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Technological Imagination in the Green and Digital Transition

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Foreword by Antonella Polimeni

Good afternoon to all participants, ladies and gentlemen, and welcome to Rome.

On behalf of the Community of Sapienza University of Rome, it is a real pleasure to welcome all of you to the first edition of the International Conference "Technological imagination in the green and digital transition". I am also pleased to give my best welcome to Dr Antonio Parenti, Head of the European Commission Representation in Italy, and to Prof. Mario Losasso, President of the Italian Society of Architectural Technology, as well as to all guests, students and colleagues.

The conference that we are about to open, organised by the Department of Architecture and Design and directed by Prof. Alessandra Capuano in cooperation with Sapienza Foundation, is to be a moment of methodological debate about built environments and the rise of contemporary urban challenges, so engaging for public and private institutions at national and international level.

The proposed key points of this conference—namely Innovation, Technology, Environment, Climate Changes and Health—are all interconnected priorities that cannot be further postponed, representing in the meantime strategic research and education activities for our University, perfectly aligned with the Italian National Recovery and Resilience plan, to be implemented in Italy as well as European member States, in order to overcome the present financial and social challenges.

I truly believe that Universities are, by definition, places of imagination, where planning the future is intended as an unavoidable "existential condition" as well as an essential moment of collective participation for an accomplished society.

Thank you for your attention, and I wish you a fruitful continuation of the conference.

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Foreword by Eugenio Gaudio

My warmest greetings to Dr. Antonio Parenti, Head of the European Commission Representation in Italy, to the President of the Italian Society of Architectural Technology Mario Losasso, to the Director Alessandra Capuano, and to Pietro Montani who will open with a Philosophical Lecture the Conference "Technological imagination in the green and digital transition".

A special greeting to Prof. Anna Maria Giovenale, my dear colleague and friend, who invited me to be here today. Thank you Anna Maria.

Let me also greet all other speakers as well other participant that will follow this Conference organized by the Department of Architecture and Design, together with the Fondazione Roma Sapienza.

From the very beginning, as President of the Fondazione Roma Sapienza, I supported the initiative of an international Conference on the theme of "Technological Imagination" having clear in mind that human imagination is inseparable from the "technical practice" with which it is entangled from the earliest origins of mankind, as Pietro Montani states in his book, *Technological destinies of the imagination.*

When the contents of the Conference were increasingly defined and focused around the areas of the green and digital transition, I realized that the very core of the Conference was becoming an attempt to respond to the contemporary challenges of the National Recovery and Resilience Plan, in their key role of revitalization for Research and University.

In this sense, the potential of technological culture is reaffirming its role of strategic tool for the conceiving, design and validation of future scenarios.

The sessions into which the Conference is structured, namely: Innovation, Technology, Environment, Climate Changes and Health, identified in order to outline the evolutionary scenarios of architectures and cities, allowing us to reflect at different levels on innovative models of building and management process, as well as design and products.

The goals of promoting digital transformation, supporting innovation in the production system, improving sustainability and ensuring an equitable environmental transition, find their clarification in the elaborations and experimentation presented through the contributions in the different sessions.

Modern technological innovation allowing multiple possibilities in all areas: nowadays digital technologies are enabling us to interact with people and things, all over the world.

There are astonishing, yet untapped potentials, suggesting that digitization, rather than a strict sense adaptive development, should be seen as an important evolutionary phenomenon and in the meantime a great opportunity.

Innovations connected with new technologies can provide to civil society a better quality of life, both at indoor and urban scale settings, addressing scientific development toward an effective culture of sustainability, reuse and security.

The employment of new technologies, a careful approach to the containment of land consumption as well as a careful consideration towards soil coverage modality and urban density, the recycling strategies and technological and typological redevelopment of degraded areas and buildings applying an energetic and eco-systemic approach, are the key elements for the conception of healthy and resilient urban habitats, able to adapt to the present global changes, as well as promoting prosperity, inclusiveness and social equity.

Last but not least, "health" issues, that need to be conceived at the very core of the potential determined by 'technological innovation and processes of ecological and digital transition.

The structure of the Conference is rooted on all these interrelated themes, and on that same basis also research needs to be reoriented.

