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REGENERATIVE ECONOMICS IN THE BUILT ENVIRONMENT: FOCUSING ON NET-POSITIVE IMPACT

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Abstract: *Environmental discourse has evolved from "green" to "sustainable" to "circular" approaches. Regenerative economics extends these paradigms by shifting the focus from damage minimisation toward value creation and net-positive impacts for ecosystems, economies, and human wellbeing. This paper revisits regenerative economics by distinguishing its normative role from its evaluative criterion: regenerative economics proposes the direction of development, while net-positive impact assesses whether this direction is realised in practice. Improved system performance reduces environmental pressures while simultaneously increasing productivity, demonstrating that environmental progress can arise as a by-product of innovation, optimisation, and improved information flows rather than constraint or sacrifice. Using the built environment as an analytical framework, the paper examines how engineering optimisation, digital information systems, and infrastructure integration expand resource productivity at both building and system scales. It further argues that institutional capacity is an important factor in translating technological potential into positive outcomes. Overall, the findings suggest that innovation-driven regeneration aligns environmental improvement with economic performance and indicators of human wellbeing, offering a coherent alternative to environmental strategies focused on constraint and damage minimisation.*

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1. Introduction and background

Environmental thinking concepts have diversified over the past decades. The "green" paradigm emphasised mitigating harm, "sustainability" focused on long-term endurance, and "circularity" promoted closing material loops (Geissdoerfer et al., 2017). Influenced by ecological design (Mang and Reed, 2012) and systems resilience (Folke et al., 2010), the regenerative paradigm moves beyond damage reduction and efficiency improvements. Rather than defining success through reduced impacts or neutrality, regenerative economics focuses on generating net-positive environmental and societal outcomes. Within Sessa's framework, regenerative economy is not defined by impact neutrality but operationalised through net-positive effects as a necessary condition for regenerative outcomes (Sessa, 2025).

In this context, regenerative economics provides a normative framework for development, while net-positive impact functions as the operational criterion for evaluating whether this normative intent is realised in practice. Net-positive impact refers to a condition in which development processes are assessed as generating environmental and societal benefits that exceed associated negative impacts over time, thereby improving indicators of human wellbeing rather than merely reducing harm (Birkeland, 2008). Regenerative economics thus suggests how socio-technical systems ought to function over time, requiring a positive balance in which humanity is treated as an integral component of the biosphere rather than as an external disturbance.

While regenerative economics is often framed around environmental, economic, and social dimensions, this paper adopts a deliberately focused analytical scope in which social outcomes are considered primarily through human wellbeing, living standards, and welfare, as commonly used in innovation- and productivity-oriented economic analysis. Accordingly, net-positive impacts are assessed at the meso level, where environmental and development outcomes emerge from the interaction of multiple technological, institutional, and spatial subsystems. From this perspective, the built environment is adopted as the object for examining regenerative dynamics. Beyond individual construction projects, it comprises interconnected systems of buildings, infrastructure, energy and water networks, materials, and long-term governance arrangements, within which environmental, social, and economic outcomes primarily emerge through the operation and evolution of interdependent systems over time.

Debates about climate change and resource scarcity still often rely on the contested assumption that a finite planet demands finite growth. Yet this view confuses physical limits with economic limits. Economic performance depends primarily on knowledge, design, and institutional arrangements, not on limited resource stocks. At the same time, technological optimisation alone does not

automatically translate into improved wellbeing or environmental outcomes. Its regenerative potential depends on institutional arrangements (in the broadest sense) that shape how efficiency gains are translated into long-term improvements. Without such conditions, efficiency gains may be neutralised by rebound effects, technological lock-in, or social and spatial limitations. Regenerative economics therefore situates climate mitigation within a broader developmental logic, in which environmental improvement is part of the effort to improve human wellbeing.

Examples from environmental history show that productive and culturally rich societies have often emerged in naturally challenging environments when knowledge, engineering, and institutional coordination were adequate (Diamond, 1997). A striking case is Venice: building the city required vast quantities of timber pylons from the Karst forests, which were effectively exhausted and never regenerated. This example is not presented as an environmental best practice, but as a civilisational illustration of how resource transformation, mediated by knowledge and institutions, can generate long-term value that exceeds local environmental losses. Rather than being attributable to a single intervention, this outcome emerged through the long-term interaction of technological capabilities, institutional arrangements, and spatial configurations such as urban form, location, and infrastructure. In this sense, the case reflects a central insight of regenerative thought: societies strive not merely for survival but for flourishing, opportunity, and dignity. Certain forms of environmental transformation, when embedded within appropriate technological and institutional frameworks, can therefore yield long-term gains that outweigh the local loss of natural resources.

