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Special Issue 1.2025

Innovation, green infrastructures and urban form

Towards regenerative city models

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PED's paradigm shift as regenerative city models between innovation, green infrastructures and urban form

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Abstract
In 2007, the European Union launched The Strategic Energy Technology Plan (SET), which is in fact the framework within which some ecological transition policies for the European territory are inserted. Contributing to the ambitious objectives of the European Strategic Energy Technology (SET) Plan, the programme "Positive Energy Neighbourhoods and Neighbourhoods for Sustainable Urban Development" supports the planning, deployment and deployment of 100 Positive Energy Districts by 2025.
Even the new Horizon Europe research and innovation plan (which will cover the period 2021-2027), Europe aims to tackle some global challenges affecting our cities and our society with determination: health and safety, digitalisation, energy and climate change in the first place. The Positive Energy Districts are part of this perspective. It is supported by 20 EU Member States and conducted by JPI Urban Europe. The programme involves stakeholders from R&I funding networks, cities, industry, research organisations and citizens' organisations.
In this sense, wanting to focus the interest of this research – of which an extract can be found in these writings – we find a first decisive orientation – at the European level – through the declination of European policies. The paper, starting from the various international strategies promoted by intergovernmental subjects, focuses its attention on the very recent energy transition initiatives in the urban area. By examining some selected case studies, he defines a methodological approach - focused on case studies/good practices - that goes beyond the classic analytical approach by moving towards a more systemic design.

Keywords
PED; Urban regeneration; Green infrastructure

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1. Introduction

Recently, as we well know, environmental policies have been consolidated all over the planet especially with a focus on climate change. Both the UN and the EU have launched initiatives to relaunch best practices after the Paris Agreement in terms of Net Zero with SDG's.

This journey of sustainability -as even Peter Newman wrote (Newman, 2018)- builds on a series of historic global agreements: from the Bruntland Report to the Rio Conference, passing through the Aalborg Charters, the Mayors' Pacts on Energy Sustainability, the SDG 2030 and then to COP 21 which was where 196 countries signed up to Net Zero and the SDG's.

These have been based on UN processes and now nations and regions are establishing strategies for how to do this such as the recent *European Green Deal*. In this long journey, our communities have also increasingly understood the need for the ecological transition of settlements.

However all polytechnic class: urban planners, engineers, architects, and designers are not, yet, sure what it means for them and how we can make such cities of the future. The *Net Zero* with SDG's agenda is now quite clearly what we as urban professionals need to be applying to our cities and does build on decades of global and local work. But it's not at all clear how we should be making such a future unfold in cities of the future.

As Peter Newman argues (Newman, 2021) the last *Mitigation Report* (https://www.ipcc.ch/report/ar6/wg3/), and from researching actual projects that are trying to demonstrate Net Zero Cities with SDG's, are:

- The core technologies will be solar and wind, batteries and electric vehicles of all shapes and sizes as they are now cheaper and more effective than any other power and transport system in history;
- This has been recognised by the world of finance as well as most global governments and professional bodies but there remains a lot of momentum in the old fossil fuel-based systems that have built our cities and economies;
- Smart technology systems are the key to integrating these core technologies into buildings, precincts, corridors and different urban fabrics, to enable microgrids and local management systems that create net zero results and other SDG's;
- Local areas with their communities and varied economic activities, will thus be drawn into greater responsibility for how the Net Zero and SDG's agenda, are envisioned, procured and implemented;
- Historic urbanism with its emphasis on local place and walkability will be more important in the next economy than the large-scale modernist solutions we have used as the basis of power and transport based on fossil fuels.

In the end it should be added that a crucial role will also be played by green infrastructure and technologies for climate adaptation and mitigation in urban design and construction indeed as stated the IPCC (https://www.ipcc.ch/): "*The strategically planned interconnected set of natural and constructed ecological systems, green spaces and other landscape features that can provide functions and services including air and water purification, temperature management, floodwater management and coastal defence often with co-benefits for human and ecological well-being. Green infrastructure includes planted remnant native vegetation, soils, wetlands, parks and green open spaces, as well as building and street-level design interventions that incorporate vegetation"* (after Culwick & Bobbins, 2016). As we wrote in the abstract this contribution aims to provide to define methodological approach - focused on case studies/good practices - that goes beyond the classic analytical approach by moving towards a more systemic design on the basis of a greater understanding of the city and the territory and on the experimentation of technologies useful for achieving the ecological transition and a new model of urban regeneration. In the following paragraphs, some decisive contributions will be addressed, namely: in section 2 how to PED'S becomes a paradigm shift, as regenerative city models; In section 3 what are the characteristics to define and implement a positive energy district; section 4. New approach by the city's future; section 5 Climate change and its consequences in the urban design: adaptive-climatic measures and mitigative-climatic measures; conclusions.

