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Article

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Abstract

As a newly established instrument of EU Cohesion Policy, the Just Transition Fund (JTF) aims to support regions most affected by the transition to climate neutrality. This study examines Baranya County in Hungary, where eligibility was primarily driven by the cement industry. The research investigates the economic and labor market impacts of recent regulatory changes—specifically supplementary mining royalties and CO_2 tax—on stakeholders in the cement and lime sectors. Using survey data from affected production units and industry trend analysis, the findings reveal substantial financial losses among local enterprises, prompting operational restructuring and reduced output. This decline in domestic cement and lime production is expected to cause job losses and the emigration of skilled labor, especially engineers. The anticipated reduction in national production capacity may lead to increased reliance on imports, driving up construction costs. Additionally, financial pressures on domestic producers threaten their competitiveness, potentially resulting in temporary plant closures. These closures are likely to affect the wider regional supply chain, forcing SMEs to downsize or suspend operations. In conclusion, the study highlights a convergence of economic risks, including brain drain and industrial contraction, that undermine the goals of the Just Transition and require targeted policy responses.

Keywords: regional policy; regional planning; green transition

1. Introduction

The Just Transition Fund (JTF) is a newly introduced financial instrument under the EU's Cohesion Policy, developed for the 2021–2027 programming period as the first pillar of the Just Transition Mechanism (JTM) within the European Green Deal. Its central aim is to support the EU's transition to climate neutrality by 2050 [1]. The JTF operates under shared management between the European Commission and Member States and is complemented by other financial tools such as the Just Transition scheme within InvestEU [2], and a centrally managed public sector loan facility in cooperation with the European Investment Bank (EIB) [3,4]. Together, these instruments are intended to stimulate investment in the most affected regions.

The Fund specifically targets territories facing high greenhouse gas emissions or significant industrial dependency on fossil fuels and carbon-intensive sectors. In accordance with the broader goals of Cohesion Policy, the JTF is meant to prevent deepening regional disparities while managing the impacts of structural transformation. It focuses on all sectors—such as energy, industry, transport, agriculture, and construction—that are impacted by the green transition. While the JTF does not directly finance decarbonization technologies, it significantly contributes to the EU's long-term climate goals by supporting mitigation of the social and economic consequences of industrial decline [5]. The eligible regions may change over time, as Member States can propose additional territories in accordance with progress toward the Green Deal objectives.

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In Hungary, three counties—Baranya, Borsod-Abaúj-Zemplén, and Heves—were designated as eligible for JTF support, with this decision adopted by the Hungarian Government on 26 August 2021. These counties submitted Territorial Just Transition Plans (TJTPs) under the Environmental and Energy Efficiency Operational Program Plus (KEHOP+) for European Commission approval. Baranya County was selected primarily due to the presence of carbon-intensive industries, while the other two are characterized by their dependency on lignite. Following feedback from the European Commission, the TJTPs were revised through collaboration between two departments of the Prime Minister's Office and the Northern Hungary Coal Region Committee, supported by a LIFE-IP project.

In each Member State, the selection of the affected NUTS3 regions was grounded in statistical analyses assessing territorial vulnerability. These analyses considered not only historical emissions and fossil fuel dependence—such as coal mining and fossil-based power generation—but also the socioeconomic risks associated with transition, including unemployment, income levels, and demographic trends. In Hungary, Baranya County represents a region undergoing a complex industrial transition with persistent developmental challenges. Historically one of Hungary's most prosperous regions due to its mining activities, Baranya has since failed to undergo a successful economic transformation. Although rich in natural resources such as black coal, uranium, and thermal water, the post-industrial period has seen a marked economic decline. Per capita investment remains well below national and EU averages, and the region has experienced a steady downward trajectory.

The region's industrial stagnation has constrained the integration of local innovation capacities, most notably those of the University of Pécs—the largest employer in the county with approximately 6,600 employees. Despite its role as a regional knowledge center, the university's economic contribution is hindered by the absence of strong industry partners. Baranya remains one of Hungary's most underdeveloped regions, marked by weak labor market conditions, high unemployment, and a significant share of inactive population. The regional economy is overdependent on the service sector, with underdeveloped industrial capacity and minimal investment in R&D and innovation. The SME sector is fragmented and undercapitalized, and a substantial portion of the active workforce is employed in the public sector. Due to low employability, especially among the low-skilled population, many working-age individuals remain inactive.

