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The Circular City and the Building Sector

Gianfranco Franz

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By Gianfranco Franz, University of Ferrara

Summary

The essay deals with the issue of urban circularity understood as a subset of the Circular Economy paradigm, highlighting potential and limits of an emerging new model spreading on a global scale. The critical reasoning starts from a very recent production of institutional documents and the still reduced scientific production around and over this topic to propose an unorthodox interpretation on the relationship between circularity and city. The building industry is considered as a key sector to promote and improve circularity in cities and some experimental case studies are presented as a proof of the relevant potentials. The essay attempts a synthetic revision of the state of the art in Italy.

Keywords: Circular Economy, Circular City, Sustainability, Building Industry

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Address for correspondence:
Gianfranco Franz
University of Ferrara
Department of Economics and Management
Via Voltapaletto, 11
44121 Ferrara
Italy
E-mail: frz@unife.it

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Potential, limits and a case study

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Introduction

Cities are responsible for 70 percent of greenhouse gas emissions (GHGs) and forecasts illustrate that such percentage may even increase in future years due to an endless agglomeration of people in urbanized areas, especially for what concerns the so-called developing countries. The city, which is humanity's ecological niche, has always played a key role in the development of human civilization, even though the number of urban dwellers has exceeded that of rural inhabitants only in the last two decades. Since the city is the evolutionary niche of humans, it is also the center of gravity of the multiple and unsustainable social and economic organizations. For this reason, the transition of cities to the circular economy represents, in my opinion, a key factor for the latter to really succeed. This gives cities huge leverage to engage in climate action at the local level.

The rise of a new paradigm

Globally, Municipalities and local administrators have recognized the opportunity to act in a context where national level policies fail to induce the necessary transformation of sectors such as mobility, energy and building renewal, among others. Recently, a pioneering group of cities started to

promote programmes and projects under the new and rasing paradigm of circularity. The Circular City of tomorrow could be considered a sub-system of the wider objective aimed to transform the *urban entropic machine* into a more sustainable, greener and smarter human artifact. Circular city is a definition that has recently become globally established, emerging from the broader and more treated fields of research and applications referred to economic and industrial circularity (Marin, De Meulder 2018). As the most important think tank engaged on this issue, the Ellen MacArthur Foundation (EMF), points out, the exploration of the circular city has just begun and much still needs to be understood so that policy makers can guide the transition in the right direction (EMF 2017).

The so-called ReSOLVE scheme (EMF 2015; ESPON 2019) schematizes the six foundamental criteria/actions to achieve circularity in production and consumption of goods: *Regenerate, Share, Optimize, Loop, Virtualize, Exchange*.

Regenerate	Transition to renewable energy. Reclaim, retain and restore health of ecosystems. Return recovered biological resources to the biosphere.
Share	Share assets (cars, built spaces, tools, etc.). Reuse (secondhand).
Optimize	Prolong life through maintenance, design for durability, upgradeability, etc.. Increase performance/efficiency of product. Remove waste in production and supply chain. Leverage big data, automation, remote sensing and steering.
Loop	Remanufacture products or components. Recycle materials. Digest anaerobically. Extract biochemicals from organic waste.
Virtualize	Dematerialize directly (e.g. books, CDs, DVDs, travel, shopping online).
Exchange	Replace old with advanced, renewable materials e.g. Mycelium. Apply new technologies (e.g. 3D-printing). Choose new product/service (e.g. multimodal transport).

These six criteria are also fully applicable to city planning, management, and to the many and very diverse urban transformations. As Sharon Prendeville, Emma Cherim e Nancy Bocken (2018) point out, the concept of circularity applied to the economy, to the industrial organization

and the urban management comes directly from ecology studies, from the 'far' and disruptive work of Barry Commoner (1972), who was the first to use the metaphor of the circle, associated with men, nature and technology. Despite the fact that the empirical literature on these issues is still scarce (Caianelli, D'Amato, Mazzanti, 2020), and despite that the applicability of the principles and models of circular economy to the field of urban sustainability appears uncertain, the previous failures in the implementation of the many possible policies for a more sustainable city, those for the so-called green city and those for the smart city, make the challenge for the Circular City an interesting field for urban studies researchers, planners and city managers.