2. PED'S paradigm shift: as regenerative city models

The theme of ecological transition is the new paradigmatic element of the progress of our species (Butera, 2023) and substantially permeates the different urban and territorial policies to the various dimensions of the city and the territory, increasingly penetrating the different paradigms of planning. The challenge posed by sustainability to co-living on earth seems to require a convergence of a plurality of institutional, scientific, technical, cultural and above all political subjects institutional, scientific, technical, cultural and above all urban and territorial policies to which reference will have to be made for the government of the territory (Palermo, 2021; Sgambati, 2022). In this sense, intergovernmental institutional actors at various scales and functions – such as the UN (with the 2030 Agenda and the IPCC Report 2022) and the EU – are actively engaged in assessing, monitoring and achieving full climate neutrality by 2050. The very recent New Green Deal and the most recent experiments, in the field of urban design, define some actions and more specifically: the Driving Urban Transition (DUT), the Positive Energy Districts (PED), the circular economy or the Circular Urban Economies Transition Pathway (CUE) in addition to the recent regulatory introductions of the various EU member states, including Italy, on Renewable Energy Communities (RECs). On these issues and actions, there is evidence that work is being done, mainly outside Italy, towards urban self-sustainability and this is evidenced by the various design case studies. All this defines differential urban development scenarios. As we said before with the new Horizon Europe research and innovation plan (which will cover the period 2021-2027), Europe aims to tackle some global challenges affecting our cities and our society with determination: health and safety, digitalisation, energy and climate change in the first place. The Positive Energy Districts are part of this perspective. Why and what are the key factors of a PED? And why are gaining a lot of importance in urban planning processes?

A. Energy districts and energy-positive neighbourhoods are an integral part of a comprehensive approach towards sustainable urbanisation and energy transition and involve several legal, regulatory, spatial, technological, social and economic aspects.
B. A Positive Energy District is seen as an urban district that is self-sufficient from an energy point of view and with zero CO2 emissions. Indeed, positive energy means that energy districts also play an important role in producing excess energy using renewable energy sources and feeding it back into the grid.
C. An energy-positive urban energy district combines the built environment, mobility, sustainable production and consumption to increase energy efficiency and reduce greenhouse gas emissions and to create added value for citizens. Positive Energy Districts also require integration between buildings, users and the energy network, mobility and IT systems.

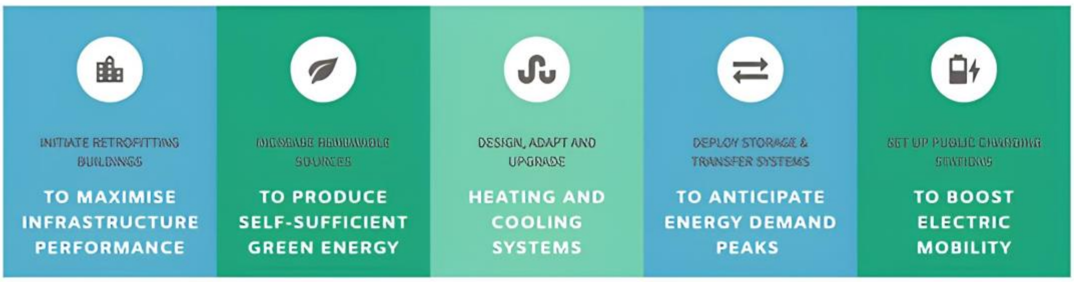


Fig.1 Balance diagram between energy efficiency, energy flexibility and local energy production

3. Characteristics of the Positive Energy Districts (PED)

We all understood clearly by now that both urban (Foster, 2024) and country living as Koolhaas (2020) would say, fully invests the individual, the community, society, and in turn space and territory, directing the dynamics of man's presence in the environment, geography (Martinotti, 2017; De Rossi, 2018) and politics and thus marking everyone's behaviors, actions, habits. Recently the European Union launched the Green Deal focusing on: 1) Transforming our economy and societies; 2) Making transport sustainable for all; 3) Leading the third industrial revolution; 4) Cleaning our energy system; 5) Renovating buildings for greener lifestyles; 6) Working with nature to protect our planet and health; 7) Boosting global climate action. How we know the European context on green actions moves at different speeds and with different geographical repercussions, on the one hand the virtuosity of Northern Europe with examples of urban self-sustainability now almost fully operational and on the other hand in Southern Europe a situation that is still struggling to understand well and align with the major policies. It should be noted that in a first summary "perimeter" those actions that have received the most attention emerge and are the PEDs present in Europe - 61 in all - well documented by Urban Europe in the report "Europe towards Positive Energy Districts ", which is in fact the official source of European programs. In this sense, it is necessary to point out that although there are other similar initiatives, the reference goes to those institutionally recognized. It is necessary to define in advance some basic conditions for the realization of PED and as well as an approach holistic system that considers the complex system. Preliminary a Positive Energy District is influenced by some factors to consider:

PED Factors	Theme
The boundaries of the district	- Physical limits and boundaries of the urban environment, of the city, of the territory; - Rivers, lakes, hills, railway areas, city blocks, roads (motorways, local roads, etc.)
The geographical and urban morphology of the district (the shape of the settlements)	- The spatial location of neighborhoods, i.e. central, semi-peripheral, in rural and urban areas, or former industrial, commercial areas, in coastal areas. - Public transport (train, bus, tram, metro.); public urban spaces (e.g. squares, green areas, play areas). - Water supplies, network systems, existence of energy supplies. - Etc…
The location of the neighborhood	e.g. neighborhoods of public housing, or historic, or recently built residential mixed-commercial, etc.
The building characteristics of the neighborhood	We refer to the type of building-construction technology e.g.: masonry, concrete, steel, prefabricated, etc...
The characteristics and behavior of the occupants	- Sociographic ethnic groups e.g. Muslim, Christian, Jewish neighborhoods; - Types of prevalent use i.e. retail, artisanal, industrial; - The current use of energy resources, e.g. if water from own sources is used, or solar energy from existing technologies on individual units; - Type of workers (occupation class), self-producers, income levels, type of social conduct.