These negative economic dynamics are reflected in the region's demographic profile. Baranya is experiencing accelerated population decline and the outmigration of skilled individuals. The population dropped from 417,000 in 1990 to 353,000 by 2024 [6]. The outflow of highly educated workers and the aging population structure reduce regional economic dynamism, weaken the labor supply, and diminish long-term competitiveness. Although the University of Pécs attracts a considerable number of young people, its economic effect is weakened by a growing mismatch between educational outputs and regional labor market demand [7]. A large proportion of university graduates leave the region after completing their studies.

The unemployment rate in Baranya is consistently above the national average, and youth unemployment (ages 15–29) is particularly critical. In 2023, the youth unemployment rate in the Southern Transdanubia region reached 13.1%, compared to the Hungarian national average of 8.1% and the EU average of 11.2% [8]. The socioeconomic conditions in Baranya resemble those found in other post-industrial regions in Europe that have undergone similar transitions since the decline of traditional heavy industries. The development of entrepreneurial ecosystems, particularly those built around universities, has proven to be an effective policy response in such contexts [9,10]. Business incubators following the entrepreneurial university model can help align academic resources with market needs. However, in Baranya, a coherent innovation ecosystem has yet to emerge.

The current hypothesis guiding this research is that Baranya's economic and social challenges could be addressed through a functional integration between market actors and a reoriented university model. A regional innovation framework that supports knowledge transfer, entrepreneurial activity, and workforce retention could help mitigate economic decline. Currently, highly educated individuals cannot find employment aligned with their qualifications, while low-

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skilled workers are largely excluded from the formal economy. This dual exclusion reinforces the depressive labor market situation. Outmigration is further accelerated by low wages and limited career prospects. The economic structure of the county is heavily concentrated around the city of Pécs, which, despite infrastructural improvements in recent years, remains geographically disadvantaged due to its poor connectivity to national and international transport corridors.

In summary, Baranya County exemplifies the challenges that the Just Transition Fund was created to address. While the TJTP framework offers important resources, successful implementation will depend on aligning national strategies with regional realities. This study focuses on the region's transition dynamics and investigates the structural obstacles that may hinder the effectiveness of JTF-supported interventions.

2. Materials and Methods

Over recent decades, the cement industry has undergone enormous growth. Global cement output in the late 20th century was around 1 billion tons per year, rising to approximately 1.8 billion tons by the mid-2000s [11]. This exponential increase has continued into the 21st century, with China alone accounting for over half of worldwide cement production by 2019, while the entire European Union contributes only a small fraction (with Germany being the largest European producer) [12]. In parallel, the U.S. cement sector experienced a significant expansion in the 1990s. Cement consumption is often regarded as an economic barometer: as a country's GDP grows, cement usage tends to rise in tandem. For example, in Hungary the long-term average cement use is about 3 million tons per year, climbing up to ~4.5 million tons during construction booms. These trends reflect fundamental drivers on both global and national scales. Key factors fueling cement demand include:

- Population Growth - The world population (now ~8 billion) is projected to approach 10 billion by 2050, increasing the need for housing and infrastructure.
- Urbanization and Living Standards - By 2050, roughly 2 billion additional people are expected to live in cities, expanding urban construction at unprecedented scale.
- Climate-Resilient Construction - The urgency of climate change has created high demand for sustainable building solutions and spurred the emergence of innovative low-carbon technologies in construction.
- Infrastructure Development - There is growing demand for both new infrastructure and the rehabilitation of existing structures, which together drive cement consumption.

Decarbonization Imperatives and Technological Innovation

Despite robust demand, the cement industry faces mounting pressure to reduce its carbon footprint. Meeting surging construction needs while aligning with climate neutrality goals requires significant technological and operational changes. The sector is a major source of CO_2 emissions, both from fuel combustion and from the calcination process inherent in cement production. Achieving carbon-neutral cement production by 2050 necessitates substantial product and process innovation, backed by intensive research and development. Studies indicate that it is in the industry's long-term economic interest to proactively pursue climate-friendly transformation rather than risk the costs of inaction [13]. Crucially, several technology pathways have been identified to reconcile production growth with emissions reduction [14]. These include1:

- **Alternative Fuels:** Transitioning from coal and other fossil fuels to alternative fuels such as biomass, municipal solid waste-derived fuel (RDF), and even hydrogen for kiln heating. Modern Hungarian cement plants are already equipped to utilize up to 100% alternative fuels, processing wastes like plastics, rubber, and sewage sludge instead of coal. This not only cuts CO_2 emissions but also supports a circular economy by diverting waste from landfills.