I am confident that this first edition of the Technological imagination conference will contribute to pave the way of an innovative and interdisciplinary scientific approach to technology and policies for built environments, considered the real human challenge of the twenty-first century.

Thank you so much for your attention and enjoy the Conference.

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Foreword by Antonio Parenti

New European Bauhaus

Good morning,

Magnificent Rector of Sapienza University of Rome Professor Antonella Polimeni
President Fondazione Roma Sapienza Professor Eugenio Gaudio,
Director Department of Architecture and Design Professor Alessandra Capuano
and others.
Ladies and Gentlemen,

It is my pleasure to address you today and to open this International Conference "Technological Imagination in the digital and green transition" organized by Sapienza University of Rome.

Let me say that the title, the contents, and the proposals envisaged by the Conference match perfectly with the main pillars of the flagship initiative shaped by the President Ursula von der Leyen and launched in September 2021: the New European Bauhaus.

The New European Bauhaus is by nature transdisciplinary: it invites architects, designers, artists, scientists, engineers, artisans and citizens to share their expertise in preparing for the future.

With the New European Bauhaus, we want to make the European Green Deal tangible and "palpable".

We want to add a cultural dimension to the economic and technological transformation. This is essential to achieve our overarching goal: making Europe the first climate neutral continent by 2050. And thus reconciling our way of life with nature.

To get there, we need both: a real transformation of our economy and society, and a debate about how we can live in respect of nature and our planet.

The historical Bauhaus was founded in Weimar and Dessau. It turned into a worldwide movement. This did not happen by chance. Some ingredients of what made the historical Bauhaus a success can also be an inspiration for the New European Bauhaus.

Let me mention three.

The first ingredient: The historical Bauhaus was created in a time of **profound transformation**. People were facing the challenges of industrialisation. Gropius and the founders wanted to respond to the emerging needs of a new era. They aimed for solutions that were functional, affordable, but also beautiful. With this principle in mind, they shaped buildings, fabrics and furniture. They always aimed higher than just innovative design. The New European Bauhaus is also striving for this mix of aesthetics and affordability. But we want to add another element: sustainability. Because the New European Bauhaus wants to match sustainability with style.

Now, the second ingredient: **The historical Bauhaus boldly promoted new materials like steel and cement**. Today, we also need to look into new building materials. But this time, it is about sustainability. It is about materials that need less CO_2 in their production process. The New European Bauhaus wants to accelerate the transition of the built environment. It wants to scale up nature-based materials, to support circular design and architecture. Buildings are responsible for 40% of our energy consumption. And if we manage to change this, we have a chance to keep global warming below 1.5 degrees.

The third important element from the historical Bauhaus is **interdisciplinarity**. We want to convene people from different backgrounds and with different competences to share and grow their ideas and visions. We can create a better tomorrow, if culture and technology, innovation and design go hand in hand.

For our New European Bauhaus, the European Commission needs scientists, activists, artists, designers, architects and entrepreneurs. We want to include the ideas and perspectives of all ages and all backgrounds.

Today, at this conference we can contribute to this evolving New European Bauhaus network.

This project is a project of hope. It is a project of change and of economic transformation.

So I hope that this conference can contribute further to making the transformation happen and to connecting more and more people who want to make it happen.

Thank you very much and have a great conference.

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Foreword by Mario Losasso

Presentation of CONF.ITECH 2022

The green and digital transition represent in the contemporary research field the two new challenges for the evolution of technology within the themes of sociotechnical innovation. Consequently, technology and innovation in contemporary world must adapt to this general objective. Innovation in its hard and digital components once again becomes a central factor in the experimental propulsion that the project is assuming within a processuality and technologies that enable its conception and implementation.

Today, research is increasingly characterised by the need to focus on specialisms that lead to and contribute to the advancement of knowledge and the predictive value of what is studied in the disciplinary fields. However, with respect to the evolving complexity of phenomena, research requires continuous disciplinary interactions to be developed because we understand that one disciplinary field cannot alone address the most important challenges of contemporary society.

New forms of coexistence must be organized in a vision of interdependence and connection, while the green transition requires the definition of the limits of design action and the characteristics of the transformation processes. The new perspective of co-evolution will have to express a design attitude that allows to repair and, where necessary, rebuild the lost links between man, technology and nature.