Tab.1 Ped factors

These mentioned above are just some of the factors that will have to be considered in the design and implementation of a PED. Subsequently, the PED cases selected technology building in according to the climate mitigation/adaptive measures and sub-actions adopted, distinguished by climate themes (energy transition, bioclimatic response, etc.), were characterized, of which a summary graph is shown in follow figure.

They can be distinguished in the four selected cases of PED, cases considered significant from the point of view of the green technologies proposed and the degree of planning and implementation achieved. Following an analysis of the PED realities present in Europe - 61 in all - well documented by Urban Europe in the report

"Europe towards Positive Energy Districts" (JPI Urban Europe, 2020) and by Fabrizio Tucci in the book "Towards climate neutrality of green architectures and cities" (Tucci, 2021), four PED cases were selected that were considered significant from the point of view of the green technologies proposed and the degree of implementation achieved, or whether they have been implemented or in any case are being implemented, in this case four case studies, just for example, were selected:

- La Fleuriaye (FR);
- Hammarby Sjöstad (SE);
- Ready Vaxjo (SE);
- Murs de Monseigneur, La Cerisaie (FR).

These previously mentioned are the cases that are considered more mature and that have been observed with greater attention even by specialist scholars (Tucci, 2023).

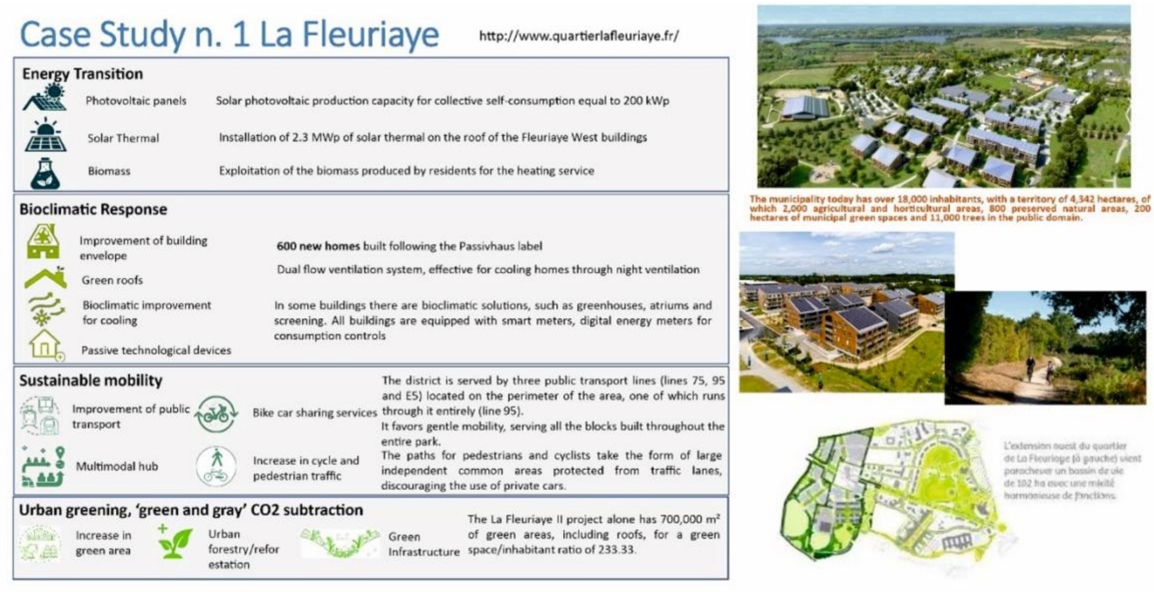


Fig.2 Case Study_La Fleuriaye (France)

