***energy sufficiency • urban landscape • energy consumption • Urban Heat Island***

# **Sufficient Energy Landscape.** Tuning Technologies with Social Practices and Other Ecologies in the Urban Context

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*Abstract*

European urban contexts and urbanisation processes are facing an energy transition that progressively requires the integration of technical solutions within consolidated spaces and energy behaviours. Concurrently, EU policies have long privileged the economic and technical dimensions of energy, often neglecting its impact on space and people.
However, these urban contexts layered with levels of complexity such as dense and historic fabrics, climate hotspots, governance inertia, require a thoughtful design that combines technological innovation, social needs and ecological balances in a general lack of space and resources. PEDFORALL, an ongoing research project, interprets Ostiense in Rome as a potential positive energy neighbourhood, embracing energy sufficiency as a key concept to tune the technological apparatuses to the socio-spatial features of the site.

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The most worrying impact of today's urban energy system, are, the alterations of the global climate due to their strong share on emissions.

*The Techno-Impasse of the Urban Energy Transition*
Energy is, and it has always been, a major driver of urban development and transformation (De Pascali, 2008), as urban areas and urbanisation processes have historically been highly energy consuming (Smil, 2021; Rahm, 2023a). Enormous amounts of the world's primary energy are drained by these environments in the production of goods, in the transformation of the Earth's surface, and in the functioning of infrastructures; but also to enable the daily-life practices with artificial lighting, means of transportation, comfort management, etc. The energy issue permeates spatial transformation, revealing the interdependence of energy systems with territorial ones (Puttilli, 2014); an aspect that is finally evident in the current transition, where, following the *rupture* of the hierarchical and monodirectional energy system and the advent of distributed production, the territorial rationalities and the geography and agency of energy spaces are changing. Energy transition is not limited to infrastructural transformations but also implies a reflection on the ways in which we produce and consume energy and their collateral effects. The most worrying impact of today's urban energy system, are, in fact, the alterations of the global climate due to their strong share on emissions (IPCC, 2022). The dramatic snowball effects are there for all to see: a steady rise in temperatures with the urban heat island (henceforth UHI) effect, direct impacts, once again, on energy consumption through increased use of air conditioning (Roesler, 2022).
The strong energy-climate conditioning exerted by cities is one of the focal points of the broader paradigm of energy transition interpreted by national and international agendas in the European context (Rifkin, 2019). In this paradigm, the transformation of the urban area is one of the levers for ecological transition; labels such as smart city, sustainable district, and green city are building frameworks to bring forward actions that point a specific goal: the energy transition to a less demand for primary and final consumption (Erba and Pagliano, 2021).
However, energy transitions are processes that cannot be described in a defined and univocal way (Smil, 2017). The current EU transition has been interpreted through an *ecomodernist* vision (Puttilli, 2014), an expression that can be roughly translated as the

restructuring of the energy system for a sustainable metabolism starting from the economic and productive sectors. This means modernising energy production and consumption through appropriate *green* or *clean* technologies. This vision has been translated into a series of time-bound strategies with many policy packages to promote renewable energy production and the development of efficient technologies to decarbonise the production and consumption systems. Actually, the design of these energy policies considers the CO2 emissions produced by energy systems as the problem to be addressed by *decarbonisation*, that is, the reduction of the carbon-hydrogen ratio in the use of energy sources (Termini, 2020). This process has been promoted by various policies, in particular those aimed at increasing the use of *renewable sources* (Ghiglione, 2019). Another paradigm that permeates the transition policies is that of *efficiency*, all of which aims aim to reduce energy demand. Energy efficiency has been interpreted by the ecomodernist vision as the technological modernisation of consumption systems for mobility (e.g. electrification of mobility) and housing (e.g. heat pumps, envelope insulation, district heating systems, etc.). Both the increase in renewable sources and energy efficiency are expected to contribute to decarbonisation.

To make renewable production desirable, policymakers have constructed a generous system of incentives to boost the implementation of new REN plants, which actually happened between 2009 and 2013 in the so-called *renewable rush*, a rapid and huge construction of many renewable energy plants (Frolova et. al, 2019). On the other hand, to accelerate efficiency practices, credit tax instruments have triggered an unprecedented urban retrofitting initiative, spreading construction sites everywhere.[1]

However, if we look at the above transition process from a socio-spatial perspective, some evident shortcomings emerge. At first, ecomodernist decarbonisation by increasing renewable energy sources through incentives for new plants is a somewhat different route from the goal of reducing or eliminating fossil sources (Arrobio, 2023). Yet the result of energy transition policies is often an accidental transformation of the landscape (Bridge, 2018; Frolova et al., 2019), where space is considered by policies as a mere support or a generic site to be developed for a maximum

**1 – A paradigmatic case is the Italian *Superbonus 110%* launched in 2020, a tax credit tool with economic facilitation that led many buildings "free" intervention by deducting the expenses with the Tax Return, transferring credit to suppliers' banks or financial and insurance institutions, or with the discount on the invoice.**

The result of energy transition policies is often an accidental transformation of the landscape.

economic profit or a technological functionalism (Carrosio, Magnani, 2022). This space-blindness has generated inevitable conflicts, new pressures on resources (rivers, soils, forests, etc.) and many layers of injustice (D'Angelo, 2023). The social-spatial indifference extends to energy efficiency, where the tax credit does not consider the feasibility of energy measures in contemporary European urban areas made up of a stratified building stock (old architecture, fragmented ownership), in specific environmental conditions (local climate, thermal service demand), in different social circumstances (income, legal capacity, energy poverty). As a result, the relationship between the socio-technical apparatuses and the quality of everyday spaces with energy practices, which, as Elisabeth Shove (2007) points out, consistently determines energy consumption, is little explored.

