NEW ENERGIES FOR THE CITIES

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Alessandro Rogora and Paolo Carli

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in which we live. Let's consider climate change; the Intergovernmental Panel on Climatic Change (IPCC, 2023*) has reached, through more than 20 years of studies and monitoring, very clear conclusions: it is necessary to eliminate climate-changing emissions by 2060, just to maintain the increase in temperature average below 1.5 °C. But the world is still failing to provide answers capable of reducing the global footprint of climate-changing gas emissions. For this reason, alongside major mitigation policies, it is important to promote adaptation actions that include innovations in clean energy in the various sustainability objectives promoted by international agencies and governments of geopolitical areas - such as the EU - and by local governments, but also by sustainable communities at a territorial, urban and neighborhood scale. All actors must mobilize by recognizing that each of us will be engaged, in some way, in these radical transformations, and to do this efficiently, everyone will need strategies, tools, good practices such as those covered in the different essays of this book.*

Gianni Scudo

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An Informal Glossary

Paolo Carli

Urban settlements are constantly increasing, and we are approaching a point where over half the human population will live in cities. This human concentration gives rise to complex problems, ranging from pollution to difficulties providing resources to sustain the inhabitants' lives.
This situation results in low resilience of urban settlements to events that may affect the territory and the settled society. The complexity of consumption patterns and the flows of energy and matter in transit (inflows and outflows) require a profound rethinking compared to the past, as these flows differ in magnitude and complexity.
This book, *New Energies for Cities*, represents an initial attempt to reflect on the complexity and specificity of urban metabolism, as well as on potential solutions to address and transform the identified critical issues into possible elements for mitigating problems.

Since this book consists of a series of very specific thematic essays on topics and themes related to energy, even though more from a quantitative than a qualitative point of view, it seems appropriate to introduce a kind of glossary, very informal, of some terms that recur in the following pages. Contributions that, however, for reasons of brevity, sometimes imply certain concepts, meanings, and important information that – as editors of the volume – we feel obligated to specify and define to support readers in a comprehensible and useful reading.

The glossary, although informal, is alphabetically ordered, thus providing the reader – from the very beginning of the book – with the complexity of the topic addressed, but also offering a useful tool for using the information contained in the text. "Informal" is indeed meant here as – and here is the first definition of the glossary – a frank, direct, and free way to highlight some key issues that deserve necessary and continuous further exploration, as well as to refresh information and concepts underlying the energy-city dualism that, perhaps, younger readers do not know.

Anthropocene: Term used to describe the current geological era, characterized by the dominant influence of human activities on the Earth's climate and ecosystems. Some scientists propose that the Anthropocene began with the Industrial Revolution in the 18th century, while others suggest more recent dates, such as the mid-20th century, when human activity had a more evident and widespread global impact. Recognizing the Anthropocene, despite ongoing debates among scientists, implies greater awareness of human responsibility in shaping the planet's future, pushing society to reflect on necessary actions to mitigate negative impacts and promote environmental sustainability.

Circular economy: (see also Life Cycle) An economic model emphasizing the reuse, repair, recycling, and regeneration of materials and products, minimizing waste, and the use of natural resources. The circular economy represents a revolutionary paradigm compared to the traditional linear economic model based on "*take, make, use, and dispose*", leading to inevitable resource depletion and exponential waste increase. In contrast, the circular economy aims to create a sustainable and resilient system that mimics natural cycles. The circular economy aims for an ambitious but necessary goal: decoupling economic growth from the exploitation of natural resources and waste production.

CO_2 (Carbon dioxide): A greenhouse gas produced by the combustion of fossil fuels, the respiration of living beings, and other natural and anthropogenic activities, contributing to global warming. Carbon dioxide is essential for life on Earth: it plays a crucial role in photosynthesis, climate regulation, and the carbon cycle, and is widely used in various industrial and medical sectors. However, managing and reducing CO_2 emissions is vital to mitigate climate change and protect global ecosystems. According to Barry Commoner's Four Laws of Ecology outlined in "The Closing Circle" (1971), CO_2 perfectly represents the delicate balance expressed by the first Law, "*Everything is connected to everything else,*" as controlling/reducing its emissions means reducing the rise in average global temperature, thus preventing sea-level rise (caused by thermal expansion of water and melting glaciers and polar ice caps) and ocean acidification, which has devastating effects on marine life, crucial for maintaining ecosystems and human communities. The decrease in biodiversity, measured through habitat loss, threatened species, and extinctions, is a critical indicator of ecosystem health, as is the loss of forests, which negatively impacts biodiversity, the carbon cycle, air quality, and land use/consumption, such as urbanization, intensive agriculture, and desertification, affecting the planet's ability to sustain life.