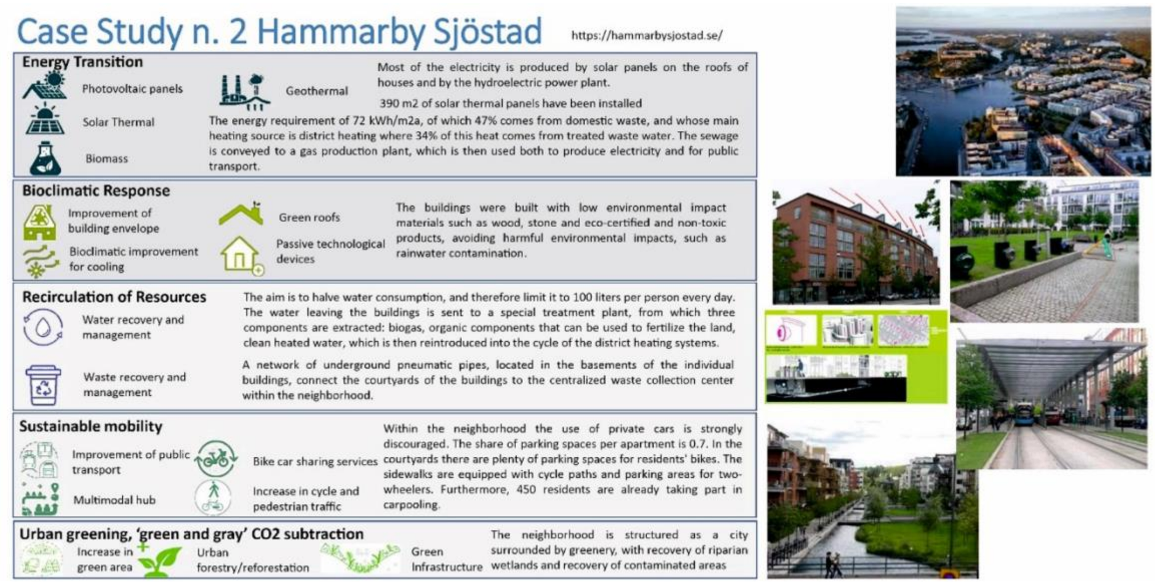


Fig.3 Case Study_Hammarby Sjöstad (Sweden)

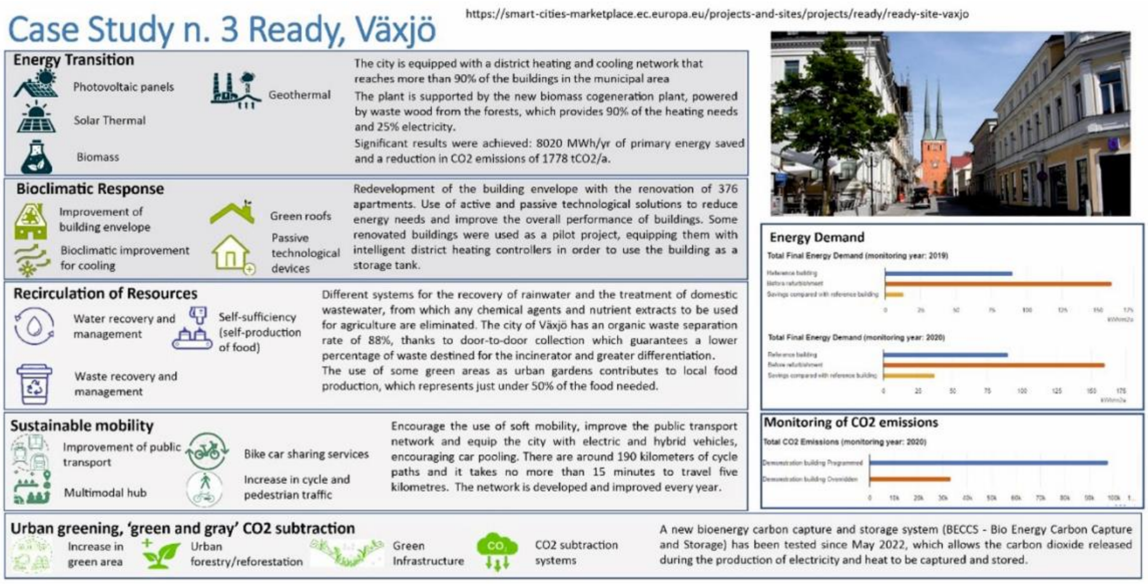


Fig.4 Case Study_Ready, Växjö (Sweden)

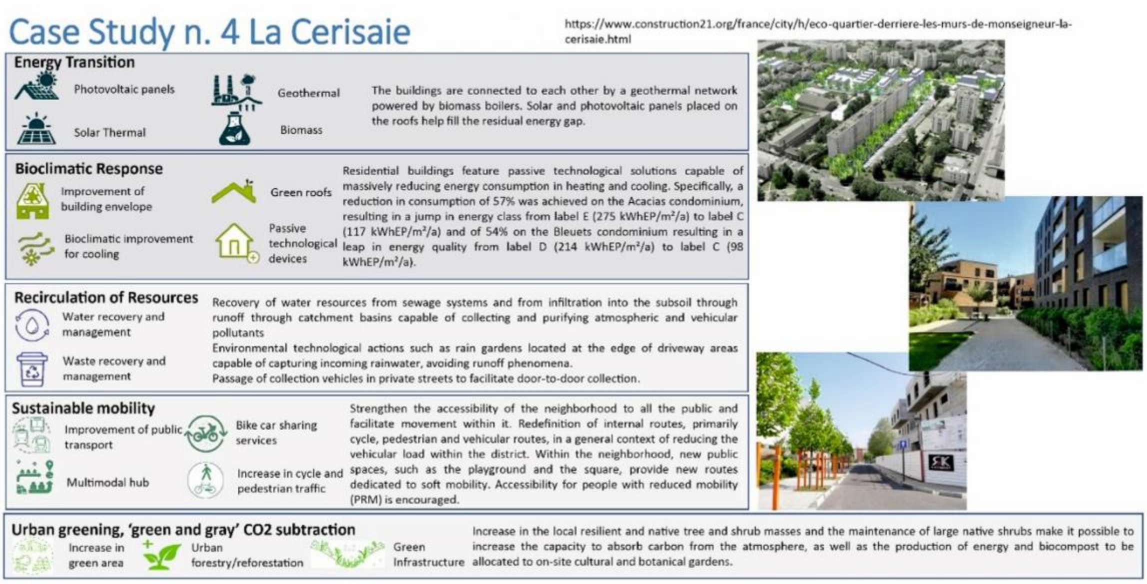


Fig.5 Case Study_La Cerisaie, (France)