The green and digital transition represent the two new challenges for the evolution of technology within the themes of social innovation. The Italian society of architectural technology SITdA has been working for a long time on the topics of the relationship between technology and urban and building development within a process-oriented and eco-systemic approach. In the field of technological design of architecture, the scientific society of the technology of architecture has activated research and training sensitivities on the themes of design experimentation framed within process and ecosystem dynamics, aimed at optimising the efficiency of products and processes by reducing inefficiencies and waste.

The SITdA supports research and spin-off outcome on territories through the activities of its scientific clusters. The Scientific Society SITdA has granted its patronage to the CONF.ITECH 2022 Conference, sharing its importance and topicality in view of the new challenges identified in the urban construction and environmental fields by the Next Generation EU Programme and the implementation programmes in the various nations of the European Union.

The topics that will be addressed during the three-day conference are fascinating and challenging, linking innovation, technology, environment, climate change and health.

These topics are strongly interrelated themes in which we are realising that it is impossible to deal with them separately, arriving in the most recent reflections at considering a single health for human beings and for the entire environment which is their living environment.

I would like to remind that the topic of digital culture, nature and technology was the central topic of the SITdA Naples 2020 Conference held last July with a delay due to pandemic difficulties, while the 2022 Conference of the Scientific Society is focused on the topic of the centrality of processes. As we can see, the work carried out in the Departments of Architecture and by the Scientific Societies in the area of architecture is an activity that has picked up significantly, foreshadowing new approaches, new fields of enquiry and new paradigms necessary for the new complexities that constitute the reference scenario of the future.

The experience of this Conference can provide a significant contribution to the sustainable and environmental evolution of the design area in its trans-scalar, multidisciplinary and challenging dimension, overcoming technocratic responses to a demand that requires the integration of the humanistic and technical-scientific dimensions.

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Foreword by Orazio Carpenzano

Welcoming Address from the Dean

On behalf of the Faculty, I wish to thank the organisers for asking me to give this opening address, while congratulating them on their efforts to bring together, in an international encounter, various perspectives on topics of such decisive importance for the future of our respective territories, as well as their people, living organisms and architecture.

My thanks go to Anna Maria Giovenale, Fabrizio Cumo, Eugenio Arbizzani, Carola Clemente, Eliana Cangelli and Francesca Giofrè, who will be giving talks on technological innovation, the environment, climate change and public health.

Thinking of energy in terms of how it relates to architecture during the green and digital transition means cultivating a *technological imagination*, a topic which leads to the broader question of the man–nature relationship and the possibility that architecture, by applying innovative ideas and concepts while promoting a growing social and emotional intelligence of its own, can contribute to inventing of new types of habitat for mankind on the planet earth, under a new pact for survival that allows all elements, both artificial and natural, to coexist in a sustainable balance which can serve as a preventive measure against the intrinsic destructive force of the Cosmos, an especially pressing problem where mankind has neglected certain methods for dissipating the energy of calamitous events made available by both ancient wisdom and scientific advances.

The 2021 Architecture Biennial, entitled "How Will We Live Together?", implicitly drew the attention of visitors to the need for a new approach to the man–nature relationship, following a thorough review of its historical and ethical premises. Hashim Sarkis, the curator of the exposition's seventeenth edition, passed on the following message: "In a scenario of exasperated political divisions and growing economic inequality, we call upon architects to imagine spaces in which we can all live in fruitful fellowship".

The man–nature relationship has always been a distinctive feature of humanistic and artistic thought on things technical, expressed in the construction of the *civitas*, the physical and political synthesis of civilisation. Medieval mysticism viewed nature as a foreboding wilderness, while the Renaissance redeemed the sense of *technè*, and the Romantic Period, with its high-strung, emotive outlook, led to the elaboration of the concept of the sublime.

Controlling and putting to use the energy generated by nature through sources of heat and movement (wind, sun, water), first through manual effort and then using the tools and machines produced by human ingenuity, was also a topic and challenge that led architecture to express, during the Modern Movement, boundless enthusiasm for the theories of Taylorism, which Corbusier summed up by interpreting human dwellings as machines of habitation.