Compatibility ecology: The ability of a project or practice to coexist and function harmoniously with local ecosystems without causing significant harm. Many years ago, about thirty, the term "*sustainable architecture*" was often used, a phrase bordering on an oxymoron, at least according to the famous aphorism of the Ticinese architect Luigi Snozzi, who said, "*Ogni intervento presuppone una distruzione…distruggi con senno!* (Every intervention presupposes destruction… destroy wisely!)". It took us a few years, but the concept underlying the principle, not to mention the mandatory design requirement in the field of building activities, of *Do Not Significant Harm* is now taken for granted: any production process, even those related to the digital dimension, creates environmental harm as they invariably and certainly withdraw some common resource from the environment, be it air, water, or soil. This awareness, albeit late and still not fully sedimented in society, is nonetheless a step forward from the vain hope that a technology to save our planet's fate will soon emerge.

Decarbonization: The process of reducing carbon emissions, typically through the adoption of renewable energy, energy efficiency, and other low-carbon technologies. In recent years, this term has replaced the concepts of sustainability and ecology in everyday speech. Decarbonizing means reducing the carbon (CO_2) of all activities, progressively converting the entire economic system sustainably by reducing the use of fossil fuels in favor of renewable energy sources, efficient use of energy resources, and the new technologies available. It is unclear whether the term has gained traction for simplicity of communication, a form of greenwashing, and an update of the vocabulary of non-specialists, or whether it responds more to a logic of decomposing the problem, focusing action on the most delicate balance element for the planet, namely carbon dioxide.

Energy saving: Energy saving refers to the reduction of energy consumption through various strategies and technologies aimed at increasing efficiency and promoting conscious behavior. This can be achieved through the adoption of advanced technologies such as LED lighting, energy-efficient appliances, and smart thermostats, which reduce energy use without compromising comfort or productivity. Additionally, energy saving involves improving building insulation, using energy management systems, and implementing renewable energy sources like solar panels to reduce reliance on non-renewable resources. Effective energy saving contributes significantly to the reduction of greenhouse gas emissions, lowers energy bills, and lessens the overall environmental impact, supporting global efforts to combat climate change and promote sustainability.

Green infrastructure: Green infrastructure is a strategically planned network of natural and semi-natural spaces designed to deliver a wide range of ecosystem services, such as water purification, air quality improvement, and temperature regulation. This network includes parks, gardens, urban forests, green roofs, and walls, as well as blue spaces like rivers, lakes, and ponds. Green infrastructure not only enhances urban biodiversity by providing habitats for wildlife but also improves the quality of life for city residents by offering recreational spaces and mitigating the urban heat island effect. Moreover, it enhances urban resilience by managing stormwater, reducing flood risks, and buffering against extreme weather events. The integration of green infrastructure into urban planning is essential for creating sustainable and livable cities that can adapt to climate change and environmental challenges.

Hydrological cycle: The continuous movement of water on, above, and below the Earth's surface, including processes such as evaporation, condensation, precipitation, and infiltration. The hydrological cycle contributes to regulating the Earth's climate, influencing temperatures and precipitation distribution. In this context, the city is often seen only as a "withdrawal point" from the hydrological cycle, while this book advocates for urban space regeneration that places water projects at the center, as a fundamental element of the landscape and—especially—of the urban environment, as well as an element of hygrothermal regulation and contrast to the urban heat island phenomenon through its use in NBS.

Life cycle: (see also Circular economy) The set of stages a product goes through from production to final disposal, including raw material extraction, manufacturing, distribution, use, and waste management. The concept of the Life cycle, understood as a methodology for assessing a product's environmental impact, originated in the 1960s/70s, was codified in the 1990s (LCA – Life Cycle Assessment), and has become a common practice used by companies and governments to evaluate and improve the sustainability of products and processes as environmental concerns and the push towards sustainability increase. LCA has become a fundamental tool for analyzing environmental impacts and promoting the circular economy. The paradox of Life Cycle analysis of production in an open and linear production paradigm, declared since the 1970s by North American counter-culture movements and eminent scientists (Carson,

Commoner, Lovelock, etc.), has emerged powerfully in recent years, giving a new centrality to LCA, thanks to the concept of a circular economy—also dated, see the Astronaut Economy in "The Economics of the Coming Spaceship Earth" by Kenneth Boulding, 1966.
Mobility sustainability: Mobility sustainability focuses on creating transportation systems that minimize environmental impact and promote the health and well-being of urban populations. This includes encouraging the use of public transportation, cycling, walking, and electric vehicles while reducing dependence on fossil-fuel-powered private cars. Sustainable mobility strategies involve the development of efficient public transit networks, safe cycling infrastructure, pedestrian-friendly urban design, and the promotion of car-sharing and ride-sharing services. Additionally, integrating renewable energy sources into transportation, such as solar-powered buses or electric vehicle charging stations, further enhances sustainability. The goal of mobility sustainability is to reduce greenhouse gas emissions, decrease traffic congestion, and improve air quality, ultimately leading to healthier, more accessible, and environmentally friendly cities.