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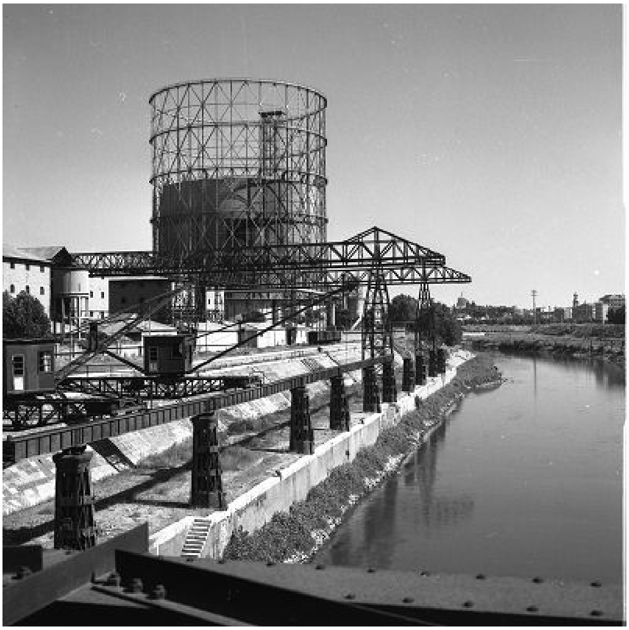
The spatial blindness of the ecomodernist policies, where the same technical solutions are devised for similar problems (Barca et al., 2012), is directly reflected in the urban design culture. Most of the European energy urban plans (e.g. SECAPs) show a standardised way of energy planning (De Pascali and Bagaini, 2018), excessive expression of quantity, vague and general objectives, and lack of spatial representation (Rutherford and Coutard, 2014). On the other hand, despite some isolated relevant territorial investigations and design explorations, the dominant design culture approaches the energy transition with a naive vision, reproducing the idealisation of techno-scientific models, thus focusing on a deep eco-efficient architecture – often brand new – isolated in the neighbourhood dimension, thus ignoring the huge urban heritage that already exists.

There is room to move beyond a purely technocratic vision and to experiment with the socio-spatial specificity of urban energy transition. Taking this possibility as a starting point, this contribution reports on a collection of inspiring design experiences and some findings related to an ongoing European JPI-funded research project entitled PEDFORALL. Starting from the premise that technocratic transition alone is insufficient and responsible for chaotic and conflictual territorial transformations, the key question here, which assumes the terms of a challenge, is how to balance the process of energy transition with actions of spatial depth, thus reintroducing thickness to social-

spatial and local issues. More specifically, the project investigates the agency of existing socio-spatial arrangements to achieve conditions of *energy sufficiency* (a concept that will be developed in the following paragraphs) and explores what the urban project can do. Although not a new concept, energy sufficiency still appears blurred through the lens of space. Unable to follow predefined patterns or refer to established research and design experience, the contribution follows hints and insights worked out through an abductive reasoning, that is a pragmatic way of proceeding by testing the most plausible hypothesis.
By building on the concept of energy sufficiency and attempting to transcend it when it is restrictive – for example, when it implies a moral judgement and contours of dismal degrowth – this study aims to contribute to the repair motion as an alternative to the techno-authoritarian urban project of sustainability. In this sense, the insistence is not on replacing the socio-technical apparatus, nor even on fixing it – both of which are susceptible to insisting on the *status quo* of practices, policies and socio-spatial organisation.

Fig. 1 - Historiacal, dense, worm, energy hungry, EU cities are facing several challanges for energy transition (Source: Fabrizio D'Angelo, 2023)

Fig. 2 - Evolving Energy Spaces: the former Italgas area in Ostiense, Rome. Neighborhoods like Ostiense are historically dedicated to the production, distribution, and storage of energy. Today, many of these decommissioned and abandoned infrastructures are being repurposed or regenerated with new energy functions, creating a stratified urban energy landscape (Source: Roma Capitale).



Rather, it focuses on the idea of a transformative process of repair (Moore, Patel, 2022) that engages with and takes on the maybes and conditions that emphasise extraction processes geared towards accumulation.

The interpretation of space by the current energy transition policies as a mere functional support has proposed an isomorphic and atopic view of the spatial configuration.

