

FROM ENERGY SHOCK TO SOCIAL INNOVATION: GEOPOLITICAL CRISIS, REGIONAL DIVERGENCE AND ECONOMIC TRANSFORMATION IN THE BALTIC REGION

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ABSTRACT

The recent energy crisis triggered by the Russian invasion of Ukraine has profoundly reshaped regional economies across the Baltic region, transforming energy from a market commodity into a strategic and geopolitical resource. While existing literature emphasises disruption and vulnerability, this paper reframes the crisis as a catalyst for social innovation. Drawing on a comparative analysis of Lithuania, Latvia, Estonia and Poland, the study examines how rising energy prices, supply insecurity and policy responses have stimulated new forms of behavioural adaptation, collective action and institutional change. Particular attention is given to decentralised energy practices, prosumer models and governance innovation. The findings reveal that social innovation emerges unevenly across national contexts, shaped by structural conditions, institutional capacity and geopolitical positioning. The paper argues that energy shocks can function as transformative moments, fostering resilience while also exposing internal divergences within the European Union, and reshaping regional pathways toward sustainability.

KEY WORDS: *energy crisis, energy security, geopolitics, regional development, social innovation.*

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Introduction

The recent energy crisis triggered by geopolitical disruptions, most notably the Russian invasion of Ukraine in 2022, and the subsequent restructuring of European energy systems, has profoundly affected regional economies across the Baltic region. What was previously understood primarily as an economic and infrastructural domain has rapidly become a matter of strategic security and political alignment (Hudák et al., 2026; Rokicki et al., 2023). Sharp increases in energy prices, supply insecurity, and the accelerated decoupling from Russian energy sources have exposed structural vulnerabilities in national and regional energy systems (European Commission, 2022; 2023; 2025; IEA, 2025). These developments have generated significant economic pressures on households, firms and public institutions, forcing rapid adaptation to a new and uncertain energy landscape (Cirella et al., 2021; Goncharuk, Cirella, 2020; OECD, 2024; World Bank, 2026).

In the existing literature, energy crises are predominantly framed through the lenses of economic disruption, market volatility and systemic risk. Studies have focused on price transmission mechanisms, supply shocks and macroeconomic instability (IEA, 2023a; 2023b; 2025; Sovacool, 2016). While these perspectives are essential for understanding the scale and severity of the crisis, they often overlook the dynamic and transformative processes that emerge in response to such disruptions. In particular, limited attention has been given to the ways in which crises, especially those with geopolitical origins, can stimulate new forms of social organisation, behavioural change and institutional innovation.

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This paper adopts an alternative perspective, by conceptualising the energy crisis not solely as a destabilising force, but also as a catalyst for social innovation (Barragan-Contreras et al., 2025). Social innovation, in this context, refers to the reconfiguration of social practices, governance structures and patterns of collective action in response to societal challenges (Howaldt et al., 2016; Moulaert et al., 2014). Unlike purely technological innovation, social innovation emphasises the role of human behaviour, institutional arrangements and social coordination in shaping economic outcomes (Howaldt et al., 2016; Solis-Navarrete, Bucio-Mendoza, 2026). In the context of energy systems, this includes changes in consumption practices, the emergence of community-based energy initiatives, and the development of new policy frameworks.

The relevance of this perspective is particularly evident when viewed through the lens of resilience theory. Resilience approaches conceptualise crises as critical junctures that disrupt existing equilibria and create opportunities for systemic transformation (Folke, 2006; Walker et al., 2004). Rather than returning to pre-crisis conditions, systems may reorganise into new configurations that are better adapted to changing environments. In this sense, the energy crisis can be understood as a transformative moment that accelerates transitions towards more sustainable, decentralised and secure energy systems.

At the same time, the crisis has triggered significant behavioural and institutional changes. From a behavioural economics perspective, rising energy costs alter incentives and risk perceptions, leading to shifts in consumption patterns and investment decisions (Kahneman, 2013; Thaler, Ganser, 2016). Households and firms are increasingly adopting energy-saving practices, investing in efficiency and exploring alternative energy sources. These changes, while initially driven by economic necessity, may become embedded as long-term behavioural adaptations. Institutionally, governments and regional authorities have responded by introducing new policy measures, accelerating renewable energy deployment and reconfiguring governance structures (European Commission, 2022; 2023; 2025). These responses reflect a broader process of institutional adaptation, in which existing frameworks are modified to address emerging challenges.