[1] Oral: Tamás Hoffman, President, Cement, Concrete and Lime Industry Association, 2024.04.09

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- **Alternative Raw Materials:** Partially substituting or supplementing traditional clinker with industrial by-products or other additives (e.g. fly ash, slag, or decarbonized materials) to reduce the limestone required and thereby lower process emissions.
- **Green Electrification:** Reducing the carbon footprint of cement production's electrical energy use by increasing the share of renewable electricity and improving energy efficiency. This may involve on-site renewable generation and energy storage to ensure a reliable low-carbon power supply.
- **Cleaner Transportation:** Lowering emissions from the transport of raw materials and products by adopting electric or hydrogen-fueled vehicles for quarrying operations and cement distribution. Given that transportation currently accounts for a small but non-negligible portion of cement's CO_2 emissions, greener logistics can further shrink the industry's overall carbon impact.

Through such measures, the cement industry can significantly cut its greenhouse gas emissions. For instance, carbon capture and storage (CCS) is being piloted in Europe to address the process emissions from calcination. Indeed, the world's first zero-emission cement plant (using CCS) is slated to begin operation in Norway, indicating the rapid technological advances underway. The Hungarian cement sector, having modernized its major plants in the past 15 years, is well-positioned to implement many of these innovations. Nevertheless, aligning the industry with climate targets will require not only technology adoption but also considerable capital investment and supportive policies.

Policy and Economic Challenges

In addition to technological hurdles, Hungarian cement producers have recently encountered economic and regulatory challenges that complicate their transition to sustainability. Notably, a series of special taxes and government interventions targeting construction materials have imposed significant financial burdens on the cement sector. The most consequential of these measures is the supplementary mining royalty introduced in July 2021. This policy effectively capped the domestic cement price at 20,000 HUF per ton, and any portion of the sale price above that cap is now appropriated at a 90% tax rate [15]. Carbon quota tax introduced in 2023, the government imposed a tax of €40 per tonne on all industrial companies that emit more than 10,000 tons of carbon dioxide per year and have a free EU quota of half of their total emissions. This tax is retroactive and must be paid for the full year [16]. Official price and price caps - the government has introduced an official price of 20,000 HUF/tone for cement, which is on average 30% lower than the cost price of cement products [17].

In summary, the literature indicates that the cement industry's evolution is shaped by robust demand growth and the imperative to drastically cut emissions. Technological solutions exist to decarbonize cement, but they require large investments and supportive policy frameworks. Hungary's cement sector exemplifies this global challenge on a national scale: it has made strides in efficiency and alternative fuel use yet must navigate the dual pressures of investing for a low-carbon future and coping with near-term economic headwinds. Continued research and policy dialogue are needed to ensure that the cement industry can remain both economically viable and environmentally sustainable on the road to 2050.

Baranya County's eligibility for support from the Just Transition Fund (JTF) rests on a dual rationale. First, the region has suffered prolonged socio-economic decline following the decommissioning of coal mining activities in the 1990s. Second, Baranya exhibits disproportionately high carbon dioxide emissions, primarily due to intensive cement production operations [5]. The county is home to three major cement-producing facilities:

- Királyegyháza Cement Plant (Holcim): Approx. annual CO_2 emissions: 500,000 tons
- Beremend Cement Plant (Duna-Dráva Cement – DDC): Approx. annual CO_2 emissions: 500,000 tons
- Beremend Lime Plant (Carmeuse): Approx. annual CO_2 emissions: 300,000 tons

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To assess the sectors responsible for greenhouse gas (GHG) emissions within Baranya, we utilized data from the Hungarian National Environmental Information System (OKIR), specifically its Air Quality Protection Information Module (LAIR). Between 2014 and 2020, and particularly in the years 2019–2020, three industrial sub-sectors accounted for approximately 94% of total county-level emissions:

- Cement, lime, and gypsum manufacturing (approx. 80%)
- Steam and air conditioning supply (7–8%)
- Wood, cork, and wickerware manufacturing (7–8%)
- Transport infrastructure construction (roads and railways) also ranked among the higher-emitting sectors during 2014–2016.
- The construction sector at large, as the primary downstream consumer of cement, is indirectly implicated in the county's emissions profile.

Thus, cement production is the leading direct contributor to CO_2 emissions in Baranya and exerts a secondary influence on emissions through its link to the construction industry. Within the framework of the JTF, funding is targeted toward supporting small and medium-sized enterprises (SMEs). Accordingly, the EU financial instruments are not intended to directly support large cement producers. Instead, these firms are expected to pursue their transition through the second and third pillars of the Just Transition Mechanism (JTM), while the first pillar (JTF) focuses on bolstering the capacity of their supply chains and subcontractors.

