D (1981) *The grand domestic revolution. A history of feminist designs for American homes, neighborhoods and cities*. MIT Press, Cambridge, MA.

democratic practices. These new forms of domesticity and care permeate the space between buildings and their urban context, generating what Silvia Federici has called "feminist housing commons". Cooperative living, networks of sharing, and diverse kinships offer renewed ways of organising the reproduction of life, counteracting gender discrimination and spatial stigma. Ultimately, these projects suggest that typological innovation, when informed by feminist values, can become a powerful tool for reimagining not only how we live, but how we care, relate, and resist.

Conclusion

In conclusion, a comparative analysis of three case studies reveals that housing typology can be a vital tool in achieving gender equality, promoting care and empowering women. Whether through reevaluating threshold spaces, dehierarchising domestic and caring functions, or creating transcalar care infrastructures that combat isolation within and outside the household, typological transformation emerges as a subtle yet potent agent of social change. Alongside a design-oriented reflection, a clear research-action perspective emerges, redefining the role of the architect within what we might call process-based architecture. Activism and architecture have converged in militant approaches, in which social and spatial dimensions have overlapped and influenced one another. The role of the architect, as explored across the three projects, reflects a diversity of engagement approaches: from reactive negotiation within institutional frameworks, as in the woman-centred project; to collaborative co-design with communities, as in the second project; to speculative experimentation with spatial hierarchies, as in the third project. These role-reactive, cooperative, and speculative can be viewed through the lens of design activism, where design is not merely a response to needs, but a means of envisioning alternative futures. In this sense, the architect is redefined not by stylistic authorship, but by their capacity to intervene, mediate and construct spaces of justice.

This reflection calls for the rearticulation and repositioning of a feminist theory of architectural typology, moving beyond formalist classifications to instead interrogate the social, symbolic, and political implications of spatial organisations. Gender Equality, Care, and Women's Empowerment would serve as design paradigms, enabling the creation of affordable, non-hierarchical, diverse, safe, accessible, familiar, and adaptable spaces. These criteria could challenge and reposition our practice and research, producing a renewed vision for our cities and neighbourhoods. Indeed, the case studies reveal design shifts that, when read critically, suggest a more profound transformation in how we conceive of domestic space and its relationship with the context. The change is not only spatial, but also epistemological, political, and relational. First, traditional housing design is grounded in a functionalist logic, where each room is assigned a specific use and a specific user. In these projects, however, the housing module loses its rigidity and becomes a relational cell, capable of accommodating plural uses and non-normative forms of cohabitation. Second, conventional layouts often replicate internal hierarchies (master/service, public/private) that both produce and perpetuate gender roles. The case studies propose a more horizontal spatiality, in which thresholds are porous, functions are redistributed, and spaces such as the kitchen or the courtyard

become sites of encounter and collective care. Third, in traditional design, the user is often abstract and idealised. In these projects, the user is concrete, plural, and actively involved. Design becomes a process of listening, co-construction, and negotiation. Fourth, the house is no longer conceived solely as a space of individual protection but as a micro-infrastructure of care that supports relationships, interdependencies, and collective practices. The projects demonstrate how care can be made visible, shared, and spatially organised through space.

The three projects exemplify how gender equality, care, and women's empowerment can be understood through approaches and project actions that present different ways of understanding these topics. Although they address the same issues: safety, accessibility, diversity, affordability, commons, no-hierarchies, there is no single or definitive solution. However, the position taken in the paper and more broadly in the research is the recognition of a need to go beyond the performative dimension to understand how these issues impact the form of space based on multiple, evolving needs. The construction of a cross-cutting approach among form, use, symbol, and perception is inherently oriented and centres intersectionality. Ultimately, this paper argues that housing typology, when critically reimagined through feminist lenses, can become a site of resistance, negotiation, and transformation, redefining a new poetic and politics of space.

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