Chapter 34
Technological Innovation for the Next Ecosystem Transition: From a High-Tech to Low-Tech Intensity—High Efficiency Environment

Carola Clemente

Abstract Technological innovation is the driver of the progress of the material culture of human civilization. A new balance between development and ecosystem requires the revision of the innovation drivers, in terms of efficiency and transformations of the anthropic environment to reduce the great divides. Sustainability and decarbonization of all production sectors are based on process management skills and optimization of technical knowledge and technologies, to move from a highly technological anthropic ecosystem to a low intensity and high efficiency managed environment. The frontier of innovation is marked by the reduction of the impact of technology and its remodelling, enhancing intangible resources and the design abilities of transformation of the built environment. It is therefore urgent to focus on the R&D models and project strategies for a low-tech environment and highly advanced carbon neutral building/plant integration, the regeneration policies of the built environment with low intensity and high energy and environmental efficiency, with the aim the recovery and inclusion of marginal contexts of energy poverty and economic, where digital and technology divide represent barriers to development and inclusion. The traumatic awareness of the material "limit" of the availability of resources involves a paradigm shift in the global system of the supply chain and resource management on which we have based the development of the "technosphere" and perhaps represents the definitive culture shock necessary to redefine a new relationship between man and the environment.

Keywords Anthropocene · Environment · Great divides · Ecological transition · Technological ecosystems

C. Clemente (✉)
Sapienza University of Rome, Rome, Italy
e-mail: carola.clemente@uniroma1.it

E. Arbizzani et al. (eds.), *Technological Imagination in the Green and Digital Transition*,
The Urban Book Series, https://doi.org/10.1007/978-3-031-29515-7_34

34.1 Complexity of Transition Scenarios

Technological innovation is the engine of the progress for the material culture of civilizations. It has improved health, security, and quality of life, and created more connected and integrated communities. However, while evolved technologies have identified more efficient energy sources, they have led to an extreme growth of the consumption of the resources needed to maintain them (Ziman 2003).

The intensity of human activity has so conditioned our planet's life over the centuries that the quantity of its manmade, artificial matter has equalled and exceeded that of the natural matter present on the globe.

Ecology has defined the portion of the physical environment created and organized as a result of human activity in the sphere of urban settlements and connected structures as the anthroposphere (Kuhn and Heckelei 2010); by extension, this term is used to indicate the set of humans and their artefacts which, beyond the transformations of the territory, also includes all environment phenomena, whether intentionally or unintentionally caused, such as pollution or developed technologies more generally, to which some studies apply the term "technosphere" (Zalasiewicz et al. 2017a).

Environment is therefore the landscape of all the systemic conflicts of this development, which is only erroneously limited in time to the first Industrial Revolution (Zalasiewicz et al. 2017b, 2017c).

What is clear is that the environment, intended as the complex physical, chemical, and biological system in which all living matter evolves, is conditioned on a local and global scale by the effects of human action, and that the intensity of this action has grown exponentially since the eighteenth century, the moment when humans' impact on ecosystems progressively increased along with world population growth, producing substantial alternations of the natural, eco-systemic equilibria (Haff 2016, 2017).

The power of the human phenomenon over the environment has been of such scope and intensity that Paul Crutzer (Crutzen and Stoermer 2000; Crutzen 2002) has defined this latest historical phase as tantamount to a geological epoch, using the term Anthropocene (Crutzen 2006, 2021).

The opening to discussion created by this session does not expect to find a solution to the evident imbalance that exists between human development and the conservation and restoration of the biosphere, but the aim has been to understand, through the research experiences we have gathered, whether there is hope for relating the demands of development, well-being, and security with the health of our host environment, or whether our disciplines are working on defensive positions, without in the least questioning the established dynamics of development of the sector of construction and of transformation of the territory.

Federico Butera recently expressed a highly critical thought on one of the pillars of current technological and economic life—the circular economy—where it is used to a distortive effect to continue to generate new material and new products only because one day they may be recycled and reused (Butera 2021). The real paradigm shift lies in

ceasing to produce certain families of materials above all, except under the condition of continuing to produce them exclusively from secondary raw materials—that is, recycled material.

This principle also holds for the technological innovation connected to all the apparatus of systems necessary—or held to be necessary—for our well-being and security; it is in fact indispensable to determine how ready and willing we are to truly change established ways of designing and managing our buildings, and how willing we are to detach ourselves from devices, even those deemed reliable and efficient, but that are now clearly anti-historical. We must therefore determine when we will contemplate abandoning the traditional systems of the environmental management of our buildings so as finally to achieve an effectively integrated planning commensurate with our actual needs, leaving behind the principle of "redundancy" looked to by much of mainstream planning, and to definitively embrace a principle of "adequacy".