4. New approach by the cities future

Positive energy districts change the way we interpret city design. Compared to the past, there is an urgent need to understand the epochal changes that the urban era has brought about. Sustainability at various scales, types and levels, is today a declared goal to be achieved for all of us for productive growth (social, cultural, economic, ...), but it is also, fundamentally, the achievement of a point of equilibrium of our planet, of the evolution of our species (Meadows et al., 1972). The complexity in which we live requires a lucid look at the (eco) systemic relationships of the planet (Bertalanffy, 1969; Butera, 2020; Lovelock, 1979; Odum, 1972; Tom, 1980), relationships that seem distant from us, but which, instead, involve us directly. This new and sought-after balance represents above all a new pact between man and the environment, a pact that is necessary to face the complexity in which we live, a complexity that requires a look at the systemic relationships and interconnections of the planet, relationships and interconnections that involve us intimately as has recently been demonstrated to us in the last five years. The effects of climate change, ongoing conflicts and the change in the geopolitical situation (Fabbri, 2023; Vince, 2021), the long wave of the covid-19 health emergency (Capasso & Mazzeo, 2020), big data, artificial intelligence (AI), etc. do nothing but underline the ways in which we produce and consume, move and organize spaces, places and contexts, how we develop energy and distribute it, all these actions have significant impacts on our habitats of which we are increasingly aware. As both environmental scientists and various urban planners have been arguing for many years now (Crutzen and Stoermer, 2000; Newman, 2012; IPCC Report, 2022), the theme of ecological transition is the new paradigmatic element of the progress of our species and substantially permeates the different urban and territorial policies to the various dimensions of the city and the territory, penetrating more and more into the different models of planning. It is clear to all of us that the ecological transition passes through the energy transition (and in this case decarbonization), the climate transition and also an economic transition (Stiglitz, 2010; Beck, 2017), in the wake of what has been said, it is possible to note that a large part of the planet's inhabitants are now aware of the need for policies to reduce the climate crisis (Newman, 2019; Butera, 2023; Pileri, 2021), the preservation of natural resources, the need and the tendency, as observed by the IEA, towards energy efficiency of progressive interest and use. Just as intergovernmental institutional actors at various scales and functions – such as the UN (with the IPCC Report 2022) and the EU – are actively engaged in assessing, monitoring and achieving climate neutrality by 2050. An extremely ambitious goal because it implies the ability to make countries, industries, transport, construction, mobility, productivity, agriculture... with zero emissions. Certainly, the ecological transition necessarily implies that – to be achieved – there must be a radical transformation of the economic and cultural model that has permeated the development of humanity over the last two hundred years (Butera, 2023), a different vision of the future (Sachs, 2022).

In the field of urban and territorial planning we are in an era of great change, the physical systems of modern urban planning that once concerned the architecture and classical engineering of the city (Sitte, 1889), its composition and the projection of ambitions on it (Le Corbusier, 1937) of the landscape (Cullen, 1961) and, subsequently, due to the expansion of cities, also of the territory (Gregotti, 1968; Samonà, 1971; De Carlo, 1976) have changed radically, complicating themselves in several dimensions and extensions (Sassen, 2013) that are not always manageable by ordinary planning tools (Gregotti, 2014).