*Space, an energy source*

To focus on the role of space is to partially reframe, if not overturn, the dominant frame of the energy transition. For Viganò (2023), the potential of space could shape the transition as a collective capital and heritage, and as an open support capable of acting and adapting, reworking the relationship between the individual and the collective. However, as we have seen above, the interpretation of space by the current energy transition policies as a mere functional support has proposed an isomorphic and atopic view of the spatial configuration. Soils and surfaces are usually treated as development sites for standardised technologies, whose morphology and distribution follow functionalist protocols. And the exclusive consideration of the urban territory for energy purposes neglects its essence as a *social construct*, as a place where social facts take place (Crosta, 2010), with the consequence that all forms of integration, synergy and contamination with social practices, uses and actors are too often overlooked. Yet space is the key to realising the conditions of the energy transition. For instance, renewable energy sources, which have a lower energy density per square metre compared to fossil sources, require the involvement of more space in a diffuse mode and in existing configurations (Pasqualetti, Stremke, 2018; Trainor et al., 2016). Or again, energy efficiency, which refers to the property of a process and/or a material not to waste energy, refers to improving the conditions, including therefore space, of something that already exists (i.e. the existing building stock) in order to make better use of the energy through recovery, recycling, and optimisation processes (Arrobio, 2023). But paying little attention to the social situation of the context means also running the risk of not recognising the essence of transition itself, understood as a change that affects the structural part as well as the set of practices of a given context (Geels et al., 2015). Otherwise, both renewable energy and energy efficiency fail to consider the potential of space and the social practices embedded in it to reduce energy demand. What happens instead is the installation of a technological system that often almost sterilises the local conditions, does not allow for alternative ways of producing and better using energy, and does not necessarily entail change in behaviour of the subjects living in the contexts in which it operates. But there is another concept that could be considered to test the possibility that its interpretations offer to overcome the socio-spatial impasse of the current energy transition, and that is *energy sufficiency*. At a theoretical level, sufficiency reduces the problem of consumption to its roots, by directly eliminating or reducing certain energy needs. Indeed, sufficiency refers to reducing waste by restricting oneself to consuming just enough (Burke, 2020). In other words, some behaviours could reduce the need for some energy demands (Arrobio, 2023). Although not new in the energy debate (Ivan Illich's contribution *Energy and Equity* dates back to 1973), sufficiency practices have been for long associated with a certain cultural rejection, overridden by a technocentric bias that neglects actions achieved by non-technological means and, above all, does not envisage practices that limit demand but only act on supply (Arrobio, 2023). Other authors have pointed to the limits of energy sufficien-

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cy, the dark side of a concept that focuses on the deliberate, voluntary actions of individuals and groups of individuals (Sorrel et al., 2020). Rebounds and spillover effects are identified as possible drifts related to the mechanism of reducing on the one hand in order to feel financially, morally and temporally legitimised to spend more energy on other goods, services and activities involving other energy uses and emissions (ibid.). Nevertheless, energy sufficiency remains the least technosolutionist and most promising concept for reformulating energy balances. Our hypothesis is that this concept has not been sufficiently considered and that it could still be a way out of the impasse.

Energy sufficiency remains the least technosolutionist and most promising concept for reformulating energy balances.

Yet traces of energy sufficiency can be found in various architectural and urban projects. From Victor and Aladar Olgyay to Glenn Murcutt and Lacaton&Vassal, the concept of sufficiency is behind studies and projects of bioclimatic architecture. It is well known that the design of climatological architecture is about establishing a close relationship with the external atmospheric and climatic conditions of the site, to achieve a high level of climatic comfort with a low input of artificial air conditioning, ventilation or heating device and, consequently, a minimum use of fossil source. However, as the work of Barber (2020) shows, the imposition of a universal standard of comfort has reduced and trivialised the relationship between the architectural artefact and the context in which it is located, entrusting mediation to mechanical means or relying on fossil fuels. Today, this line of research is once again attracting attention, and a set of solutions that make an economy of means is seen as one that can help to rearticulate the architectural project (Grohar et al., 2023; Rahm, 2023a; Rahm, 2023b). Without taking sides against thermomechanical systems, these works endorse the hypothesis of variable indoor climatic conditions, as well as the possibility of discomfort due to less stable thermal conditions as well as the obligation to constantly take care of one's surroundings (Kedziorek, 2023).

And urban space? As early as the 1980s, Hough called for "more ecologically sound ways of manipulating the climate of cities than the current total reliance on technological systems" (1984: 28). His work, as well as that of Spirn (1984) or Tjallingii (1995), among others, integrates sufficiency even without direct reference to it. They offer attentive readings of urban space that highlight design possibilities that contribute to creating urban conditions of comfort while reducing energy demand. More recently, design scenarios such as the "Climatic Urbanism" by Philippe Rahm (2023b) consider the reduction and elimination of some energy consumption by reintroducing the nexus of "natural geographical location." In projects such as the Taichung Central Park (Taiwan), or the Scalo Farini (Milan), the public spaces generate a high quality of comfort that contributes to the well-being of those who directly inhabit them and, more broadly, work to mitigate the local microclimate through strategies such as increasing the albedo in horizontal surfaces; extending the phenomenon of convective winds; and cooling the air by evaporation, planting trees or activating fountains. Particularly interesting is the pre-modern knowledge that Rahm (2023a) recalls to design with the context, a valid and central point in the spatial strategies for energy sufficiency. The way to reduce energy consumption through a bioclimatic approach also informs contemporary research and projects, especially those dealing with the UHI effect. The "Climactions" project in Rome (Pone, 2023), for example, provides design solutions for urban open spaces to counteract the UHI, and also assesses their impact on temperature reduction and perceived comfort.