The Baltic region provides a particularly relevant context for examining these dynamics, due to its historical dependence on external energy sources, and its geopolitical proximity to the conflict. Countries such as Lithuania, Latvia and Estonia have long faced heightened energy security concerns, and have responded rapidly to the crisis through diversification strategies and regional cooperation within the European Union (EU) (IEA, 2023a; 2025). Poland represents a complementary and critical case in this regional context. As one of the largest economies in Central and Eastern Europe, Poland combines structural dependence on coal with increasing efforts toward energy diversification and modernisation. The crisis has intensified these dynamics, accelerating both technological transition and socially embedded adaptation processes.

However, the regional response to the energy crisis has not been uniform across the EU. While Poland and the Baltic States have pursued rapid decoupling from Russian energy sources, other member states, notably Hungary and Slovakia, have maintained a continued reliance on Russian oil and gas (Batzella, 2024; Mišík, Oravcová, 2024). This divergence highlights emerging internal tensions within the EU, revealing that not only has the crisis exposed external vulnerabilities, but also generated internal fragmentation in energy policy and strategic alignment. These contrasting responses provide an important analytical dimension, illustrating how geopolitical pressures interact with national energy structures and institutional capacities to shape uneven pathways of adaptation.

The problem addressed in this paper is the limited understanding of how energy crises, particularly those driven by geopolitical conflict, contribute to socially embedded innovation processes in regional economic systems. While technological aspects of energy transition have been widely studied, the social, behavioural and institutional dimensions remain underexplored, especially in comparative regional contexts.

The purpose of this paper is to examine how the recent energy crisis has triggered social innovation in the Baltic region, and to assess its implications for regional economic transformation. The object of the study is the process of regional economic adaptation under crisis conditions, while the subject focuses on the forms of social innovation emerging across different levels of the economic system. To achieve this, the paper pursues the following tasks: (1) to conceptualise social innovation within the context of energy transitions; (2) to analyse the energy crisis as a geopolitical and systemic catalyst using a resilience perspective; (3) to conduct

a comparative analysis of Lithuania, Latvia, Estonia and Poland; (4) to identify and examine key forms of social innovation at household, community and institutional levels; and (5) to assess the implications of these processes for regional development and European energy governance.

The study applies a qualitative, exploratory methodology based on the analysis of secondary data, policy documents and existing literature related to energy transitions and regional development in the Baltic region. The central research question guiding this study is: How has the energy crisis, shaped by geopolitical conflict, acted as a catalyst for social innovation in the Baltic region, and how do these processes vary across national contexts?

In addressing this question, the paper contributes to the literature on social innovation in management and economics in three key ways. First, it reframes crisis as a generative and politically conditioned driver of innovation, rather than solely a source of disruption. Second, it integrates insights from resilience theory, behavioural economics and institutional analysis, to provide a multi-level and comparative understanding of adaptation. Third, it highlights the Baltic region as a critical empirical context in which energy transition, geopolitical conflict and regional economic transformation intersect.

2. The theoretical framework

2.1. Social innovation in socio-economic systems

Social innovation has become an increasingly central concept in debates on economic development, governance and sustainability, particularly in contexts characterised by complex and systemic challenges. While definitions vary, a common understanding emphasises the creation and implementation of new social practices that address societal needs more effectively than existing solutions (Howaldt et al., 2016; Moulaert et al., 2014). Unlike technological innovation, which focuses primarily on products and processes, social innovation involves transformations in social relations, institutional arrangements and forms of collective action.

Within economic systems, social innovation plays a critical role in shaping how resources are allocated, how actors coordinate, and how value is created and distributed. It often emerges in response to systemic failures or limitations in market and governance structures. As Cajas-Santana (2014) argues, social innovation entails changes in social structures that redefine interactions between actors, thereby enabling new forms of economic organisation. This perspective highlights the importance of social embeddedness, where innovation is not merely technical but rooted in social contexts, norms and relationships.

In the context of energy systems, social innovation manifests through decentralised governance models, community-based renewable energy initiatives, and participatory forms of decision-making (Hargreaves et al., 2013). These developments challenge traditional centralised energy regimes, by redistributing power among actors and introducing new forms of coordination. They also contribute to broader sustainability objectives by enhancing inclusivity, resilience and local engagement.

A key characteristic of social innovation is its relational and embedded nature. As Polanyi (2010) emphasises, economic processes are inseparable from social relations, and transformations in economic systems often reflect shifts in social structures. Accordingly, social innovation can be understood as a process through which economic practices are reconfigured in response to changing environmental, institutional and geopolitical conditions.