This paper revisits regenerative economics in the built environment, with human wellbeing as the primary evaluative objective. The central research question is whether regenerative approaches – combining innovation, engineering optimisation, and institutional evolution – can reduce environmental pressures while simultaneously sustaining economic performance and improving wellbeing when assessed at the level of integrated built environment systems. The paper links ecosystem-integrated approaches, technology, and institutions to improved system performance, reduced environmental pressures, and higher productivity.

2. Planetary boundaries, human creativity, and innovation

Concerns about planetary boundaries (Rockström et al., 2009) and global warming are scientifically grounded, yet they are frequently interpreted in a deterministic manner, implicitly assuming that once biophysical thresholds are identified, social and technological responses are fixed or insufficiently adaptive. Human societies, however, advance by accumulating knowledge, and knowledge continuously expands the feasible production frontier. Laplace's insight that "what we know is little; what we do not know is immense" (Laplace, 1951) captures this asymmetry between existing knowledge and the infinite opportunities for future discoveries on a physically finite planet.

Modern innovation theory confirms this dynamic. Technological progress repeatedly alters production functions, introduces new resource substitutes, and opens solution spaces that were previously inconceivable. Constraints identified at any given

moment therefore rarely remain permanent. Instead, scientific advances, new materials, improved designs, and institutional reforms continually push technological possibilities forward, transforming perceived limits into drivers of innovation.

Empirical evidence supports this view. The Simon Abundance Index documents long-term improvements in resource abundance measured through declining time-prices of essential commodities, driven by innovation, trade, and improved extraction and processing technologies (Tupy and Pooley, 2022). Scarcity has historically triggered adaptive responses rather than collapse.

Institutions play a decisive role in shaping how societies respond to such constraints. Research in institutional economics demonstrates that decentralised decision-making, competition, and entrepreneurial discovery outperform central planning in allocating resources and generating innovation (Hayek, 1945; North, 1990). Rational environmental policy therefore prioritises interventions with the highest welfare returns, consistent with comparative assessments such as Lomborg's prioritisation analyses (Lomborg, 2023).

Within regenerative economics, constraints are understood as stimuli. Environmental progress is co-produced with technological and institutional innovation rather than achieved through economic contraction. Historical experience suggests that prolonged reductions in economic activity are often associated with adverse social outcomes. Evidence from economic history links such periods to deteriorating public health (Mokyr, 1990) and reduced educational opportunities (Crafts, 2004), while macroeconomic analyses indicate a diminished capacity to invest in cleaner and more efficient technologies during extended downturns (DeLong, 2022). Movements that resisted technological change or sought to roll back industrial development have rarely produced sustained environmental or social gains; instead, they crippled the mechanisms that enable societies to escape poverty and improve wellbeing.

3. Engineering, digital information, and the productivity engine of regeneration

Engineering has historically played a central role in improving human wellbeing. Safe water, resilient structures, sanitation, transport networks, and energy systems form the material foundation of modern living standards (Smil, 2017). Across these domains, a core principle of engineering practice has been material and labour efficiency: achieving greater functionality, safety, and performance with fewer resources. This logic long predates contemporary environmental policy and reflects a continuous effort to optimise system performance under technical, economic, and physical constraints.

A classic illustration is the comparison between the Eiffel Tower (1889) and the Tokyo Tower (1958). Despite similar height and structural requirements, the Eiffel Tower required approximately 10,000 tons of iron, whereas the Tokyo Tower achieved comparable performance with roughly 4,000 tons of steel. This reduction in material intensity resulted not from environmental considerations but from advances in materials science, structural analysis, and design optimisation

driven by the price mechanism. Improved understanding of load paths and material behaviour enabled engineers to deliver equivalent functionality with substantially less material, illustrating a broader historical pattern in which engineering progress systematically reduces resource intensity while improving performance (Ashby, 2013).