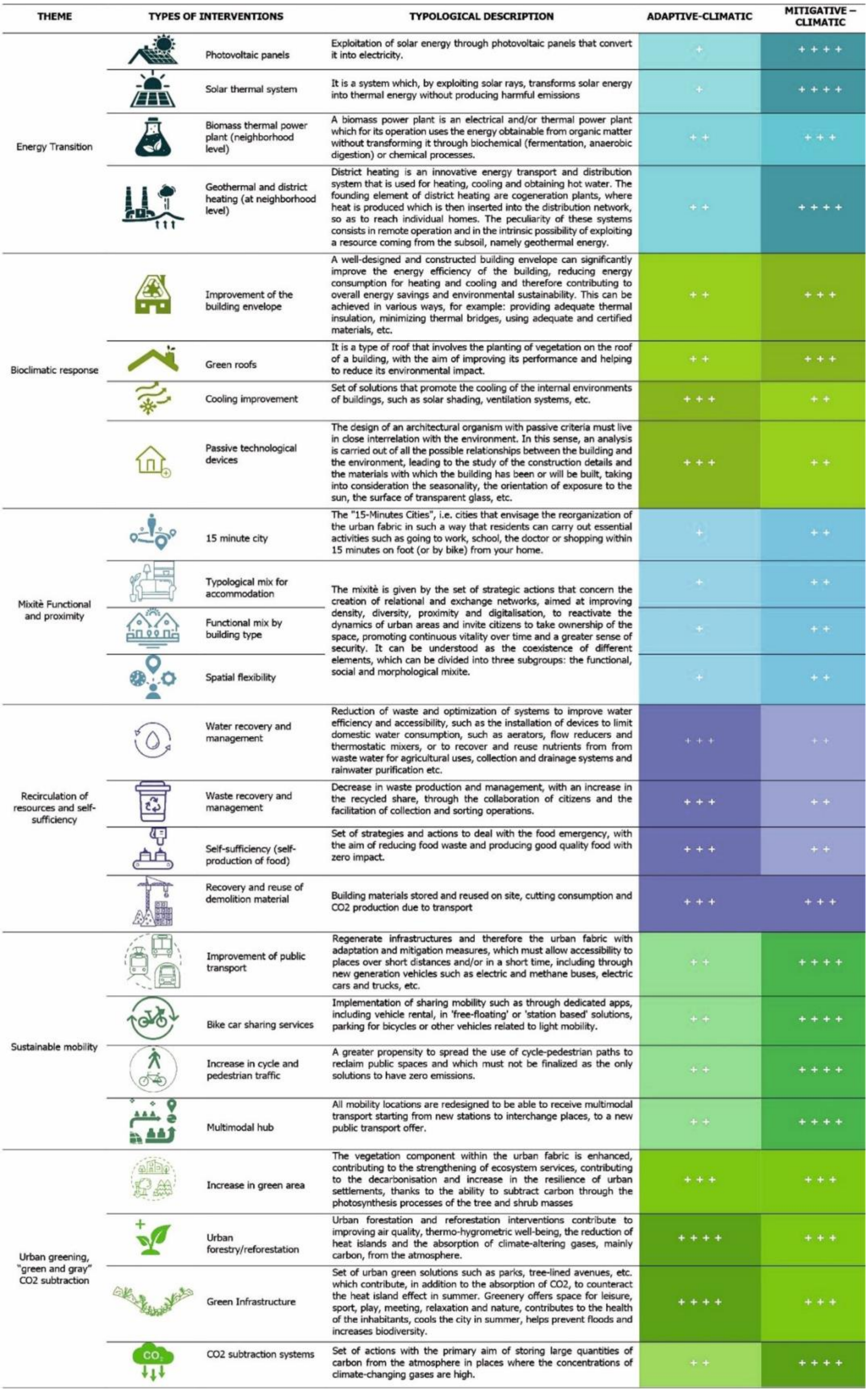
It follows that dealing with planning – even in operational tools – preliminarily implies a holistic approach, a much broader look (Indovina, 2014), a complex matrix reading that concerns the ecology of systems, the elements and their relationships (Morin, 2006; Chomsky, 2020) not always physical but increasingly spatial, fluctuating, interconnected even in immaterial dimensions that concerns the individual and his movement/interaction in the context (Moreno, 2023).

The time has come to start rethinking new models of cities, it is no longer possible to continue to adapt nineteenth-century planning models (through functional zoning) to cities that in the meantime have been radically transformed by addition and with new technologies.

5. Climate change and its consequences in the urban design: adaptive-climatic measures and mitigative-climatic measures

In the next three decades, nearly 80% of the population is expected to live in cities and that, on a global scale, the areas urban areas will see an increase in the population settled in cities up to almost 7 billion people, which will be more than two-thirds of the whole of humanity. And at the same time there is the awareness that the cities will be less and less livable, due to climate change, unstable weather conditions and weather events extreme (Tucci, 2023).

This has led, and is always continuing to bring more incisively, to widespread impacts on food and water security, on human health, the economy and society, with its losses and damage to nature and human settlements that have now for at least two decades we have learned to know in their progressive virulence.