Given the introduction of new national regulatory instruments, we hypothesize that these policies exert a significant influence on the operational viability of the cement plants in Baranya, with downstream effects on their supplier and subcontractor networks. This dual impact is expected to manifest in the implementation of Hungary's JTF program, planned as Priority Axis 5 of the Environmental and Energy Efficiency Operational Programme Plus (KEHOP+). The program is designed to support transition pathways in the following areas:

- Investment in workforce reskilling and upskilling
- Promotion of green economic diversification, technological shifts, R&D, and innovation
- Development of renewable energy infrastructure
- Support for environmentally sustainable household energy production and consumption

We anticipate that if cement manufacturers reduce production volumes in response to regulatory or economic pressure, this may trigger reductions in procurement from subcontractors and suppliers. These ripple effects may, in turn, compel affiliated SMEs to pursue alternative business strategies or exit the market altogether. Furthermore, such developments are likely to affect the internal workforce of large producers and delay their decarbonization progress. A potential benefit, however, is the reduction in CO_2 emissions. These factors must be critically considered in the design of training and retraining programs, as well as in initiatives promoting green diversification and technology transitions.

This study investigates the validity of the above assumptions. Our analysis is based on a structured survey conducted among relevant production units in Baranya County, complemented by a review of industry-wide trends, with particular focus on the cement and construction sectors.

3. Results and Discussion

All three companies operating in Baranya County, as well as the Hungarian Cement, Concrete and Lime Industry Association, were contacted with a questionnaire. No response was received from Duna-Dráva Cement (DDC). Due to considerations of corporate confidentiality, individual company responses cannot be disclosed in detail; however, our conclusions based on the aggregated data can be shared. The responses pertain to the year 2024, while data for 2025 are based on estimates only.

The answers were evaluated in response to the following questions, which were categorized into three main thematic groups:

1. Questions related to workforce impact:

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- To what extent were employees laid off in the industry in Baranya County in 2024 (as a percentage of the total workforce)? How many individuals does this represent?
- Among the various segments of the workforce, which groups were affected by the wave of layoffs in 2024, and to what degree?
- What alternative measures have production units implemented to mitigate the impact of reduced production on employment? What was the distribution (%) of these measures in terms of workforce retention?
- If the company engages in the international secondment of labor to cement factories in other countries, for which types of employees is this already occurring, which categories are planned for future deployment, and to what extent?

2. Questions regarding the impact on suppliers/subcontractors:

- Which categories of suppliers and subcontractors—classified by industry group—are affected by the above-mentioned developments? How many companies are impacted in each supplier type?
- What level of workforce downsizing is expected among suppliers and subcontractors in each industry group (expressed as a percentage)?

3. What other negative effects are anticipated?

Key Findings Based on the Survey Responses:

1. Workforce-Related Observations:

In 2024, an 8% workforce reduction was reported in highly automated operational areas. In one case, an entire engineering staff was laid off, while another plant reassigned its engineers to international production units within the same corporate group. However, a substantial portion of maintenance and operational activities—such as quarry logistics, rail operations, cleaning, scaffolding, kiln lining, landscaping, and site security—are outsourced to subcontractors. As a result, workforce reductions predominantly affect these small and medium-sized enterprises (SMEs).

Employees expected to leave in 2025 are unlikely to be replaced. Companies intend to manage the resulting labor gaps through internal reorganization. The anticipated wave of layoffs will primarily impact skilled blue-collar segments. Nevertheless, production units are actively seeking to avoid redundancies by applying alternative measures to absorb the impact of declining production volumes.

One common strategy involves the reallocation of employees within the corporate group—both domestically and internationally. Wage growth has been kept moderate, with budgets approved below the inflation rate. Companies anticipate reductions in training and development efforts, limiting activities to legally mandated programs only.

Drastic cuts are also expected in local community support programs, including initiatives such as the "Community Value Program," as well as donations, sponsorships, and corporate volunteering. Marketing and communication budgets are similarly projected to be significantly reduced.

Additionally, companies are pursuing the international placement of skilled workers and engineers to foreign manufacturing sites within their enterprise networks.

2. Findings Concerning Suppliers and Subcontractors

Due to the scope of the Just Transition Fund (JTF) in Baranya County, the analysis of supplier and subcontractor impacts was limited to enterprises operating within the county's boundaries. Under JTF eligibility rules, only companies registered or operating in Baranya are eligible for support. However, the structure of the cement industry is such that a significant proportion of its supplier network is located outside the county. For this reason, the investigation was extended to cover the broader subcontracting ecosystem.