Digital technologies amplify this long-standing trajectory. Building Information Modelling (BIM), digital twins, and data-driven design environments integrate geometric representation with material properties, cost data, life-cycle impacts, and operational performance metrics. These tools transform the built environment into an information-rich system in which design decisions can be evaluated across multiple dimensions simultaneously. Environmental performance thus emerges not as an external constraint, but as a measurable outcome of improved coordination, optimisation, and knowledge integration. Empirical studies show that early-stage optimisation using integrated digital tools can significantly reduce embodied carbon by enabling earlier and better-informed material and system choices, without sacrificing functionality (Azhar, 2011; Krygiel and Nies, 2008; Röck et al., 2020).

Similar dynamics operate at the level of urban and regional infrastructure systems. Decarbonisation increasingly proceeds through system-wide integration rather than isolated technological upgrades. Electrification of public transport and the deployment of smart energy networks have been shown to reduce emissions while improving system efficiency and reliability (IEA, 2019). Integrated assessments further indicate that such system-wide transformations can deliver broader productivity gains at urban and regional scales (IPCC, 2022). Coordinated upgrades of the built environment – such as improved insulation standards, prefabrication, low-carbon materials, and construction standardisation – have delivered long-term emissions reductions alongside increased resilience and growth in construction-related knowledge and export capacity (IEA, 2019).

The built environment is particularly significant for regenerative transformation because it concentrates both mitigation and adaptation challenges within a single, long-lived system. Climate mitigation requires low-carbon buildings and materials, while adaptation depends on resilient infrastructure capable of withstanding increasing environmental stresses. Empirical analyses consistently show that the construction sector plays a central role in planning, construction, renovation, and renewal processes within the built environment (IEA, 2019). Empirical research further indicates that investments in infrastructure can simultaneously enhance climate resilience and support economic development, positioning construction as a dual-benefit sector (Hallegatte et al., 2019). A Deutsche Bank Research analysis similarly characterises construction as a "double winner" of climate change, noting that decarbonisation drives demand for new building technologies and materials, while climate adaptation stimulates sustained investment in resilient infrastructure (Deutsche Bank Research, 2021).

Taken together, these examples demonstrate that technological and informational advances can reduce CO_2 emissions as natural by-products of improved engineering practice driven by economic reasons. Within regenerative

economics, enhanced system performance – enabled by engineering optimisation and digital information – can simultaneously reduce environmental pressures and increase productivity, thereby contributing to higher levels of human wellbeing.

4. Regenerative value creation and the role of cross-reis

Regenerative economics reframes environmental policy by shifting attention from impact minimisation to value creation at the level of integrated socio-technical systems. While engineering optimisation and digital technologies can substantially improve system performance, technological progress alone does not guarantee regenerative outcomes. Whether efficiency gains translate into sustained environmental improvement and higher levels of indicators of human wellbeing depends critically on institutional arrangements that shape incentives, investment decisions, and the diffusion of innovation over time.

Human aspirations for safety, prosperity, and improved living standards remain a powerful and empirically persistent driver of development. Political and sociological research consistently shows that populations prioritise material wellbeing, opportunity, and security, even under conditions of environmental stress (Inglehart, 2018). Xi Jinping's statement that "people's aspirations for a better life will not change" captures this broader empirical regularity. From a regenerative perspective, environmental strategies that conflict with widely shared aspirations for improved living conditions are unlikely to be socially durable or politically stable.

The last century delivered unprecedented improvements in nutrition, education, shelter, and connectivity (Rosling et al., 2018). The central risk today lies not in economic growth itself, but in weakening the institutional mechanisms—innovation systems, markets, science, engineering practice, and research environments—that enabled these gains. Regenerative economics therefore explicitly rejects de-growth approaches that prioritise economic contraction as a primary environmental strategy. Empirical analyses indicate that degrowth strategies are unlikely to provide an effective or efficient route to environmental improvement, and may undermine welfare and the institutional and political conditions required for sustained environmental progress (van den Bergh, 2017).

Instead, regenerative economics emphasises institutions that enable innovation-driven value creation: secure property rights, competitive markets, research funding, skills development, and governance frameworks that reward improvements in system performance rather than symbolic compliance. Institutions thus act as the mediating layer between engineering potential and realised outcomes. High-performance technologies can either amplify regenerative effects or remain marginal depending on whether institutional conditions support learning, scaling, and long-term system optimisation.

Institutional capacity plays a decisive role in determining whether engineering optimisation and digital technologies translate into sustained regenerative outcomes. Projects such as CROSS-REIS illustrate how research cooperation, skills development, and digital competence strengthen the conditions under which system-

level performance improvements can emerge over time. Such initiatives do not create net-positive impacts directly; rather, they enable their realisation by supporting learning, diffusion, and long-term optimisation.