Sufficiency could also serve as a paradigm for reading urban space as a whole in terms of energy. The work of Paola Viganò (2012; 2014) focuses on the possibilities of reducing consumption, integrating renewable energy production, recycling energy and valorising embodied energy as key factors to address the transition in consolidated urban areas. This is a key set of urban research based on the figure of isotropy, the scenario tool and territorial mapping, which has explored the possibilities of reducing energy consumption in large territories such as the metropolitan areas of Paris (Viganò et al., 2014), Brussels (Région de Bruxelles-Capital; Bozar Architecture, 2012), Lille (ADULM, 2014) and the central area of the Veneto region (Viganò et al., 2014). It shows how the mapping of the large amounts of embodied energy and labour accumulated in the existing urban morphologies legitimises the existing territorial stock and acts as a ba-

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sis for thinking about design strategies that elaborate possible promising relationships that re-energise the existing heterogeneous mass of materials. The main outcome of this work is the valuation of the existing territorial stock as a capital, the important role of the existing isotropic network of grids and infrastructures, and the research based on the radical reduction of car use. Less attention has been paid to the elaboration of project strategies for energy sufficiency, including architecture and everyday practices.

The concept of sufficiency is explicitly interpreted in an inspiring study on buildings' energy sufficiency by the European Council for an Energy Efficient Economy

The concept of sufficiency is explicitly interpreted in an inspiring study on buildings' energy sufficiency by the European Council for an Energy Efficient Economy (2019) or in the guidelines of NégaWatt (2022) to promote energy sufficiency (referred to as *sobriété*) in France. In particular, the latter examines energy savings that could be achieved by changing energy behaviour both in buildings (e.g. setting the thermostat to higher temperatures in summer and lower temperatures in winter) and in open spaces (e.g. reducing lighting consumption in car parks). Although presented as a principle among others, sufficiency is also an asset of energy plans such as those of Zurich (Energy Master Plan Steering Group, 2016) or Geneva (République et Canton de Genève, 2020). However, the sufficiency measures that could actually be taken are still general or vague.

Energy sufficiency is therefore not a new or ignored concept, but it is often treated implicitly and/or as non-primary. While there is certainly a greater awareness of practices that lead to reduced energy consumption, it is less clear how to create the spatial, physical, and infrastructural conditions to facilitate and replicate them in a specific context. Architectural, landscape and urban design expertise could converge to treat space as a continuum, shaped to accommodate configurations that enable social practices that reduce energy demand.

At an operational level, it is already possible to identify an initial portfolio of energy-sufficient design options, based on the above work and that of other researchers and designers, that make use of existing urban space and encourage practices that reduce energy consumption. For example, in order to mitigate the UHI effect and the use of mitigating appliances for comfort, streets, car parks and squares could be landscaped by introducing lawns, planting trees and shrubs in rows or groups (Dessì, 2015; Latasa, 2022; Pone, 2023), adding shading structures such as PV canopies or *pergolas* (Ratti, 2017), replacing permeable paving with light-coloured asphalt or similar (Adjuntament de Barcelona 2018; APUR, 2020). Alternatively, to reduce indoor temperatures, existing buildings could be retrofitted with *brise-soleil* or double-skin facades that, when closed in winter, form an insulating space and, when open in summer, filter the sun's rays and create ventilation spaces; rows of trees could be planted along the southern façade to reduce the albedo index (Erba and Pagliano, 2021). Existing flat roofs can be used to accommodate PV and solar energy systems for energy self-consumption, but also to form vegetated (and cultivable) roofs that passively insulate buildings and reduce surface overheating (Guida, 2022; Toboso et al., 2023). In medium-density urban patterns, courtyards, loggias and porticoes could also host PV and solar systems for self-consumption or community consumption (Marrone and Montella, 2022). The shared use of these spaces, but also of facilities such as shared laundries and bike/car sharing, can allow to reduce individual consumption (Erba and Pagliano, 2021). The urban street section could be reorganised as a space of light mobility, concentrating, where possible, social, recreational, commercial and vegetated spaces, thus reducing the movement of local citizens for basic uses in other neighbourhoods and recovering the quality of public spaces (e.g. planning programmes such as *Superillas* in Barcelona; or the *Ville du quart d'heur* in Paris). Or again, the use of the Cool Material technique in the form of white paintings is used both to mitigate UHI and to give social agency to street spaces (e.g. the intervention in streets and car parks by the Bureau of Street Services in Los Angeles; and the *outdoor cooling station* in Tiffany Street Plaza, New York designed by Interboro and the Department of Health and Mental Hygiene).