Compared to the previous paradigms, the one for the circular city offers some concrete advantages, the most important of which, for the first time, is full involvement of the economy and of the local production systems at regional, national and global scale (Mosannenzadeh, Vettorato 2014).

The city has always been circular

Observing the history and evolution of the city, it makes sense to think that it has always been circular, having always been a complex organism, a composite set of materials and artefacts, a system and a network of flows, that has simultaneously followed processes of linearity (demographic, economic, spatial growth) and circularity (adaptation, reuse, transformation of the existing). Nowadays, the city still follows this double trend, with a continuous growth of the spatial dimension (and a continuous consumption of the soil resource) and an incessant process of internal redefinition, which concerns urban areas, large built complexes, single buildings, single housing units or productive structures. Just to give an example, the many practices, public and private, thanks to which Italian historic centers have been reused, starting from the 1960s and 1970s of the XX century, can be considered fully circular.

We cannot speak of urbanism and even less of planning for the ancient city since the discipline was born only in the second half of the 19th century. However, we have great ancient examples of circularity: the transformation of the Stadium of Domitian into today's wonderful Piazza Navona; to that of Diocletian's Palace in the current historic center of Split; the transformation of the Roman Lucca's amphitheater in the wonderful middle age housing of the current Piazza Anfiteatro of the small Tuscan town.. The Colosseum, in Rome, has been used for centuries as an "on demand" mine for stones and bricks. Of course today we would be horrified by such a destructive practice, but it was fully circular when it was practiced. Fortunately, the Pantheon, which was probably a private sacred building of the Julia family, connected to the large Agrippa bath complex, was not

dismantled. In fact, it was possible to use it as a Christian temple thanks to its morphology similar to that of Christian temples with a central plan. The most utilitarian recycling of the Roman vestiges is the one ordered, in 1625, by Pope Urbano VIII Barberini: the bronze lining of the Pantheon entrance pronaos was melted to make 80 cannons.

During the XIX century, starting from 1857, one of the most colossal intervention of urban adaptation and space reshaping was certainly the demolition of the huge Vienna's Walls become a functionally useless artifact. In place of the Walls was created the RingStrasse, the 5 kilometer ring of circumference around which the capital of the Habsburg Empire was functionally reorganized in its transition towards contemporaneity. The urban soil used for a military infrastructure become a precious resource to reorganize the city with new and modern facilities, museums, railroad stations, public parks, etc. The historiography on the construction of the RingerStrasse has never looked for data on the possible reuse of millions of cubic meters of rubble produced by the demolition of the walls, but it is very probable and fully reasonable that that waste was reused to fill the vast open spaces of the moat. and as foundation for the new streets and for the large new buildings built in Vienna in those years, exactly as happens today.

The culture and the art of recycling, adapting and metabolizing have represented a constant of urbanized human civilization, up to the moment of our entry into the contemporary era. A very different era from those of the past, characterized by the immense strength of the technique and by an endless sequence of technological disruptive innovations, from the invention of the steam engine to that of internet. A single example makes us understand the power of technique and technology in relation to the transformation of the city: the invention of the elevator by Elisha Otis, in 1853, which radically changed the building industry and the real estate values of the central areas of the city, simply allowing the 'infinite' growth of buildings. This process permitted to build bigger and faster, overshadowing the virtuosity of the recovery and recycling of materials. For Western countries and their people, the culture of recycling and reuse of materials, objects and goods has begun to fail both with the progressive urbanization, the consequent gradual disappearance of the previous rural civilization, and with the growing presence of plastic in everyone's lives. , starting from the second half of the 1960s.

Apparently it seems that the contemporary city, built from the beginning of the last century and then, impetuously, from the mid-1950s onwards, has lost the ability to recycle, reuse and re-adapt 'objects', especially those of more recent manufacture: large public residential complexes for thousands of families, large industrial areas and productive buildings or large infrastructural nodes and facilities now obsolete: airports, harbours, railroad stations, power plants, fire stations, prisons, hospitals,

schools, big sport facilities, etc.. The need for functional modernization leads the contemporary city on the road of replacement and relocation through the abandonment of the existing buildings, opting for new construction and continuous land consumption on the edge of the compact city or in the outermost territories of metropolitan areas. Recycling, reuse and urban adaptation in these cases take place with excessively long times. Speed, especially when investments are private, prevents us from accepting the excessively long term processes usually required for recycling, reuse and adapt the existing city.