But it is from the time of Vitruvius that architecture, engaged more or less explicitly with the triad of *utilitas-firmitas-venustas*, has addressed the problem of dissipating heat (or thermal inertia), as well as kinetic and elastic energy (in the case of earthquakes), at various latitudes of the globe, drawing on the available resources and raw materials. Historic Italian buildings, for example, built with walls roughly a metre thick and a structural layout measuring 4×4 or 5×5 m, have offered excellent thermo-hygrometric performance (in terms of energy consumption), as well as structural dependability (against seismic risk). In both cases the objective is to "mitigate", a term used by many modern-day scholars, the dissipation of different types of energy.

The history of architecture is filled with archetypes that need to be updated and reinvented. Think of the ingenuity it took to build Venice atop a giant underwater forest, or the aesthetic quality of the Tu'rat walls constructed by Southern Italian peasants, the windmills of Northern Europe and countless other magnificent examples of *swarm intelligence* collected by Bernard Rudofsky in his well-known book *Architecture without Architects: a short introduction to non-pedigreed architecture*, published by Doubleday & Company Inc., Garden City, (in 1964), following an exhibition at New York's Museum of Modern Art. Though, in truth, Roberto Pane and Gino Capponi had already touched on the topic in articles on the architecture of Ischia published in "Architettura e Arti decorative" in 1927, as did Giuseppe Pagano at the Milan Triennial "Rural Italian Architecture", published in the Notebooks of the Milan Triennial by Hoepli in 1936.

Looking beyond the confines of architecture, a recent reconsideration of the topic of Cinema and Energy can provide potentially useful points of affinity with architecture, especially in the collection of essays found in issues 7 and 8 of the periodical Imago, under the title *Cinema & Energy. Interdisciplinary Outlooks Combining Science, Aesthetics and Technology*, edited by Marco Maria Gazzano and Enrico Carocci (and published by Bulzoni in 2013). In an essay entitled *Dissipation and Aesthetic Experience*, the physicist Giuseppe Vitiello, in commenting on the film Transeurope Hotel by Luigi Cinque, writes: "The brain [which leads me to think of *swarm intelligence*] is described as an open system engaged in continuous exchanges

with its surrounding environment. In both models and films, antinomies such as information/knowledge, feeling/knowing, blend with each other in the aesthetic experience, the favourable connection between 'me and the object' that characterises our existential dimension."

Dissipation, therefore, should be seen as part of the evolution of our ecosystem, of our contemporary habitat. It gauges the possibilities for losing and exchanging, through a rekindling of collective emotional intelligence and technical and intellectual micro-revolutions. It is a risk that we must continue to face, as otherwise architecture will die, depriving man of an indispensable tool for managing the complexity of the physical habitat through creativity, in order to transfigure energy in a way that, at times, can prove so unreal, and yet so effective and indispensable, that it leads to the construction of new values and sublime beauty.

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Chapter 73
Energy Efficiency Improvement in Industrial Brownfield Heritage Buildings: Case Study of "Beko"

Jelena Pavlović, Ana Šabanović, and Nataša Ćuković-Ignjatović

Abstract Brownfield sites often form on industrial sites of once successful companies dating from the era of industrialization, due to loss of active function and despite their historical significance. Accompanied by urban decline, they contribute to continuous pollution, decrease in economic values, as well as loss of local identity. On the other hand, they represent a reserve of space of great potential in central urban locations. The main purpose of this research is to examine possibilities for improvement by their reuse, while preserving built-in cultural values and acknowledging contemporary requirements. A review of contemporary literature considering the concept of brownfield sites provides a starting theoretical basis for understanding their strengths and potentials, as well as the problems when redeveloping such sites. The subject of the research is exploring strategies for brownfield revitalization while reactivating industrial buildings through adaptive reuse. This includes sustainable solutions in accordance with modern requirements, especially energy efficiency, as one of the main concepts of existing building stock improvement that recognizes importance of responsible energy resources management. The paper includes a case study of the previously devastated brownfield site of "Beko" industrial building, located in the central urban area of Belgrade. Its former state, as well as parts of the documentation for reconstruction and its conversion into a modern business facility "Kalemegdan Business Center," is thoroughly analyzed, emphasizing the positive results of energy efficiency improvements despite the restrictions intended for historic buildings alterations. The aim of the paper is to create a theoretical platform that provides firm arguments in favor of realizing the importance and potentials of industrial brownfield sites revitalization at present, as well as the constraints regarding its practical implementation considering buildings of cultural value.