Integrated technological planning of the building/installations/urban surroundings system allows the quality of the indoor environment and the quality induced by our building on the outdoor environment to be conceived in a way suited to the needs of use. Only in this way can the material impact of producing the building be reduced: not by remodulating our demand, but by effectively optimizing the material response offered by the built environment.

An environment of low technological intensity does not imply a low-tech approach to realizing it, typical of a demand for more or less successful degrowth, but the use of high-precision planning technologies to carry out interventions with high added value in environmental terms.

The frontier of innovation is marked by technology's reduced impact and by its remodulation, capitalizing on intangible resources and the design capacities for transforming the built environment.

A new balance between development and ecosystem requires revising the drivers of innovation, in terms of efficiency of the transformations of the manmade environment and of closing the "great divides" (Wealth, Health and Technology) (Stiglitz 2016), which are more and more dramatically clear and dangerous for the geopolitical as well as socio-demographic balance of many areas of the planet (Information Resources Management Association 2020).

The fast growth of human technological development has in fact never permitted the egalitarian redistribution of its benefits throughout the planet's social and geo-demographic stratification but has instead widened the divide: locally among the various social groups and globally among geographically or culturally distant communities (Barca and Lorefice 2021).

The key for human activities to coexist with the environment, then, lies not in perfecting technology as relates to its performance, but in reducing its impact or in diminishing its use—and, as a last resort, in reducing the consumption of resources.

This session would aim to set the boundaries of a new technological and constructive imagination, for a path of innovation oriented towards increasingly low-impact/high-value technologies. This is also to be achieved using precision components for increasingly ZEB—Zero Energy Buildings in order to maintain the management of a **low-tech environment**, possibly capable of autonomously healing

the injuries suffered over time, in which technology is not required to go about correcting the distortions produced by human activities.

The new technological imagination needed to achieve the objectives of sustainability and decarbonization of all production sectors requires not only high-value/low-impact technologies but also the formation of soft skills governing the processes and the optimization of competences and technologies, in order to transition from a manmade ecosystem with high technological intensity to an environment managed with low intensity and high efficiency.

34.2 Research Outcomes and Contributions

This session compares R&D models and design strategies for a low-tech environment and advanced, carbon neutral building/plant integration, and policies to regenerate the built environment with low intensity and high environmental and energy efficiency.

This first meeting allowed a variety of research experiences to be compared, which dealt with the complexity of managing the built environment's transformation processes, while examining the issue's various scales, from the urban to that of the building component and of managing the materials.

On the urban scale, certainly of particular interest are the issues of Energy Communities (Paola Marrone and Ilaria Montella—Roma Tre) and of PED—Positive Energy Districts and Neighbourhoods for Sustainable Urban Development (Rosa Romano—University of Florence, Emanuela Giancola—2UiE3—CIEMAT, and Maria Beatrice Andreucci—Sapienza University of Rome). They have also highlighted the importance that the interconnection of every urban planning and construction choice has for the proper commensuration of needs to be met and services to be distributed on the territories.

The issue of the technical policies to guide the process of technical programming and of planning is dealt with in the papers by Claudio Piferi (University of Florence) and Anna Dalla Valle (Polytechnic University of Milan)—two very different contributions, both examining the initial phases by process. The former reconstructs the history and evolution of the leading, multi-year programme for financing university residential construction, a strong example of long-term technical planning that has proved able to evolve in a mature and aware manner, also by learning from its own critical areas, thus bringing about real progress in the technical, environmental, and functional quality of the buildings constructed in the context of that programme. The latter provides an interesting account of the issue of LCA at the initial levels of the construction programming process, as a preliminary form of assessment of the building's technical feasibility.

The paper by Antonella Violano and Monica Cannaviello (University of Campania Luigi Vanvitelli) sets out an example of an experience of integrated management of a public service and of its stock of carbon neutral instruments.

Resilience and emergency are two faces of the fragility of environmental equilibria; on these issues, the paper by Vincenzo Gattulli (Sapienza University of Rome)

with Elisabetta Palumbo (Bergamo University) deals with the issues of the resilience of human settlements in one of the most fragile and at-risk environments in the western region of the Indian Ocean, while the paper by Maria Vittoria Arnetoli and Roberto Bologna (DIDA—Department of Architecture, University of Florence) deals innovatively with the issue of post-disaster temporary emergency settlements in terms of impact and of actual circularity of their management.