Since the early 1970s, the disciplines of architecture, urbanism and planning defined new theories and practices characterized by the prefixes *Re* and *Ri*, meaning the need to return to what has already been built in the past: restoration, recovery, renovation, reuse, and then, requalification, revitalization, rehabilitation, regeneration. All these terms, in particular the last four, refer to planning and design practices that have been implemented with increasing frequency, starting from the 1980s in all Western countries, while in Italy since the 1990s. Recently, the PBL - Netherlands Environmental Assessment Agency defined an R-strategy that is broader than the typical R practices of architecture and urban planning because it is aimed at the world of goods and industrial production. The terms proposed by the Dutch R-strategy are: *Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycling, energy Recovery* (Potting J. et al. 2017).

The dilemma of the unsustainability of human settlements

It is an ontological problem: cities, that are our better and more complex invention after language, that are built due to our knowledge and technologies, are historically unsustainable. Thousands of years ago humans began to modify and transform the environment around them. The great oak forest of Veneto, described by Strabo and Pliny the Elder, between the first century BC and the first century AD, had already disappeared when the first barbarians appeared on the eastern borders of Italy.

In my opinion the process of circularity can never completely replace that of linearity, because this one can count on about 350 years of cultural and scientific mental construction, and because not even the nomadic civilizations or the millenary rural civilization have been completely circular, having started the process of bio-diversity reduction that characterizes the action of human beings. The transformation of the global economy into a circular economy represents, in fact, a colossal challenge. However, it is a cultural challenge, not limited only to economic and financial aspects, or to production processes, as unfortunately many of the main supranational

organizations (United Nations, World Trade Organization, European Union, foundations and research centers, etc.) seem convinced. This transformation from linear to circular can only be tackled to overcome through a complete theoretical-philosophical revision underlying the linear concepts of growth, progress and development. A model of linearity that derives directly from the scientific method defined by Galileo, Descartes and Newton and which, in vain, Giovan Battista Vico tried to contradict, with his losing idea of circularity, as well as in vain, at least until today, the concept of linear growth has been thwarted both by post-modern thinking and by "ecological minds" who, starting from the 1960s, have tried to sound different alarm bells (Franz, 2019).

Even if such a theoretical-philosophical revision could require decades of cultural elaborations and perhaps it could never be accomplished, it is important that the city be increasingly engaged in policies of circularization. The definition of a circular city and the objectives that can be achieved seem particularly interesting as a theoretical and empirical research field, but also from a managerial point of view. The most interesting aspect is that just as industrial civilization has forever changed the city starting from its size to arrive at specialized functional zoning, to arrive at the substantial unsustainability of the last decades, today, industrial civilization itself has the opportunity to modify this path in a sustainable way. The process of circularization presents, in fact, some similarities between the incipient one that is spreading in production and the one that is partly traditional and partly to be invented concerning cities. For more mature and large industrial systems (chemical / petrochemical, steel, automotive, etc.) the transition towards circularity will require long-term processes (two or three decades) and huge investments, just like the city needs long term to reuse and renovate large disused industrial and previous infrastructural equipments. As in the industrial production sector, the transition from linear to circular can be easier for small and medium-sized enterprises, for cities, many objectives can more easily be achieved through small-scale and management transformations.

I refer, for example, to several different opportunities to be promoted and achieved through very different tools and practices:

a) Through fiscal policies, subsidies and loans, many private buildings (housing or working) can be renovated, re-equipped and refurbished contributing to energy saving, but also to saving land and not using raw materials such as concrete, bricks, metals, plastics, wood, etc..
b) On another front, simply through management reorganizations of public administrations, great impact results can be obtained in terms of urban bio-masses transformation into energy or compost to enrich peri-urban soils or for urban gardening.