THEME	TYPES OF INTERVENTIONS	TYPOLOGICAL DESCRIPTION	ADAPTIVE-CLIMATIC	MITIGATIVE – CLIMATIC
Energy Transition	Photovoltaic panels	Exploitation of solar energy through photovoltaic panels that convert it into electricity.	+	+ + + +
	Solar thermal system	It is a system which, by exploiting solar rays, transforms solar energy into thermal energy without producing harmful emissions	+	+ + + +
	Biomass thermal power plant (neighborhood level)	A biomass power plant is an electrical and/or thermal power plant which for its operation uses the energy obtainable from organic matter without transforming it through biochemical (fermentation, anaerobic digestion) or chemical processes.	+ +	+ + +
	Geothermal and district heating (at neighborhood level)	District heating is an innovative energy transport and distribution system that is used for heating, cooling and obtaining hot water. The founding element of district heating are cogeneration plants, where heat is produced which is then inserted into the distribution network, so as to reach individual homes. The peculiarity of these systems consists in remote operation and in the intrinsic possibility of exploiting a resource coming from the subsoil, namely geothermal energy.	+ +	+ + + +
Bioclimatic response	Improvement of the building envelope	A well-designed and constructed building envelope can significantly improve the energy efficiency of the building, reducing energy consumption for heating and cooling and therefore contributing to overall energy savings and environmental sustainability. This can be achieved in various ways, for example: providing adequate thermal insulation, minimizing thermal bridges, using adequate and certified materials, etc.	+ +	+ + +
	Green roofs	It is a type of roof that involves the planting of vegetation on the roof of a building, with the aim of improving its performance and helping to reduce its environmental impact.	+ +	+ + +
	Cooling improvement	Set of solutions that promote the cooling of the internal environments of buildings, such as solar shading, ventilation systems, etc.	+ + +	+ +
	Passive technological devices	The design of an architectural organism with passive criteria must live in close interrelation with the environment. In this sense, an analysis is carried out of all the possible relationships between the building and the environment, leading to the study of the construction details and the materials with which the building has been or will be built, taking into consideration the seasonality, the orientation of exposure to the sun, the surface of transparent glass, etc.	+ + +	+ +
Mixitè Functional and proximity	15 minute city	The "15-Minutes Cities", i.e. cities that envisage the reorganization of the urban fabric in such a way that residents can carry out essential activities such as going to work, school, the doctor or shopping within 15 minutes on foot (or by bike) from your home.	+	+ +
	Typological mix for accommodation	The mixitè is given by the set of strategic actions that concern the creation of relational and exchange networks, aimed at improving density, diversity, proximity and digitalisation, to reactivate the dynamics of urban areas and invite citizens to take ownership of the space, promoting continuous vitality over time and a greater sense of security. It can be understood as the coexistence of different elements, which can be divided into three subgroups: the functional, social and morphological mixite.	+	+ +
	Functional mix by building type		+	+ +
	Spatial flexibility		+	+ +
Recirculation of resources and self-sufficiency	Water recovery and management	Reduction of waste and optimization of systems to improve water efficiency and accessibility, such as the installation of devices to limit domestic water consumption, such as aerators, flow reducers and thermostatic mixers, or to recover and reuse nutrients from from waste water for agricultural uses, collection and drainage systems and rainwater purification etc.	+ + +	+ +
	Waste recovery and management	Decrease in waste production and management, with an increase in the recycled share, through the collaboration of citizens and the facilitation of collection and sorting operations.	+ + +	+ +
	Self-sufficiency (self-production of food)	Set of strategies and actions to deal with the food emergency, with the aim of reducing food waste and producing good quality food with zero impact.	+ + +	+ +
	Recovery and reuse of demolition material	Building materials stored and reused on site, cutting consumption and CO2 production due to transport	+ + +	+ + +
Sustainable mobility	Improvement of public transport	Regenerate infrastructures and therefore the urban fabric with adaptation and mitigation measures, which must allow accessibility to places over short distances and/or in a short time, including through new generation vehicles such as electric and methane buses, electric cars and trucks, etc.	+ +	+ + + +
	Bike car sharing services	Implementation of sharing mobility such as through dedicated apps, including vehicle rental, in 'free-floating' or 'station based' solutions, parking for bicycles or other vehicles related to light mobility.	+ +	+ + + +
	Increase in cycle and pedestrian traffic	A greater propensity to spread the use of cycle-pedestrian paths to reclaim public spaces and which must not be finalized as the only solutions to have zero emissions.	+ +	+ + + +
	Multimodal hub	All mobility locations are redesigned to be able to receive multimodal transport starting from new stations to interchange places, to a new public transport offer.	+ +	+ + + +
Urban greening, "green and gray" CO2 subtraction	Increase in green area	The vegetation component within the urban fabric is enhanced, contributing to the strengthening of ecosystem services, contributing to the decarbonisation and increase in the resilience of urban settlements, thanks to the ability to subtract carbon through the photosynthesis processes of the tree and shrub masses	+ + +	+ + +
	Urban forestry/reforestation	Urban forestation and reforestation interventions contribute to improving air quality, thermo-hygrometric well-being, the reduction of heat islands and the absorption of climate-altering gases, mainly carbon, from the atmosphere.	+ + + +	+ + +
	Green Infrastructure	Set of urban green solutions such as parks, tree-lined avenues, etc. which contribute, in addition to the absorption of CO2, to counteract the heat island effect in summer. Greenery offers space for leisure, sport, play, meeting, relaxation and nature, contributes to the health of the inhabitants, cools the city in summer, helps prevent floods and increases biodiversity.	+ + + +	+ + +
	CO2 subtraction systems	Set of actions with the primary aim of storing large quantities of carbon from the atmosphere in places where the concentrations of climate-changing gases are high.	+ +	+ + + +

Legend

+	**Low** impact solution adaptive/mitigative) 0.34	+++	**Medium** impact solution (adaptive/mitigative)
++	**Moderate** impact solution (adaptive/mitigative)	++++	**High** impact solution (adaptive/mitigative)

Fig.6 Catalog of the types of solutions to be adopted (mitigative-adaptive)

Urban infrastructures, transport, systems of water, sanitation and energy supply, are constantly and increasingly problematically compromised extreme events, resulting in economic losses,
disruptions of services and negative impacts on well-being. Scientific evidence unambiguously indicates that action needs to be taken much more to keep our planet livable: limiting global warming temperature at 1.5 °C requires rapid, deep reductions and long-lasting global greenhouse gas emissions.
Approaches, addresses, strategies, actions, whereas, using the most frequently used key terms at international level, are attributable to (Tucci, 2023; Newman, 2023; Moreno, 2024):

1. energy transition with renewable energy and net zero carbon technologies;
2. bio-climate responsiveness and especially with biophilic urbanism, permaculture and nature based-solutions;
3. functional mixitè and proximity, in this way first the *Cities of 15 mins* concept;
4. Resources circularity and self-sufficiency by regenerative ecosystems and circular economy;
5. sustainable mobility with attention to electromobility, micromobility, walkability and active transport;
6. urban greening, green CO_2 subtraction; gray CO_2 subtraction and storage.