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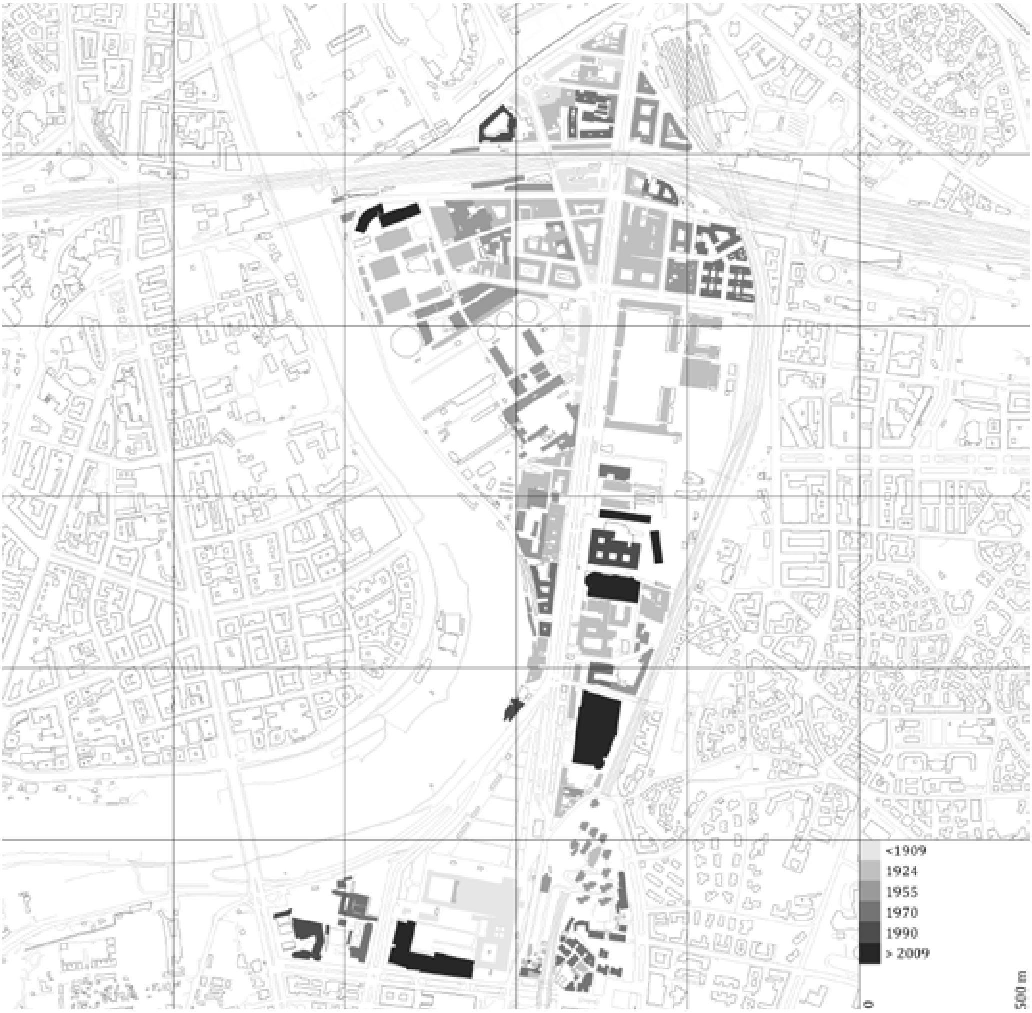
*Ostiense energy-sufficient neighbourhood*

The reference case of PEDFORALL is the context of Ostiense in Rome. Faced with social and governance inertia, this historic neighbourhood is representative of the relationship between comfort and energy demand in a city where the consumption system in the

**2 – Within the city limits (1.285 km2), only 195 MW are available from 17.000 installations. Few of these are integrated into buildings, for example, only 1% of condominiums have photovoltaic systems.**

**3 – Today 65,5% of the total building stock is certified according to the EU Energy Performance Certificate in classes F and G, the lowest.**

building and mobility sectors still plays a major role in the production of climate-altering gases and where the implementation of renewable energy installations and energy efficiency retrofitting is particularly slow (Roma Capitale, 2023). The implementation of renewable energy installations is very slow,[2] while energy efficiency measures are particularly complex and therefore slow.[3] Inertias is also related to the fact that large parts of Rome were built before any energy efficiency regulations, often as a result of speculative and unauthorised processes (Insolera, 2011). This led to problems in the organisation and construction of urban technical services (e.g. electricity distribution networks, district heating, etc.) and resulted in the proliferation of buildings with low energy perfor-



mance. The high energy consumption generated by housing discomfort affects urban energy poverty, with more than a hundred thousand users that are in serious situations of distress (Asdrubali et. al., 2023; ENEA, 2018). In Ostiense, the imbalance between the consumption system and the production system is quite evident: an average of 150 MWh is consumed per month while the installed capacity, including the existing renewable energy installations, is only 400 kWp. The significant weight of consumption is linked to a specific spatial-environmental phenomenon: the urban heat island. Ostiense is one of the hottest parts of the city in summer, especially at night, when the temperature rise can reach up to +3°C (Pone, 2023). This condition leads to an impressive use of artificial

Fig. 3 - Ostiense is largely made up of buildings constructed before the 1970s, i.e. without any energy saving solutions. This results in a legacy characterised by widespread low energy efficiency labelling (Source: Fabrizio D'Angelo 2024).