Option a) is very complex and complicated financially and fiscally speaking,

requiring also monitoring and control. Option b) is very simple and plain, requiring only a different management of existing services, increasing the value and meaning of ecosystem services, reducing costs for the municipalities that can sell the natural resource to produce energy, increasing the air quality, the urban bio-diversity and, finally, to counteract heat waves (Musco, 2016).

Food and Building industries

The two sectors in which urban circularity can determine the most tangible advances are the food and construction chains, that is to mean two of the most articulated production clusters and two of the most extended value chains, with an immediate and direct impact on the national economies of countries all over the world. Other sectors, much better known and investigated and already heavily involved in circularization processes are those of waste, energy and, in part, transport, with the success (at least before the crisis produced by the covid pandemic) of companies for shared transport (cars, bicycles, electric scooters). As I said, the construction sector will be strategic with respect to the objective of reducing the consumption of raw materials and, therefore, of emissions. On the one hand, the real estate market, in times of crisis and stagnation in demand, tends to focus on the most valuable offers, which today means smart and energetically performative housing; on the other hand, the stagnation of the market favors the renewal and regeneration of the huge stock of obsolete and energetically entropic buildings. Finally, the sector will be increasingly interested in enhancing materials from the demolition of modern and contemporary buildings lacking architectural qualities or difficult to use for other functions. In these terms, the construction cluster, which goes from the mining sector (stone, concrete, marble, clay, metals) to the financial sector, passing through the petrochemical, forestry, glass, textile and mechanical sectors will find a growing interest in recycling and reuse of secondary raw materials (PACE 2019; Heisel et al. 2019; World Economic Forum 2018).

In Europe, the Netherlands, Denmark and the Scandinavian countries are leading the transition process towards urban circularity, demonstrating that it is precisely the cities that can determine this type of transition, even starting from some sectors, rather than pursuing a holistic strategy. The Holland Circular Hotspot report *Accelerating the transition towards Circular Cities* (HCH-CE, 2019) proposes the Netherlands as a pioneering laboratory with an international leadership function. The HCH alliance assumes the leadership role with respect to the national government 2030-2050 transition agenda, confirming the strategic role of cities to implement urban circularity on some macro-sectors:

- **buildings and infrastructures**, responsible - according to the study in question - for 45% of the global consumption of resources and with respect to which the value chain must commit itself to increasingly use low-carbon and recycled materials, which are easily dismantled and reusable / recyclable;
- **food**, which is estimated to be a sector responsible for 20-30% of so-called global GHG emissions (greenhouse gas emissions) and for which the consumption of local products must be promoted, also through the use of innovative technologies and practices, minimizing water and energy consumption and recovering any possible food waste until completely eliminating the waste itself;
- **energy**, for which cities make up 75% of the total global demand, with the commitment to produce all the energy required from renewable sources and increasingly produced by local, decentralized and small-scale generators (the so-called energy communities); finally, the energy produced must be managed and locally distributed through smart systems, to avoid any minimum loss;
- **water**, for which Dutch cities must carry out closed cycles of consumption, treatment and recycling, recovering all raw / secondary materials from wastewater through the use of circular technologies;
- **consumer goods**, on this front the report shows how between 2015 and 2030 cities will be responsible for 91% of global consumption and must promote i) recycled, renewable and modular products and materials, ii) sharing economy models and practices to reduce individual ownership of potentially shareable goods, reducing global consumption.
- **plastic**, with respect to which the circular city prevents the use of disposable plastics;
- **industrial parks**, to promote the development of circular industrial systems capable of implementing processes of industrial symbiosis with increasingly closed cycles both with respect to energy consumption and with respect to production waste and potentially recyclable waste.

The seven points indicated to create the circular city appear at first sight to be reallistically implementable by every city, at least with regard to buildings and infrastructures, for mobility and also for water and energy. In my opinion it will be more difficult for cities to autonomously impress a process of economic and therefore systemic circularity on the fronts of goods, plastic and the whole food chain. About the industrial parks, the aforementioned ESPON report (2019) underlines how only this type of

industrial urban areas can achieve circularity, thanks to potential and progressive symbiosis between different producers who are sharing the foundamental requirement of proximity to promote several practices in terms of circularity towards the remanufacturing: recovery, regeneration, re-production, recycling, renewal, restoration. In Italy, the potential for a symbiotic process promoted within existing urban industrial areas is seriously implementable due to the peculiar character of Italian industrial districts, nowadays widely diversified but still based on geographical proximity and sectoral collaboration. This is the case of the historic industrial district of Prato, that has been transformed into the most circular cluster in Europe, as highlighted by Francesca Mazzoni in a recent contribution (Mazzoni, 2020).