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Keywords Sustainability · Brownfield · Industrial heritage · Adaptive reuse · Energy efficiency

73.1 Introduction

After a global shift of paradigm in the industrial processes, once successful companies established during the period of industrialization experienced downfall lacking the resilience to change. It gradually led to the loss of their active function and formation of industrial brownfield sites. With some of the vital functions of the city diminishing, urban decline ensued, deepening the loss of local identity. The very motive for writing this paper is exploring possibilities for reviving industrial brownfield locations by improvements regarding contemporary demands, primarily respecting and preserving their built-in cultural values.

Reinstating an active function of an industrial brownfield is facilitated through the concept of adaptive reuse. Theoretical basis regarding brownfield characteristics, classification, and inventory mainly considers contemporary authors within Serbia and the neighboring region, with respect to the regional specifics on the matter in comparison to developed EU countries.

An overview is given of contemporary strategies for buildings' improvement that is necessary for contemporary purposes, emphasizing energy efficiency as the first and foremost requirement for compliance, with essential legislative framework presented.

The case study presented serves as an example of a building conversion, formerly used for an industry function. After losing its original purpose, it has become part of an industrial brownfield, deteriorating rapidly despite a favorable location within the central region of Belgrade. A previous state analysis and evaluation of industrial brownfield characteristics according to a referent model are included, as well as an assessment of planned and executed works on improving the energy efficiency during the process of adaptive reuse carried out in order to revive the brownfield site.

73.2 Adaptive Reuse and Revitalization of Brownfield Sites of Industrial Heritage

Even regardless of a building's historical significance, treating the existing unused building stock as a resource provides substantial benefits with retaining the built-in materials and embodied energy, thus reducing raw material use, pollution, and waste.

On a larger scale, utilizing inactive central urban capacities contributes to the compactness of the city, optimizing infrastructure and population density, resulting in considerable energy savings, and preventing the urban sprawl at the expense of natural resources.

Adaptive reuse, a contemporary concept of protecting the architectural heritage, represents improvement of the built environment through adaptation for new purposes and requirements, while preserving the identity and intrinsic collective memory. It gains foothold in international conventions regarding industrial heritage, such as the Dublin Principles (International Council on Monuments and Sites (ICOMOS) 2011), and architectural heritage, as in the Leeuwarden Declaration (Architects' Council of Europe (ACE) 2018). It is important for heritage preservation, sustainable urban development, and growing environmental concerns.

In the most developed EU countries, the reuse of urban areas is a priority of spatial development strategies, meeting economic, environmental, and social conditions—the three basic principles of sustainable development. (Danilović et al. 2008) Even though the issue of brownfield sites revitalization has been present globally since 1980s, within the post-socialist countries, it has been considered only since the 2000, due to their transition causing delay (Đukić et al. 2014).

In relation to greenfield investments, brownfield revitalization is a complex process with uncertainties, additional risks, and costs, involving significant private investment and public intervention, while in some cases it is not even possible. However, investing in brownfield sites is a better long-term investment due to increasing economic values of the land in question, less investment in infrastructure, growing employment, and overall activities on the local level. Brownfield sites represent an important reserve of urban space which, if strategically designed in accordance with the actual development capacities, can significantly improve the characteristics of an entire urban area. They are more of an opportunity and a challenge than a problem for the local context.

The ecological load of the brownfield site implies that its decontamination is necessary for the reuse or conversion, unless the pollution is resolved naturally. The need for investments in consolidation of a site can significantly affect its market price, even to its negative value. Liability for environmental pollution can be determined and charged according to the "polluter pays" rule. Since the Republic of Serbia is the inheritor of formerly state-owned companies, a more significant government-funded realization of such consolidations is necessary.

The key problems are stereotypes of unprofitability of investing in brownfield sites, neglect of their spatial potentials as an "inherited burden," lack of development strategies and declarative commitment without practical engagement. Investment models that are supporting greenfield investments and excessive urbanization, with perception through the prism of economic aspects, result in their suburbanization. (Đukić et al. 2014).