5. Discussion and Conclusion

Environmental challenges can be productively approached as engineering and innovation problems rather than as civilisational limits. The analysis supports the argument that innovation-driven regenerative approaches in the built environment can reduce environmental pressures while sustaining economic performance and improving wellbeing. Societies can innovate out of constraints when institutions support creativity, competition, and knowledge exploitation. Policies explicitly aligned with human wellbeing objectives may also generate environmental co-benefits when institutional and technological conditions are supportive.

Regenerative economics provides a coherent framework for aligning environmental objectives with human development. It recognises environmental risks without resorting to alarmism and acknowledges biophysical constraints without assuming stagnation. Crucially, it identifies innovation, rather than austerity or contraction, as the primary mechanism through which CO_2 emissions can be reduced while welfare continues to improve.

Policy implications follow. First, prioritisation is essential: resources should flow to interventions with the highest welfare returns, a principle supported by comparative assessments (Lomborg, 2023) and echoed in arguments that climate policy should focus on high-impact technological pathways rather than symbolic interventions (Gates, 2021).

Second, engineering optimisation and digital information systems represent low-cost, high-impact levers for emissions reduction and should remain central to climate policy. High-quality engineering delivers durable, efficient, and materially lean solutions whose benefits far exceed those produced by bureaucratic compliance or formalistic scoring systems. A regenerative policy approach, therefore, strengthens the role of engineering judgement, ensuring that real performance improvements take precedence over symbolic targets.

Third, institutional capacity remains a decisive enabling condition. Innovation-oriented research environments, skills development, and open markets determine whether technological potential translates into sustained regenerative outcomes. Conversely, policies that weaken scientific, technological, or economic institutions risk undermining the mechanisms that historically improved living standards and environmental performance.

Humanity today lives longer, safer, and more meaningful lives than at any point in history. The task is to carefully improve—rather than dismantle—the mechanisms that produced this progress. Regenerative economics provides a structured framework for doing so by integrating engineering insight, economic incentives, and digital technologies to enhance system performance, reduce environmental pressure, and

improve human wellbeing simultaneously. It shifts policy attention from abstract environmental targets toward concrete human outcomes.

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REGENERATIVNA EKONOMIJA U IZGRAĐENOM OKRUŽENJU: FOKUS NA NETO POZITIVAN UTICAJ

Apstrakt: *Diskurs o životnoj sredini evoluirao je od „zelenih", preko „održivih", do „cirkularnih" pristupa. Regenerativna ekonomija nadograđuje ove paradigme pomeranjem fokusa sa minimizacije štete ka stvaranju vrednosti i ostvarivanju neto pozitivnih uticaja na ekosisteme, privredu i blagostanje ljudi. U radu se preispituje koncept regenerativne ekonomije kroz razlikovanje njene normativne uloge i evaluacionog kriterijuma: regenerativna ekonomija definiše pravac razvoja, dok neto pozitivan uticaj omogućava procenu u kojoj meri se taj pravac ostvaruje u praksi. Unapređenje performansi sistema doprinosi smanjenju pritisaka na životnu sredinu uz istovremeno povećanje produktivnosti, pokazujući da napredak u oblasti zaštite životne sredine može proisteći kao posredan rezultat inovacija, optimizacije i unapređenog protoka informacija, a ne nužno kao posledica ograničenja ili odricanja. Koristeći izgrađeno okruženje kao analitički okvir, u radu se razmatra kako inženjerska optimizacija, digitalni informacioni sistemi i integracija infrastrukture doprinose povećanju produktivnosti resursa, kako na nivou pojedinačnih objekata, tako i na nivou celokupnih sistema. Pored toga, ističe se da institucionalni kapacitet predstavlja važan faktor u pretvaranju tehnološkog potencijala u pozitivne rezultate. Sveukupno, nalazi ukazuju na to da regeneracija zasnovana na inovacijama omogućava usklađivanje unapređenja životne sredine sa ekonomskim performansama i pokazateljima blagostanja ljudi, nudeći koherentnu alternativu strategijama zaštite životne sredine koje su prvenstveno usmerene na ograničenja i minimizaciju štete.*

Ključne reči: *regenerativna ekonomija, neto pozitivan uticaj, sistemi izgrađenog okruženja, inženjerska optimizacija, digitalne tehnologije, tehnološke inovacije, blagostanje ljudi.*