The transition towards circularity can represents an opportunity to revitalize industrial districts in crisis or properly declining. In this option, a declining productive vocation can be regenerated or completely replaced, hosting in abandoned buildings disassembly, recycling and reuse activities.

An important opportunity, albeit controversial and potentially dangerous, could be storage of toxic and contaminating waste in abandoned industrial buildings. In fact, while in Italy in the recent past many countryside territories have been heavily contaminated by illegal and criminal disposal of industrial waste, on a global scale the toxic waste market is finding almost legal ways to leave the rich and strongly regulated Global North to disappear into the emerging and poorly regulated Global South. Abandoned industrial buildings could serve as repositories to leave toxic waste, under strict public control, until technologies and procedures for their safe disposal are available. In this way a rich illegal business disastrous for the environment and the health of many local communities could find a legal solution controlled by the public authorities, creating a legal market that is absent today.

Potencial and limits of urban policies

Beyond the innovations that large or small companies can implement in the transition towards circularity, cities will play a no less relevant role, opting for both radical innovations and incremental advancements, being able to implement a heterogeneous range of policies, projects, actions and services of varying scope and complexity:

- the treatment of waste and the management of the urban water cycle, which are usually well known and practiced,
- the promotion of virtuous practices for the strategic sector of food packaging, involving national and international Large-Scale Retailers,
- the improvement of green procurement practices and contracts for

the supply of public services, supporting and protecting the growth of local circular actors,
- the support and propmotion of urban farming, also to support the birth of hydroponic or aquaponic agriculture small companies and startups, capable of reusing food waste and even gray water, closing the circle with the production of vegetables, fruit and fish (EMF 2017),
- the promotion of organic peri-urban agriculture, also as a tool and action to regenerate agricultural soils and create urban bio-economy chains,
- the continuous investment in smart city actions, such as the energy system (smart grid, renewable energy production, biofuel from biomass, etc.), the technologic renewal of public lighting systems, a very expensive voice in terms of energy and of public finance,
- the urban mobility system, a huge sectors in which is possible to innovate plans and rules (intangible actions), to design better streets, bike tracks, and 30 km/h neighborhoods (very cheap actions), to invest in new public transport infrastructures (very expensive and long-term actions),
- the refitting, repairing, the maintenance and adaptation of public buildings for energy saving, technological advancement, and health safety (Franz 2006),
- the definition of measures, rules, procedures, adherence to certification protocols and incentives to drive the public-work and building sector towards the increasingly virtuous use and reuse of materials (the infinite range of building components), recovery and the recycling of demolition materials, up to the improvement of often spontaneous urban regeneration practices with the reuse, even temporary, of unused or underused buildings.

To achieve these objectives, an infinite catalog of national and international best practices is already available, as well as practical handbooks, guidelines, tools, regulations, process methodologies and financing programs are available, adoptable and adaptable to local contexts. The implementation of the sustainable city through circular processes and actions is a challenge that must be played, with the awareness that the city remains intrinsically unsustainable, both for the *natural desirability* of spatial expansion and for its historically hegemonic relationship with the environment, which is still considered, in fact, its resultant. (Amenta, van Timmeren, 2018). As Piyush Dhawan writes in the aforementioned manual, which has the typical limitations of any manual, progress can only be grasped through collaborative actions, which certainly include technical and technological innovations, the redesign of infrastructures, the identification

and implementation of new economic models and the purchase of circular supplies, but it will not be possible to consolidate the circular economy starting from technological innovations, rather from the involvement of individuals, the private sector, the different levels of government and the so-called civil society, a list in which individuals play a key role in creating demand (Dhawan, 2018).