73.3 An Overview of Strategies for Buildings' Improvement

Contemporary solutions that can be used to improve existing structures are the same as in new buildings construction, but the implementation is as difficult as the existing conditions and/or conservation requirements are challenging. As shown in Table 73.2, evaluation of the current state is the first step for any strategy, in order to determine the factual state as accurately as possible before selecting applicable measures.

Energy efficiency is one of the basic contemporary requirements, with European legislation on the matter being transmitted into national strategies and regulations of the Republic of Serbia, as part of the Accession to the European Union. The EU Directive 2018/844 (Directive (Eu) 2018) amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency thus were transferred, respectively, into the Law on Planning and Construction (Gazette office of RS 2021), as well as the Rulebook on Energy Efficiency of Buildings (Gazette office of RS 2011), and Rulebook on the Conditions, Content, and Manner of Issuance of Certificates of Energy Performance of Buildings (Gazette office of RS 2018). The European Standard for Conservation of cultural heritage—Guidelines for improving the energy performance of historic buildings (Standard 2016) give further directions regarding acknowledged heritage, although serving only as a recommendation.

The most immediate energy performance upgrades are the enhancements of the envelope with the aim of reducing energy consumption required for heating and cooling. External walls' thermal characteristics are directly advanced by adding thermal insulation. Integrated and interactive façade systems can prevent overheating during the summer and heat loss during the winter but are disputable regarding heritage buildings.

Improving the roof means adding waterproofing and thermal insulation and can include "green roofs." The structures on the ground are amended by performing proper drainage, waterproofing, and thermal insulation. By repairing or replacing doors and windows, their thermal properties can be increased. In the case of buildings with strict conditions for protection of façade elements, these measures are applied accordingly.

Reducing the need for heating, cooling, and ventilation is achieved primarily through the use of passive solar systems, such as: greenhouse, Trombe's wall, or double façade.

The advantages of the latter are reduced energy consumption, comfort, and esthetics, as it is most often used as a design solution when renovating the façades of protected buildings. Passive natural ventilation systems are achieved through appropriate positioning of openings or introducing solutions such as the Venturi effect. When it comes to retrofit, the design of natural lighting is an important component, because most conversions involve changing the elements that affect the entry of daylight, and analysis of daylight is included in all relevant performance evaluations. Further reducing the demand for electricity is accomplished by modifying

electrical installations and equipment according to new purposes and requirements of efficiency.

Due to high share in carbon dioxide emissions, the decarbonization of the building stock in the EU will be mandatory by 2050 according to the Directive 2018/844 (Directive (Eu) 2018).

This implies ever stricter requirements for the building sector and would not be possible without the use of renewable resources that should therefore be promoted in Serbia.

All things considered, one should keep in mind the possible integration of individual solutions, which decreases the amount of space and substructure required. Adapting all applied systems after the final phase of execution of works enables fine-tuning and optimization of the whole instead of maximizing the individual elements.

73.4 Case Study of "Beko"—Kalemegdan Business Center

The case study discloses data on the previously abandoned textile industry facility on Vojvode Bojovića Boulevard in Belgrade, as well as the phase of its conversion into the Kalemegdan Business Center office building, which was completed in 2019 with a comprehensive adaptation of the assembly.

73.4.1 Previous State of Industrial Brownfield

The "Beko" (Fig. 73.1) was built in 1931 and is especially important because of its location in the very heart of the city in Dorćol, within the Belgrade Fortress assemblage, which was declared a cultural monument in 1965 and determined to be immovable cultural heritage of exceptional importance for the Republic of Serbia in 1979. It has lost its active function in 2002 and gradually turned into ruin, despite its advantageous position.

The technical and environmental characteristics of the brownfield location of the Belgrade clothing brand "Beko" building were originally analyzed in the research by Krstić-Furundžić et al. (Krstić-Furundžić et al. 2014) among eleven other industrial brownfield locations in Belgrade. An evaluation was performed according to a selected model, which used technical criteria and brownfield factors to identify properties and priorities significant for their treatment, in support to creating a central register for brownfield refurbishment.

The extracted data for the location in question are listed in Table 73.1.