Fig. 4 - Energy consumption and Climate Change. The city of Rome is increasingly affected by heat waves and urban heat islands, the effects of which lead to intensive use of cooling devices and consequently to electrical peaks and blackouts. The map represents urban areas based on the percentage increase in electricity consumption during summer, ranging from the most intense (black) to the least intense (white) (Source: Fabrizio D'Angelo 2024).

air conditioning with a 10% increase in electricity demand (Asdrubali et al., 2023). As studies have shown (e.g. Cattaneo, 2023), the UHI is strongly influenced by the large presence of mineral surfaces, mostly asphalt, in addition to the scarce availability of permeable soils and vegetation, the massive use of cars and the given topographic conditions.

PEDFORALL aims to combine the potential for new renewable energy installations with the implementation of energy efficiency strategies, and the promotion of energy-sufficient practices.

Aspects such as those just mentioned are only marginally present in urban energy transition programmes, such as the *Piano Quadro per la Transizione di Roma* (Rifkin et al., 2010) or the Sustainable Energy Climate Action Plan (SECAP, 2021, updated in 2023) which, like similar planning tools designed for other contexts, propose techno and isomorphic solutions, without specific consideration of the spatial dimension related to energy systems (De Pascali, Reginaldi, 2016) and the contextualisation and rooting of planning strategies in specific local actors and social practices (Nessi, 2018). PEDFORALL therefore aims to combine the potential for new renewable energy installations with the implementation of energy efficiency strategies, and the promotion of energy-sufficient practices. For example, in order to reduce the massive energy consumption of air-conditioning, it is necessary to mitigate or, if possible, eliminate the socio-spatial conditions that make air-conditioning necessary. Referring to energy mapping studies that work on the existing energy spatial capital (Viganò et al., 2014), a series of detailed maps of urban spaces and social practices have been compiled, such as the existing energy system, roof characteristics, albedo, solar radiation, and extends to the observation of typo-morphological aspects, land cover, land subdivision, presence of vegetation, wind direction, but also the distribution of common spaces in residential and tertiary buildings, income distribution, mobility behaviour, energy poor users, and other statistical data capable of revealing the socio-spatial complexity.

On this basis and taking into account the insightful studies on bioclimatic architecture and urbanism mentioned above, PEDFORALL elaborates, supported by master's thesis works, design speculations at the architectural, urban design and territorial scale. The neighbourhood's areas are designed to combine low energy mobility facilities, shading and cooling options to mitigate UHI, interventions in building facades and courtyards to regulate irradiation and air exchange, installation of PV systems on roofs and shading struc-

tures, vegetated roofs, ventilated attics for thermal insulation, limitation of artificial lighting.
At the same time, some of the more economically viable and less technologically demanding options are being prototyped and implemented as test cases. For example, a workshop with the municipality and a local association is transforming large areas of asphalt in front of schools and other public spaces using Cool Materials (Figure 6). Test cases such as these provide an opportunity to get the views of the people who live in Ostiense, to investigate the impact using simple monitoring tools and to study possible improvements. Other research initiatives include a series of co-design workshops where experimental representative tools are tested to qualitatively design how space and social practices interface with the energy system in the domestic environment. Through iterative interactions with a selected group of actors-residents, a series of semi-directive interviews, households' maquettes, and participatory spatial design workshops are conducted. This work is very similar to what is happening in Brussels with La Pile (City Mane(d), 2023), a project that seeks to socialise the energy issue by creating opportunities for neighbours to discuss energy and how to reinvent electricity in the city.
The aim of designing the energy arrangement by improving the energy synergy between buildings and the whole urban environment (Roesler, 2022) (including human and other-than-human), through maps, design speculations and actions with people, brings together social practices and space, approaching different scales (the urban and the architectural), different disciplinary fields (urbanism, landscape, architecture, engineering, sociology and law) and different urban materials (vegetation, soils, streets, public spaces, housing, etc.). In turn, the combination of these different aspects aims to reshape the technology of energy production and consumption, offering a more integrated urban energy landscape to design and live in. Not just new vegetated areas, but comfortable urban spaces; not just high performance buildings, but renovated with spaces and equipment for *sufficient* lifestyles; not just more cycle paths, but places designed for social interaction and the sharing of activities and practices.