In my opinion, a double limit seems to emerge from the beginning of the new paradigm diffusion and is the emphasis once again placed on the stakeholders of greater economic and political importance and on the strategic relevance of the data availability, rather than on citizens considered in their generality. These are the same two limits that have weakened the very concept of smart city for years and which are the result of the technocratic hegemony of which contemporary human civilization is ill. The first problem is what I call: stakeholder squint. a conceptual weakness without resolution until we stop using a highly contaminating category such as that of the stakeholder, since sustainability concerns the general interest, while the interests are always and only particular. The second problem represents the weak point of the whole culture of sustainability from the moment of its consolidation and epiphany to the world in 1992: a blind faith in technology and in the accumulation and management of data rather than in a progressive construction of cultures of sustainability capable to shape a new ecological mind in citizens and therefore a real ecologically oriented political initiative.

Today, worldwide, the main building built according to these criteria is the Triodos Bank in Zeist, in the Netherlands, designed by Rau himself, while the Venlo region has been the first in promoting the CradleToCradle (C2C) model, aiming at 100% recycling of each material. The concept of a building as material bank (conceiving it as a temporary storage of materials) gives a new value to construction materials and products and therefore to the maintenance phase, while the concept of the building life is extended to the single materials life, adding the reuse/recycling of every single element to the three traditional steps of the building life cycle: durability, maintenance, and repair. In this sense, the concept of the building as temporary storage of materials automatically increases the value of both the final object and its components, giving greater importance to both the maintenance phase, which extends the product's life cycle, and the dismantling phase, which allows to extend the end-of-life of any single material recovering natural and artificial resources (iron, metals, clay, marble, concrete, glass, wood, etc.).

Compared to the traditional linear production of cities (extraction, transformation, construction, demolition), the new conception of the building as a storage of natural resources also gives greater importance to urban regeneration projects and practices in which buildings are rehabilitated and renewed as well as the open and public spaces of the neighborhood are regenerated and improved. In fact, life cycle extension practices postpone the

costs of dismantling and/or disposal over time, also postponing the extraction and the supply of raw materials. Actually, this goal is relevant in terms of waste management, considering that in Italy about 40% of the waste sent to landfills is made up of materials produced with the demolition of buildings.

The European Union Directive 2008/98/CE expects to reach a target of 70% recycling of demolition waste in 2020. This is a very important goal but, paradoxically, it limits the growth of the reuse of building materials. Fortunately, as landfill disposal costs are rising in every European country, businesses are being pushed towards selective demolition, a growing circular practice that allows them to retain a higher value of disassembled materials. For this reason, in 2018 the EU amended the Construction and Demolition Management Protocol, with the aim of strengthening reuse before recycling, improving:

- the identification of waste, the separation and collection phase,
- waste logistics,
- waste treatment,
- quality management,
- the adjustment of policies.

This Protocol has been developed to be applied in all 28 EU countries and has the following target groups of stakeholders:

- Industry practitioners; construction sector (including renovation companies and demolition contractors), construction product manufacturers, waste treatment, transport and logistics as well as recycling companies,
- Public authorities at local, regional, national and EU levels,
- Quality certification bodies for buildings and infrastructure,
- Clients of C&D (construction and demolition) recycled materials[3]

The new frontier of circularity in the building industry is the so-called design for disassembling or for deconstruction aimed at exploiting the maximum potential of the materials and components second life. This means that during the design phase the assembling and disassemblig of components and materials has to be planned in advance. The models for this new approach are:

- the Olympic Stadium in London, which was designed and built foreseeing its transformation to accommodate other sporting uses or to be completely dismantled,

[3] https://ec.europa.eu/growth/content/eu-construction-and-demolition-waste-protocol-0_en

– the Martin Hospital built in 2008 in Gröningen, that could be adpated to other functions as offices or up to 250 apartments.