The data show that "Beko" brownfield site was characterized by moderate environmental impact hazards and having substantial economic potential that would be fulfilled through its adaptive reuse. This would result in increased values, improving

Fig. 73.1 "Beko" building before reconstruction: **a** street view (*Author* Đorđe Kojadinović, RAS Srbija), **b–d** interior and structure. (*Source* Remorker Architects)

Table 73.1 Characteristics of the brownfield location "Beko" (*adapted from* Krstić-Furundžić et al. (Krstić-Furundžić et al. 2014))

Technical criteria	Toxicity of contaminated sites	Concentration in traces, toxicity below 100, bioactive below 500
	Site characteristics	Large volume of waste, low concentration of settlements, existing structure not maintained and cannot be maintained, possible displacement
	Human exposure	High possibility of human exposure—residential neighborhood
	Environmental exposure	Possible exposure of protected habitats
Brownfield factors	Potential for site restoration with benefits	High possibility of renewal
	Possibility of creating public benefit	Creation of amenities at locality required by the local community
	New jobs openings	20–50 new job openings
	Increase in tax revenues	Moderate increase based on mean increase in value or job openings
	Location within or near a poor neighborhood	Site far from underprivileged community

the quality of life for the local community, enhancing both social and environmental sustainability.

73.4.2 Improving Energy Efficiency Within Adaptive Reuse

According to the Technical Description of the Architectural Design for building permit (Kopring 2018a), the evaluation of the current state executed by the Faculty

Table 73.2 Observed building improvement strategies

	Improvement strategies	Applied measures
1	Evaluation	Technical expertise
2	Conservation measures	Issued and respected
3	Envelope enhancements	
3.1	External walls	Façade reconstruction, thermal insulation added
3.2	Roof cover	Flat roof, thermal and hydro insulation added
3.3	Ground structures	Thermal, hydro insulation
3.4	Doors and windows	All new, Al, 3-layer glass
4	Passive systems	
4.1	Passive solar systems	No specific system
4.2	Passive natural ventilation	No specific system
5	Electrical equipment	All new installations
6	HVAC	All new, standard
7	Renewable energy sources	No

of Civil Engineering showed that the six floors high structure was practically in a derelict condition, with no roof construction, roof cover, doors, windows, nor internal installation. Respecting former methods of building, the façade was left without any thermal insulation, and the final layer with façade plastic was in very poor condition. The structure expertise pointed out the need for improvement of the load bearing elements, so the design officially included the structural rehabilitation of the building.

Conditions for conservation, maintenance, and use of cultural heritage and heritage that has status of preliminary protection and protection measures for the preparation of the Detailed Regulation Plan (No. 39/10, dated 09.11.2009) were issued by the Institute for the Protection of Cultural Monuments of Serbia, which provided opportunities and conditions for the transformation that the authors respected throughout the design.

All floors have been completely adapted, in terms of function and construction, and instead of an attic, an additional floor has been formed, as shown in Fig. 73.2.

The Energy Efficiency Study (Kopring 2018b) included detailed calculations for the structure, renewed in a combined structural system—reinforced concrete columns and beams, solid façade walls made of bricks of the old format, massive reinforced concrete finned ceilings. Regarding the improvement of the envelope, in accordance with received requirements for conservation that were not restrictive in terms of retaining the existing façade surface, the design included its complete reconstruction with the addition of stone mineral wool thermal insulation layer, plastering and fabrication of façade elements according to the original appearance. The new façade mimics the look of the original but is made in a modern system. The roofs were planned as flat, laying on reinforced concrete construction, with vapor barrier, rock wool thermal insulation, waterproofing membrane, and mechanical protection. The ground floor was also repaired by performing waterproofing, placing XPS boards for