The session also included numerous presentations that may be framed within the two future projections of the environmental management of constructions, which is to say the sector's digital and green transition; it is highly interesting that a large portion of these papers originates from doctoral research, with young PhD candidates therefore becoming interpreters of the more innovative thrusts within the sector (cf. Irene Fiesoli, University of Florence; Francesco Sommese and Gigliola Ausiello—University of Naples Federico II; Tecla Caroli—Polytechnic University of Milan; Nazly Atta (Polytechnic University of Milan).

The researchers who chose to share their work effectively covered all this session's topics; the only regret is that no deeper analysis has been offered as relates to contexts of energy and economic insecurity, in which the digital and technology divides present fundamental barriers to development, especially at a time like the one we are living in, which might further worsen many people's inability to meet their own energy needs.

34.3 Conclusions

Representing one of the largest economic systems and markets, the European Union has always aimed to play a driving role in supranational environmental strategies. The 8th EU Environmental Action Programme of 2020 (European Parliament and of the Council 2022), which guides European environmental policy until 2030 within the framework of the long-term strategy to 2050, intends to speed the transition towards a climate-neutral economy, an economy efficient from the standpoint of managing resources, that aims to be "regenerative"—which is to say able to restore to the planet more than it has taken from it.

All the documents shared on an international level (UE and UN) recognize that the well-being and quality of life of human beings depend on the health of the ecosystems in which we operate.

The European Green Deal (European Commission 2019) sets six priority goals:

- to achieve the goal of reducing greenhouse gas emissions by 2030 and climate neutrality by 2050;
- to strengthen the capacity for adaptation, strengthen resilience, and reduce vulnerability to climate change;
- to progress towards a regenerative growth model, by dissociating economic growth from the use of resources and from environmental degradation, and speeding the transition towards a circular economy;

- to pursue the goal of "zero pollution", comprising air, water, and soil pollution, and to protect the health and well-being of Europe's citizens;
- to protect, preserve, and restore biodiversity and strengthen natural capital—in particularly the air, water, soil, and forests, freshwater, wetlands, and marine ecosystems;
- to reduce the environmental and climate pressures connected to production and consumption (particularly in the sectors of energy, industrial development, construction and infrastructure, mobility, and the food system).

Unlike the UN's 2030 Agenda which has a global vision more conditioned by the weight of the global south, this document has been written with a view to the European setting, marked certainly by a situation of economic crisis, but just as certainly not comparable with the extraordinary historic phase we have been experiencing in recent years. First the pandemic, followed by the geopolitical clash that is destabilizing the entire continental economy and a large portion of the systems economically interconnected with our own, raise important questions to be answered, and have at last brought to the general attention the backwardness of the implementation of environmental and energy transition policies that scientifically, for the entire community, no longer hold any secrets and are instead still quite far from being actually operative and metabolized by the "market". Precisely when our scientific community met for this conference, the European Council adopted general guidelines on reductions of emissions and on their social impact through the implementation of the package of measures termed "Fit for 55" (European Commission 2021) which is to say to achieve, as an intermediate result, the EU's target of reducing net greenhouse emissions by at least 55% by 2030. The proposed package is instrumental for aligning the regulations of the community and of the Member States with a view to the 2030 deadlines, which is to say that a consistent, balanced framework and a new Social Climate Fund for achieving the EU's climate targets is to be provided (Council of the European Union 2022), able to:

- guarantee a socially fair and proper transition;
- maintain and strengthen the innovation and competitiveness of the EU's industry while at the same time insuring conditions of parity for economic operators in third countries;
- support the EU's leading position in the global fight against climate change.

The urgency of achieving the Green Deal's goals, during a setting of crisis linked to a global economic situation rapidly evolving after the events of 2022, has clearly linked environmental demands with the social equity of the increasingly indispensable ecological and energy transition, in order to keep it from generating new poverties and phenomena of social de-cohesion depriving of the benefits of the ecological transition precisely those layers of the population that will suffer most from the greater costs expected for energy procurement in the near future.

Will it be the war economy to allow us to discover the unsustainable costs of traditional energy sources?

Will it be the scarcity of valuable resources to remind us that the first kilowatt earned is the one not consumed? Will it drive home that the whole quantity of devices we will be forced to cast off will have to be the new mines from which to extract those metals, rare earths, and special alloys that we have discovered originate from once-productive scenarios that are now scenarios of war that can no longer be drawn from?

Anyone who has done research over these past twenty years on the environmental and energy efficiency of the construction sector has seen many developed designs break apart against the ruthless comparison between the high "cost of efficiency" and the low-cost availability of energy and of many raw materials. This has always led to the belief that investing in reducing energy consumption and in diminishing the material footprint of construction was unaffordable.