Despite the evident market potential, this sector is still far from being developed and interesting for the whole building industry. Best practices are still pilot cases from the bottom, isolated and voluntary, the framework of the rules is not complete and coherent, both at the European Union and at the national level, there is no economic support in terms of subsidies or tax exemptions. Some prerequisites are needed to boost the growth of the sector. One of the most important concerns urban planning, defining stringent rules to stop land consumption, thus increasing the attractiveness of the existing city, promoting re-development projects, with the recovery, rehabilitation or demolition of pre-existing buildings. Another fundamental prerequisite concerns the national regulations that define secondary raw materials, differentiating them from waste, associating this measure with a taxation system that penalizes the use of virgin raw materials. Databases are also needed to increase knowledge on the performances of each material and platforms to connect operators, from professionals to companies

The state of the art in Italy

The role that cities can play in promoting practices of circularity is concrete and the Dutch example proves it, with nine cities that have signed the agreement "Green Deal: Circular City", to collaborate, share and implement pilot projects with the support of three national ministries and three research centres. In this context, Amsterdam has decided to become the world-leading city, defining a plan, for the period 2020-2025, and finalized to achieve the full circularity in 2050 (City of Amsterdam, 2019), concentrating efforts and investments in the building value chain, in biomass production, in the supply and distribution of food and goods.

In Italy the situation is dual and contradictory. The industrial system is the most advanced in Europe for circular practices, as reported by the Circular Economy Network (2019), while is totally and historically absent a national urban policy to promote innovation and transition. A lack of policies that has produced the serious delay of all Italian cities in terms of infrastructures, public facilities, social and public housing needs, public transport, smart infrastructures, maintenance of public assets (buildings and facilities as schools and hospitals). In 2019, precisely to fill this gap in urban policies, the Italian Circular Economy Stakeholder Platform (ICESP) published a survey focues on circualar economy in urban and peri-urban areas. The report proposes an action plan model based on four macro-sectors:

– resource optimization (which also includes the so-called anthropic

water cycle and the energy efficiency sector of buildings);
- agri-urban complementarity (which includes at least part of the overall food supply and consumption system);
- control and protection of air quality;
- protection and enhancement of the historical-artistic and naturalistic capital (which includes the green and blue infrastructure sector).

In addition to these four sectors, two are considered corollaries: urban regeneration and sustainable tourism. A review of urban case studies presented at the Catholic University of Milan was published in 2019 having three major foci: cities, materials and technologies (Tondo APS, 2019), considering: some projects of the Carlo Ratti Associates office, more related to the smart city model, some projects of the Ove Arup group based on the LEED model, a case of urban farming and the model of Amsterdam. It is possibile to say that this sector is not yet very crowded and populated both in studies and in realized or on going projects. And this despite the fact that in 2016 the national government signed the Amsterdam Pact which, consistently with the United Nations 2030 Agenda and the 17 SDGs, defined the European Urban Agenda, identifying urban areas as the engines of the economy and continental innovation, and the place where the challenges of the 21st century will be overcome. For this reason, the Agenda considers circular economy as one of the 12 priority axes for the European cities development.

The *Circular Economy Working Group* of the Green Building Council Italy published in 2018 an important report on circular economy in the building industry. The reason that led to the drafting of the position paper is the need to define the state of the art on the use of the circular economy in Italy in this specific sector, that is suffering for the long crisis of 2007 and is divided between a few large technologically advanced players and many small companies that use traditional systems and materials and are often reluctant in facing challenges. Circularity applied to the construction industry is in fact based on some particularly fascinating conceptual innovations but not easy to apply (GBC Italy, 2018). In particular, the concept of Urban mining, closely linked to circular economy strategies, proposes the built environment as a "mine" of materials that can be reused. In this vision never previously formulated, Urban mining therefore favors new systematic management of anthropogenic resources and waste (such as products, buildings, spaces, and ruins from demolitions), proposing long-term conservation of resources and economic benefits from their dismantling, reuse or recycling. That is what Sabine Oberhuber and Thomas Rau explain with great effectiveness in a book published in The Netheralands in 2016, the most advanced country in the challenge of circularity (Oberhuber, Rau, 2016): consider each building as a sort of bank of materials, considered as portions of

the planet extracted and not to be thrown away as waste. Every element of a building has a value. Dismantling is still very expensive, but already possible. The cost of dismantling can be reduced when the design of buildings also begins to consider the phase of dismantling and reuse.