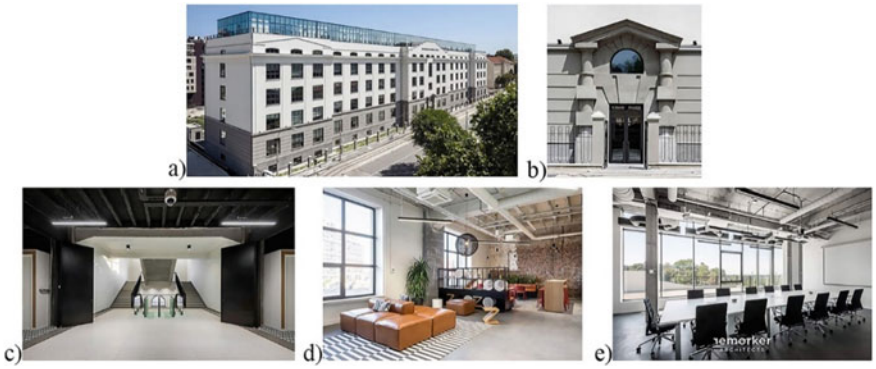

Fig. 73.2 "Kalemegdan Business Center" (ex "Beko") after adaptation: **a** exterior, **b** main entrance, **c–e** interior. (*Source* https://www.gradnja.rs/beko-kalemegdan-business-center-remorker/)

thermal insulation, cement screed, and final floor coverings. Doors and windows of aluminum profiles with thermal break and three-layer low-emission glass package were installed. The document concluded that all individual assemblies of the new thermal envelope met the conditions of the maximum allowable heat transfer and water vapor diffusion.

Existing geometry and position of the building allows for proper insolation, as well as natural ventilation, so no new passive systems were deliberately introduced. Natural lighting was maximized through open space design concept in addition to organizational flexibility. All new electrical and mechanical equipment were installed, ensuring modern-day efficiency. The heating is supplied via district heating system, and renewable sources of energy were not proposed, even though a more substantial utilization of these strategies could have contributed to an even greater advancement.

As the result of improvements, current design puts the building into Energy Performance Class "C," according to national regulations (Fig. 73.3).

73.5 Conclusions

Despite the less strict attitude toward conservation today and existing standards for the application of energy efficiency, industrial brownfield heritage buildings will hardly meet contemporary requirements in terms of environmental certifications that are constantly being improved. Instead of further tightening the rules for values to be achieved, it is more urgent to insist on a greater degree of existing buildings' improvements, through various renovation programs, and with an emphasis on public buildings as representatives of the concept.

The analysis of the "Kalemegdan Business Center" case study undoubtedly confirmed that, despite additional restrictions in the field of architectural heritage

ENERGIJA POTREBNA ZA GREJANJE

TRANSMISIONI GUBICI		**Qt = 466809.01 kWh**
VENTILACIONI GUBICI		**Qv = 753320.53 kWh**
SOLARNI DOBICI	(koristi se)	**Qsol = 155474.2 kWh**
DOBICI OD LJUDI	(koristi se)	**Qp = 80738.62 kWh**
DOBICI OD EL.UREDJAJA	(koristi se)	**Qel = 184334.74 kWh**
ENERGIJA POTREBNA ZA GREJANJE (razlika izmedju gubitaka i dobitaka)		**Qh,nd = 799581.94 kWh**
Energija potrebna za grejanje po m²		**Qh,an = 41.59 kWh/m²a**

Energetski razred

Za usvajanje energetskog razreda koristi se specifična godišnja energija potrebna za grejanje za sisteme koji rade bez prekida

En. razred	Qh.rel = 64.0 %	Qh = 41.59 kWh/m²
A+	<=15	<=10
A	<=25	<=17
B	<=50	<=33
C	**<=100**	**<=65**
D	<=150	<=98
E	<=200	<=130
F	<=250	<=163
G	>250	>163

Na osnovu energije potrebne za grejanje po m², objekat spada u C energetski razred

Energent	**Daljinsko grejanje na fosilna goriva**
Faktor pretvaranja	**1.8**
Primarna energija	**2187946.75 kWh**
Emisija CO_2	**822945.70 kg CO2**

Fig. 73.3 Excerpt from the energy efficiency study—energy performance class (EPC) evaluation (Kopring 2018b)

protection, the potentials for improving the built environment through the revitalization of industrial brownfields by adaptive reuse are substantial. Furthermore, the application of measures for improving energy efficiency realized in this particular case met the set requirements for new construction in Serbia of a minimal "C" Energy Performance Class. This is still far from the coveted concept of energy-neutral buildings but represents a significant achievement since it is not mandatory for buildings of cultural heritage.

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