The sudden unavailability of certain routes for the supply of raw materials, including those produced for decades at an incalculable environmental cost, and the need to differentiate the sources of energy procurement, at last risks creating that culture shock, on top of the economic one, that might allow the construction industry as well to find justification once again in developing efficient and low-impact—and perhaps actually regenerative—solutions as required of us by the **Green Deal**. This will be done by seeking to give back to the planet more than what is taken from it but also by interrupting the taking of many of the natural resources currently deemed still preferable to regenerated ones.

In this phase, so particular as it is, discussion sessions like this one are important for consolidating, beyond the scientific assumption, an increasingly solid awareness of the urgency of implementing, on the territory and in the market of technical operators and above all of public stakeholders, the result of these research efforts through their engineering and industrial development, in order to contribute towards building real energy and environmental communities that are collaborative and regenerative towards the host environment.

References

Barca F, Lorefice F (2021) Disuguaglianze conflitto sviluppo. Donzelli Editore

Butera F (2021) Affrontare la complessità. Per governare la transizione ecologica. Edizioni Ambiente, Italia

Council of the European Union (2022) Interinstitutional File: 2021/0206 (COD)—ST 10775/22—'Fit for 55' package—proposal for a regulation of the European Parliament and of the Council establishing a Social Climate Fund—General approach, Brussels. https://data.consilium.europa.eu/doc/document/ST-10775-2022-INIT/en/pdf

Crutzen PJ (2002) The "Anthropocene". J Phys IV Fr 12:10–11. https://doi.org/10.1051/jp4:20020447

Crutzen PJ (2006) The "Anthropocene". In: Ehlers E, Krafft T (eds) Earth system science in the Anthropocene. Springer, Berlin, Heidelberg. https://doi.org/10.1007/3-540-26590-2_3

Crutzen PJ (2021) The "Anthropocene" (2002). In: Benner S, Lax G, Crutzen PJ, Pöschl U, Lelieveld J, Brauch HG (eds) Paul J. Crutzen and the Anthropocene: a new epoch in earth's history. The Anthropocene: politik—economics—society—science, vol 1. Springer, Cham. https://doi.org/10.1007/978-3-030-82202-6_4

Crutzen PJ, Stoermer EF (2000) The Anthropocene. In: IGBP newsletter, vol 41, pp 17–18. http://www.igbp.net/download/18.316f18321323470177580001401/1376383088452/NL41.pdf

European Commission (2019) Communication from the commission—the European green deal. COM(2019) 640 final Brussels. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0640&qid=1666537322699

European Commission (2021) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 'Fit for 55': delivering the EU's 2030 climate target on the way to climate neutrality, COM(2021) 550 final, Brussels. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0550&qid=1666535452461

European Parliament and of the Council (2022) Decision (EI) 2022/591 of the European Parliament and of the Council of 6 April 2022 on a General Union Environment Action Programme to 2030. Official J Eur Union L 114 65:22–36. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022D0591

Haff PK (2016) Purpose in the Anthropocene: dynamical role and physical basis. Anthropocene 16:54-60. ISSN: 2213-3054. https://doi.org/10.1016/j.ancene.2016.07.002

Haff PK (2017) Being human in the Anthropocene. Anthropocene Rev 4(2):103–109. https://doi.org/10.1177/2053019617700875

Information Resources Management Association (2020) Wealth creation and poverty reduction: breakthroughs in research and practice. IGI Global

Kuhn A, Heckelei T (2010) Anthroposphere. In: Speth P, Christoph M, Diekkrüger B (eds) Impacts of global change on the hydrological cycle in West and Northwest Africa. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-12957-5_8

Stiglitz JE (2016) The great divide: unequal societies and what we can do about them. Norton & Company

Zalasiewicz J, Williams M, Waters CN, Barnosky AD, Palmesino J, Rönnskog AS, Edgeworth M et al. (2017a) Scale and diversity of the physical technosphere: a geological perspective. Anthropocene Rev 4(1):9–22. https://doi.org/10.1177/2053019616677743

Zalasiewicz J, Waters CN, Wolfe AP, Barnosky AD, Cearreta A, Edgeworth M, Ellis EC et al. (2017b) Making the case for a formal Anthropocene epoch: an analysis of ongoing critiques. Newsl Stratigr 50(2):205–226. https://doi.org/10.1127/nos/2017/0385

Zalasiewicz J, Waters CN, Summerhayes CP, Wolfe AP, Barnosky AD, Cearreta A, Crutzen P et al. (2017c) The working group on the Anthropocene: summary of evidence and interim recommendations. Anthropocene 19:55–60. https://doi.org/10.1016/j.ancene.2017.09.001

Ziman J (ed) (2003) Technological innovation as an evolutionary process. Cambridge University Press