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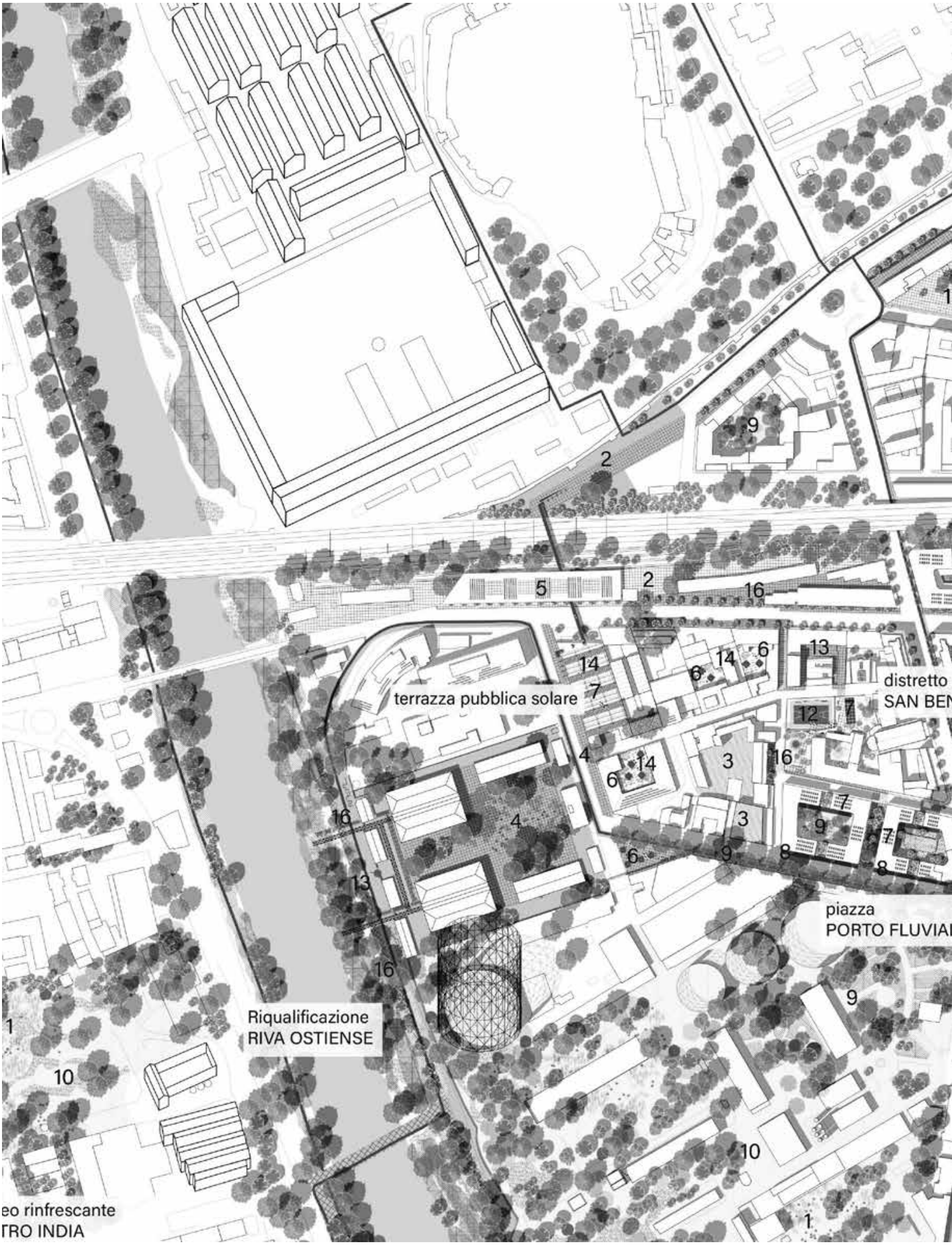
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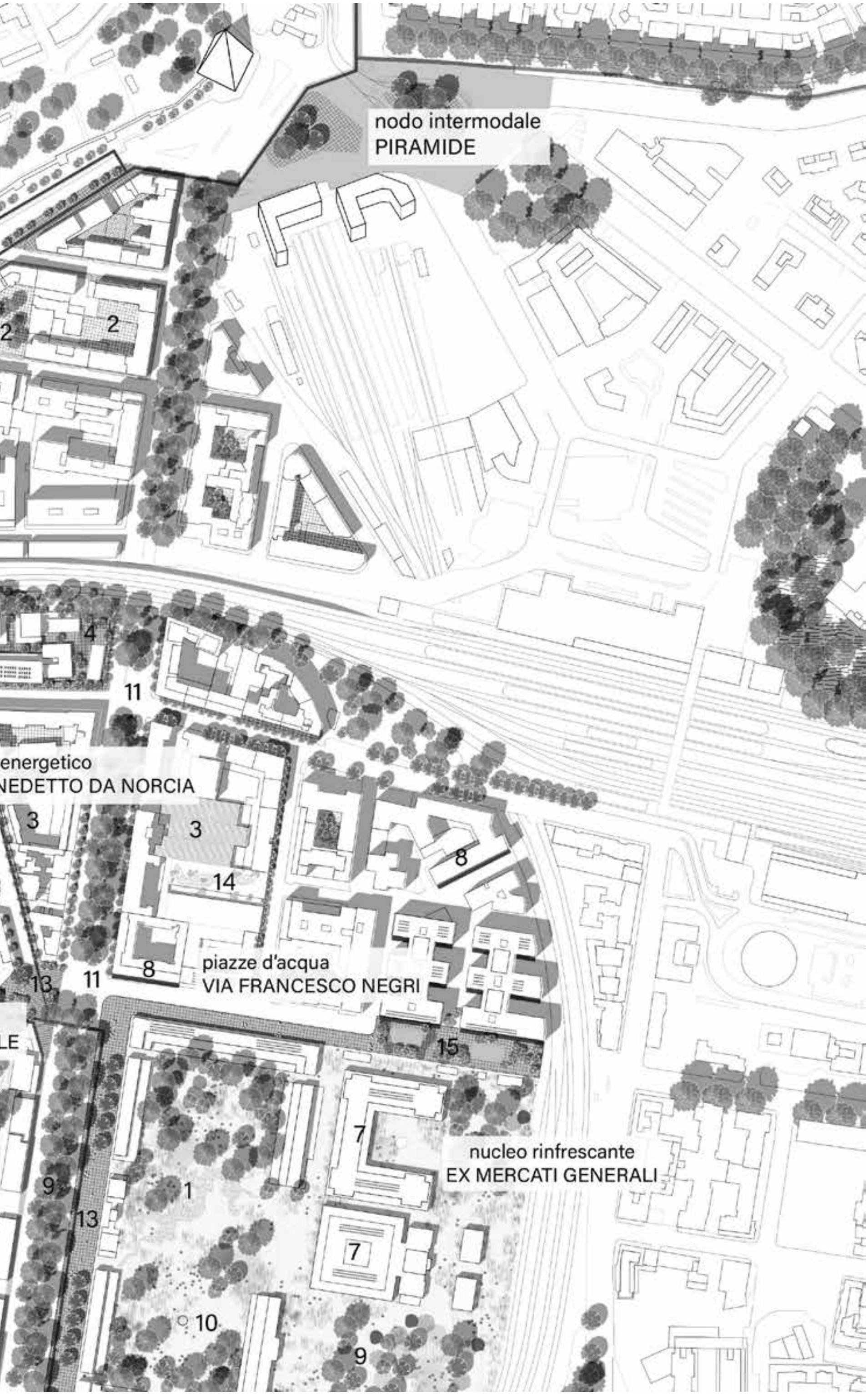