In July 2020 GBC Italia edits a new report confirming the same difficulties of the previous 2018 review, because the sector is still very young and experimental, the materials are not yet tested in their flexibility and longevity, the characteristics of resistance and durability are not yet clear, and the micro-sector of urban mining suffer for the entire value chain of the building industry, particularly fragmented into too small companies, while regional chains are still absent, not allowing the reduction in transport and supply costs. Fundamental aspects, such as the selection of waste, its separation, processing and assembly into new ready-to-use materials are still to be solved (GBC Italia, 2020).

The Ferrara case study

In Ferrara, between 2017 and 2019, a large urban redevelopment project was carried out which also acts as a pilot project in terms of urban circularity. At the end of the 1980s, urban planning procedures were initiated for the construction of a large public-private business center in an agricultural area on the southern outskirts of the city. In the first half of the 90s, the entire complex was confiscated by the judicial authorities and the owners were arrested for collusion with organized crime. For almost thirty years the tens of thousands of cubic meters complex remained abandoned and in decay, populated by squatters and homeless people of different nationalities, producing a lot of social problems for drug dealers and foreign prostitutes.

Between 2010 and 2016, a national real estate investor acquired the real estate asset at a judicial auction and a very long and complex urban recovery process, reuse and regeneration was implemented, with the Municipality, which must collect a few million euros in taxes and urban planning charges, gathered around the same table with the new real estate owner and some creditor banks, the Cassa Depositi e Prestiti, a public-private bank whose objective is to promote 'patient' investments in compliance with the strategies of the national government, and the local public housing agency (ACER). After years of negotiation, an agreement is found between all the partners, now members of an Urban Public-Private Redevelopment Trust, that defines a new large scale urban project. The actors decide not to demolish the existing huge buildings, but to proceed towards a selective dismantling and deconstruction, to meet two objectives: reuse the existing reinforced concrete structure still in efficient condition, also using the existing foundations, recovering and recycling dismantled building materials. Up to 11,700 tons of

materials to be recycled are extracted from the ruined building, allocating the 'waste' to the reuse chain, with a percentage of recovered material equal to 98%. It is one of the first cases in Italy in terms of size and complexity of the entire operation.

This urban mining best practice produced resources equal to 860 tons of iron and steel, 96 tons of aluminum, 49 tons of building insulation, 20 tons of wood and over 10,000 tons of aggregates (cement and other stone or ceramic material). 700 trips were made to transport the materials to the reuse and recycling centers, of which 91% in existing plants within the Ferrara territory, in a 50 kilometers radius, 8% in plants within a radius of 100 kilometers and only the 1% of the total dismantles material was transported to more distant territories. Among the curiosities, it is interesting to highlight that not a single kilo of copper was recovered since the electric cables had already been extracted by squatters and groups of foreigners specialized in this sector. Unfortunately, no reports, giving an exact account of the results and the economic and environmental savings achieved, have yet been published about this national best practice. Nowadays, a new residential neighborhood qualifies the southern outskirts of Ferrara, offering 233 social housing units, 3,000 square meters of stores and offices, and a dormitory for a hundred university students. Other apartments and public facilities will be realized in the next years.

Conclusions

The challenge of circularity in the building industry is already a reality, albeit embryonal. Beyond the evident technological advances that can be achieved in terms of circular economy in other industrial systems and within specific value chains (plastics, electronics, automotive, textiles, food and distribution, etc.), the construction sector can be affirmed as the main item of urban circularity, both for the volumes of recoverable material, and for the tens of thousands of existing buildings already obsolete or in obsolescence. It is a challenge that can help to strongly reduce the use of virgin natural resources, significantly reducing important environmental impacts, while at the same time bringing new quality to the city.

The process for an increasing urban circularity, however, will require huge public and private financial investments, a need that will be in conflict with a condition of growing 'traditional' needs: maintenance and modernization (re-fitting) of public infrastructure and equipment built over the last 70 years, such as schools, gyms, museums, libraries, hospitals, etc.. This is true especially for cities of the richest countries, which for most of the twentieth century and certainly after World War II were the protagonists of a process of growth and redistribution (of rights, resources and incomes)

unprecedented in human history.

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Fondazione Eni Enrico Mattei
Corso Magenta 63, Milano – Italia

Tel. +39 02.520.36934
Fax. +39.02.520.36946

E-mail: letter@feem.it
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