The most severely affected areas include transportation and logistics, maintenance services, quarry operations (including blasting and internal logistics), cleaning, site security, rail transport, raw material supply, catering, and temporary staffing. Approximately 50% of subcontractor and

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supplier capacity is expected to be affected in 2025, with partial or full relocation of these capacities to other regions or countries anticipated.

3. Other Anticipated Negative Impacts

- Waste management performance is projected to deteriorate significantly: in 2025, only one-third of the volume of waste recycled in 2021 is expected to be recovered.
- A substantial decline is anticipated in local business tax revenues, directly linked to the shrinking economic footprint of affected companies.
- Electricity consumption is projected to fall to one-third of its previous level, resulting in losses in system usage fees for the local energy grid.
- Annual investment levels (Maintenance and Development CAPEX) are also expected to decrease sharply, with negative implications for equipment renewal, innovation, and regional economic stimulation.

While intended to shield consumers, this measures drastically reduces profit margins on domestic cement and has created a substantial competitive disadvantage for Hungarian manufacturers. Crucially, imported cement is not subject to the price cap or the extra levy, meaning foreign producers can sell in Hungary without bearing the same cost, undercutting local companies. The domestic industry has protested that this policy not only harms their financial viability but may also slow down construction projects (by causing supply uncertainties and price distortions) and ultimately reduce tax revenues from lost economic activity. Industry associations have lobbied for the removal of the mining surcharge, arguing that its broader economic damage outweighs the short-term benefits.

This recent fiscal burden comes on top of the substantial capital expenditures needed for decarbonization, placing cement companies in a difficult position. Balancing sustainability investments with these external costs will require careful policy calibration. Ideally, climate policy and industrial policy should work hand-in-hand: for example, phasing out punitive taxes as companies invest in green upgrades, or providing incentives and support (grants, tax credits, carbon contracts) to accelerate low-carbon innovation in cement production. Without such alignment, there is a risk that well-intentioned climate measures or tax policies could inadvertently curtail the industry's capacity to modernize. A stable economic environment—one that internalizes carbon costs while avoiding sudden, onerous levies—would enable the Hungarian cement sector to plan long-term and attract the financing necessary for its sustainable transition

5. Conclusions

Based on the findings of the present research, it can be concluded that certain aspects of the Territorial Just Transition Plan (TJTP) for Baranya County require revision due to recent industry-specific developments.

The case of Baranya differs substantially from the northern Hungarian counties also covered by the JTF. In contrast to those regions, the European Commission has not designated any sector in Baranya as one that is in immediate decline or expected to cease operations in the short term. Rather, the county hosts sectors that are considered to be undergoing transformation as part of the broader decarbonization process and the objectives of a just transition. Moreover, it has been established that the negative effects associated with the historical closure of mining operations in the region have not been adequately mitigated. These ongoing socio-economic challenges necessitate targeted intervention. Consequently, Baranya County may be regarded as a low-risk area in terms of JTF implementation.

However, due to the imposition of the supplementary mining royalty and the CO_2 taxation policy, cement and lime manufacturing companies in Baranya operated at a significant loss in 2024. As a result, in 2025 these enterprises will be forced to optimize production, which will lead to a decrease in the volume of domestically manufactured cement and lime products. This development is expected to result in potential workforce reductions or the relocation of jobs to other countries, particularly affecting skilled engineers.

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This situation poses several risks. Over the long term, the emigration of qualified engineering talent may lead to a brain drain, while the reduction in domestic production will likely be compensated by imports from foreign producers. This, in turn, could lead to an increase in construction costs—signs of which are already observable. Domestic manufacturers, burdened by the additional costs stemming from these special taxes, are increasingly unable to maintain their competitiveness, even within the Hungarian market.

Furthermore, the periodic shutdown of cement and lime production facilities has a ripple effect on their supply chains, compelling subcontractors and suppliers to downsize their workforces or halt operations. This trend has a particularly severe impact on the small and medium-sized enterprise (SME) sector.

These developments directly affect the design of labor market-related calls for proposals under Priority 5 of the Environmental and Energy Efficiency Operational Programme Plus (KEHOP+), particularly those concerning vocational training and reskilling initiatives. Due to the delays in technological transition within the cement industry, a partial revision of this priority is warranted. Specifically, the focus should shift away from sector-specific industrial transformation (e.g., cement) and toward broader objectives related to the development of a green economy or the greening of economic activities in general.

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