Fig. 5 - 'Bioclimatic Ostiense', a design speculation to ground different bioclimatic devices and new energy solutions (Source: Giordana Panella and Giancarlo Scarascia Mugnozza, 2023).

Fig. 6 - Marciapiede Fresco/Cool Siedwalk. On-site workshops for testing Cool Materials tecnique in public asphalted spaces. (PEDFORALL in collaboration with Laboratorio di Progettazione dello Spazio Urbano - LAPSUS, Università Roma Tre, Municipio VIII and Sportlab. (Source:  Alessandro Vitali, 2023)and Sportlab).

*Ostiense as a laboratory to explore the relationality of energy*

In its current stage, the work of PEDFORALL for Ostiense functions as an open framework aimed at studying, promoting and implementing the possibilities for improving and strengthening the relationship between the socio-spatial characteristics of the neighbourhood and energy, a world of flows increasingly present in economic concerns and political attention, but still abstract, intangible and seemingly difficult to operate. The effects of the *rupture* of the technocratic energy paradigm inevitably complexify the energy question, which is no longer governed by infrastructures alone, but is pervasive in territory and society. How can we grasp the possibilities that open up between the folds of this rupture, in order to activate connections with that from which we have been separated (Stengers, 2021), namely the material and operable dimension of energy production and consumption that the socio-technical apparatus and the associated urban energy service system have gradually made inaccessible and untouchable? How

do we socialise the energy world we inhabit and that inhabits us?
The *spatial design nebulose* presented in this contribution holds together many fragmented projects carried out at many different scales and by different disciplines. In these experiences we see more or less explicit signs of energy sufficiency, a concept that allows us to recover and explore many experiences and sensitivities that are closely imbricated with the socio-spatial aspects of the energy question. Unfortunately, sufficiency is usually associated with narratives of crisis and scarcity, and this tends to make it associated with temporary efforts rather than outlining proactive horizons (Arrobio, 2023); at the same time, as recalled above, sufficiency can lead to unintended effects, known as rebounds, where the elimination of some consumption practices may elicit others (Sorrel et al., 2020). Finally, sufficiency as understood by policies and programmes is based on individual responsibility, a condition that could also increase socio-spatial inequalities and disempower political and planning action.
For these reasons, PEDFORALL does not position itself exclusively within this concept. The policies' more technical recommendations for efficiency and decarbonization are taken into consideration, but only to the extent that they qualify the space and provide opportunities to deepen the relational dimension with energy. In this search for ways to enhance the *relationality of energy*, Ostiense is a laboratory where the context is reinterpreted through the paradigm of sufficiency, and at the same time it is opened to integration with other visions of efficiency and decarbonisation (including renewable energy production), always highlighting the relations they open with social practices and space. The laboratory becomes a time and a place for experiments strongly focused on spatial relationships with bodies and practices through the materialisation of design actions in domestic and urban space (workshops, living labs, etc.). Some of these experiences can be replicated, some will find space in local regulations to promise their recursiveness, in any case all are intended to be widespread possibilities that give agency to space and people in the world of energy.

The *spatial design nebulose* holds together many fragmented projects carried out at many different scales and by different disciplines.

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