The renewal Architectural and urban according to the Green City model the approach aims to improve, recover and reuse the heritage by adopting an integrated approach through measures aimed at increasing characters, performance and behaviours ecological, energy and bioclimatic of buildings and urban districts (Tucci, 2021). It seems essential to understand the great contribution that this approach makes in the new design (Alvira Baeza, 2018). First, a distinction must be made between adaptive-climatic measures and mitigative-climatic measures:

- Adaptive-climatic measures are defined as the set of actions aimed at preventing or minimizing the damage that can be caused by the adverse effects of climate change, or exploiting the opportunities that may arise. Examples of adaptation measures are large-scale infrastructure changes, such as building defenses to protect against rising sea levels, or small-scale such as behavioral changes, such as reducing food waste by individuals. In essence, adaptation can be understood as the process of adapting to the current and future effects of climate change;
- Climate-mitigation measures are defined as the set of actions aimed at reducing the emission of so-called greenhouse gases (GHGs) into the atmosphere. Mitigation is achieved by reducing the sources of these gases, either by increasing the share of renewable energy or by creating a cleaner mobility system, or by enhancing the storage of these gases, by increasing the size of forests. In short, mitigation is a human intervention that reduces the sources of greenhouse gas emissions and/or strengthens sinks.

What increasingly defines the creation of the Positive Energy Districts is the dual strategic direction: adaptive and mitigative. These strategies, increasingly necessary and evident, are implemented in consideration of places, environmental contexts, construction technologies. Starting from these considerations and in line with what scientific research in the field of urban planning and technology is developing, the examples (already mentioned above) were observed that contain a series of adaptive and mitigative parameters and criteria that will have to be implemented in urban regeneration, and which will be summarized below in the table.

6. Conclusions

As Peter Newman reminds us "There is now a plethora of large renewable energy projects outside cities with a need for massive expenditure on large transmission systems. So, we need to think about the scale and scope of our urbanism based on net zero technologies. How do we best support the net zero city transition? Do we enable a bottom-up policy approach based on local place and local management or a top-down policy approach which is trying to build big scale net zero grids with no serious local systems? This conflict will need to be better understood as I believe this is turning into a major conflict between two ways of thinking about cities which has been well known to those of us involved in urban planning traditions: the conflict between modernism and historic urbanism".

The PED are enabling progress to be made and new technologies to be tested. But they are not enough: the energy transition must be a system. To enable the ecological transition of the city, positive energy districts can represent a powerful vector for regenerating entire urban areas and above all putting the economy of self-sustainability back at the center, which is fundamental for communities (Pultrone, 2024; Fistola et al., 2024). The next strategies to implement the zero-emission city (with the PED approach) will have to focus on the following steps:

- Sustainable cities. City policy, urban planning, sustainable transport, reducing urban sprawl and making the city compact (as Carlos Moreno 15 mins), green and affordable buildings, decarbonizing urban development, biophilic urbanism, 21st century planning tools, water and waste, walkable urban design and sustainability policy;
- Participatory sustainability. New governance models based on collective intelligence (and used by big data), wisdom and power of people for a sustainable planet with sustainable civilizations societies, and communities;
- Green innovation systems. Innovation in technology, renewable energy, value systems, population policy, women and development, structural and cultural changes, new business models and professional activity;
- Resilient Systems. Climate adaptation, coastal sustainability, culture and science-governance dialogue to enable natural systems to perform more sustainably.

It is evident, therefore, that the main challenge of the future is to alleviate the exploitation of natural resources and move towards a re-balance that can be achieved through an intelligent (smart) use of resources, work on the green system (linked to the green economy), open urban systems to inclusiveness or to alleviate inequalities (inclusive), ceasing to wear out the territory through uncontrolled urbanization and optimizing consumption (Foster, 2024; Papa, 2024). Today more than ever, the complexity of the disciplines tends to interact and often to integrate, creating a new plot necessary (also methodological, De Certeau, 1990) for the articulated declination of sustainability in the various transformations, which cannot be achieved without a protean dimension, which contains the needs of the present, the awareness of the past, the experimentation on anticipation, increasingly visionary and holistic (Pidalà, 2014a and 2021b; Volpatti et al., 2024) for the future (Foster, 2024).

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Image Sources

Fig.1: Balance diagram between energy efficiency, energy flexibility and local energy production from

https://www.lumi4innovation.it/positive-energy-district-distretti-energetici/

Fig.2: Case Study_La Fleuriaye (France). Source: Elaboration by the author

Fig.3: Case Study_Hammarby Sjöstad (Sweden). Source: Elaboration by the author

Fig.4: Case Study_Ready, Växjö.(Sweden) Source: Elaboration by the author

Fig.5: Case Study_La Cerisaie, (France). Source: Elaboration by the author

Fig.6: Catalog of the types of solutions to be adopted (mitigative-adaptive). Source: Elaboration by the author

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