Paris Agreement: An international treaty adopted in 2015 during the Conference of the Parties (COP 21) in Paris, aiming to limit global warming to well below 2°C above pre-industrial levels, preferably to 1.5°C. The Paris Agreement remains the global framework for climate action, and member states continue to present their Nationally Determined Contributions (NDCs) to strengthen their greenhouse gas emission reduction policies. However, recent climate conferences, such as COP 26 held in Glasgow in 2021, have reiterated the urgency of strengthening global efforts to limit global warming. Despite progress, many experts warn that current policies and commitments are still insufficient to reach the 1.5°C target, necessitating greater commitment and more ambitious actions from all countries (IPCC, 2023).

Renewable Energy: Renewable energy is energy generated from natural resources that are replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Unlike fossil fuels, which take millions of years to form and release harmful emissions when burned, renewable energy sources produce little to no greenhouse gases during operation, making them essential in the fight against climate change. Technologies harnessing renewable energy include solar panels, wind turbines, hydroelectric dams, and geothermal plants. The transition to renewable energy is crucial for reducing carbon emissions, enhancing energy security, and fostering sustainable economic growth. Additionally, advancements in energy storage and smart grid technologies are making it increasingly feasible to integrate renewable energy into existing power systems, paving the way for a cleaner and more resilient energy future.

Resilience: Resilience refers to the ability of urban settlements to withstand, adapt to, and recover from adverse events such as natural disasters, economic shocks, and social disruptions. Building resilience involves enhancing the capacity of cities to absorb and bounce back from these impacts through robust infrastructure, effective governance, and community preparedness. Key strategies include disaster risk reduction, climate adaptation planning, and the development of resilient infrastructure systems that can continue to function during and after crises. Social resilience, which focuses on strengthening community networks and ensuring equitable access to resources, is equally important. By fostering resilience, cities can protect the well-being of their inhabitants, maintain economic stability, and preserve environmental health in the face of challenges.

Resource Consumption Complexity: Resource consumption complexity refers to the intricate patterns and dynamics of how resources such as water, energy, and materials are used within urban environments. Modern urban settlements exhibit complex inflows and outflows of resources due to diverse consumption patterns driven by population growth, economic activities, and technological advancements. Understanding and managing this complexity requires a multidisciplinary approach that considers the entire lifecycle of resources, from extraction and production to distribution, consumption, and waste management. Addressing resource consumption complexity involves promoting circular economy principles, improving resource efficiency, and implementing sustainable practices that minimize environmental impact while meeting the needs of urban populations. By doing so, cities can achieve a balance between development and sustainability, ensuring the well-being of current and future generations.

Urban Metabolism: Urban metabolism is a conceptual framework that likens the flow of energy and materials within a city to the metabolic processes of a living organism. It involves the analysis of inputs (such as food, water, and energy), their transformation within the urban system, and the generation of outputs (such as waste and emissions). Understanding urban metabolism helps identify the environmental impact of cities, uncover inefficiencies, and develop strategies for sustainable resource management. By mapping and analyzing these flows, urban planners and policymakers can design interventions to reduce resource consumption, minimize waste, and enhance the overall sustainability of urban areas. Effective urban metabolism management promotes the creation of more resilient and self-sufficient cities that can thrive within the limits of natural ecosystems.

Urban Settlements: Urban settlements are areas where human populations live in concentrated and structured communities, typically characterized by higher population density and infrastructure development compared to rural areas. The continuous increase in urban settlements is driven by factors such as economic opportunities, access to services, and social amenities, leading to a global trend where over half of the human population now resides in cities. This concentration of people gives rise to complex problems, including pollution, resource scarcity, and challenges in providing adequate housing, transportation, and public services. Urban settlements also face heightened vulnerability to environmental hazards and climate change impacts, necessitating comprehensive planning and management to enhance their resilience and sustainability. Effective urban planning must address these issues by integrating green infrastructure, promoting sustainable mobility, and ensuring equitable access to resources, thereby creating liveable, inclusive, and sustainable urban environments.

As cities continue to expand, now encompassing over half of the global population, the complexity and challenges they face grow exponentially. From pollution to resource scarcity, the intricate dynamics of urban living demand innovative and sustainable solutions. "*New Energies for Cities*" delves into these complexities, offering a detailed exploration of urban metabolism and the transformative potential of new energy strategies. The accompanying glossary serves as a tool, guiding readers through the nuanced terminology and concepts essential for understanding and addressing the energy-city dualism. In an era marked by rapid urbanization and environmental challenges, the essays in this book are a crucial step towards envisioning and realizing a sustainable future for our cities, where human activities harmonize with the planet's ecological balance.

Paolo Carli

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