2.2. Crisis, geopolitics and systemic transformation

The relationship between crisis and innovation has been widely examined within resilience theory and socio-technical transition studies. Crises are typically conceptualised as disruptive events that destabilise existing systems and expose underlying vulnerabilities. However, they also create opportunities for transformation, by opening windows for structural change (Folke, 2006; Walker et al., 2004).

Resilience theory defines resilience as the capacity of a system to absorb disturbance, adapt and reorganise, while maintaining its core functions (Folke, 2006). Importantly, resilience does not imply a return to pre-crisis conditions, but allows for transformation into new, potentially more sustainable configurations. This perspective is particularly relevant in the context of energy systems, where crises can accelerate transitions towards alternative models of production and governance.

In this regard, the role of geopolitics is crucial. The Russian invasion of Ukraine represents not only an external shock, but a systemic disruption that redefined energy as a strategic and political resource (Ciot, Butișcă, 2025; Wang et al., 2026). Geels (2002), through the multi-level perspective on socio-technical transitions, describes such events as ‘landscape shocks’, capable of destabilising dominant regimes and enabling alternative pathways. The energy crisis in Europe can therefore be understood as a geopolitically driven transformation process that extends beyond market dynamics into the realm of security and political alignment.

Furthermore, crises may lead to what Pelling (2003) describes as ‘transformative adaptation’, involving fundamental changes in system structure and function. These transformations encompass not only technological innovation, but also shifts in social practices, governance arrangements and institutional frameworks. As such, resilience and social innovation are closely interconnected, both reflecting adaptive processes triggered by external pressures.

2.3. Behavioural adaptation and social practices

Behavioural responses constitute a key mechanism through which economic systems adapt to crisis conditions. Traditional economic models assume rational decision-making; however, behavioural economics demonstrates that decisions are shaped by cognitive biases, social norms and contextual influences (Kahneman, 2013; Thaler, Ganser, 2016).

In the context of an energy crisis, rising prices and supply uncertainty alter the decision-making environment for households and firms. These changes influence consumption patterns, investment decisions and risk perceptions. For instance, higher energy costs incentivise energy-saving behaviours, efficiency improvements and the adoption of renewable technologies. At the same time, social norms and peer effects contribute to the diffusion of these practices across communities.

Importantly, behavioural adaptation is not purely individual, but socially embedded. As Shove (2010) argues, everyday practices, such as energy consumption, are shaped by routines, infrastructures and cultural conventions. Crises can disrupt these practices, creating opportunities for their reconfiguration. This perspective shifts the focus from individual choice to collective patterns of behaviour, and their transformation over time.

Such behavioural changes contribute directly to social innovation by reshaping interactions within the energy system. The emergence of ‘prosumer’ models, where individuals both produce and consume energy, exemplifies this transformation. These developments illustrate how micro-level behavioural adaptation can drive broader systemic change, linking individual action to structural transformation.

2.4. Institutional change and governance under crisis

Institutions play a central role in shaping economic behaviour and enabling or constraining innovation. Defined as the formal and informal rules governing social and economic interactions, institutions provide stability, but can also become rigid in the face of changing conditions (North, 1990).

Crises often act as catalysts for institutional change, by exposing the limitations of existing frameworks and creating pressure for reform. In the context of the energy crisis, governments have introduced a range of policy measures aimed at enhancing energy security, accelerating renewable energy deployment and mitigating social impacts. These measures include subsidies, regulatory reforms and strategic investments in infrastructure.

Institutional change can take multiple forms. As Hall (1993) suggests, policy evolution may involve adjustments in instruments, shifts in policy goals, or transformations in underlying paradigms. The current energy crisis reflects elements of all three, as governments balance short-term crisis management with long-term sustainability and security objectives.

Governance innovation is a critical component of this process. It involves new forms of coordination between public authorities, private actors and civil society. Collaborative governance models, as highlighted by Sørensen and Torfing (2011), enhance system capacity to respond to complex challenges by integrating diverse knowledge and resources. Recent studies further emphasise that participation and governance styles significantly influence the trajectory and legitimacy of energy transitions, particularly under crisis conditions (Radtke, 2025; Radtke, Renn, 2024).

In geopolitically sensitive contexts such as the Baltic region, institutional adaptation is shaped not only by economic considerations, but also by strategic and security imperatives. This adds an additional layer of complexity, as governance responses must navigate both internal policy objectives and external geopolitical pressures (Sköld, 2025; Strážay, 2025).

2.5. Analytical framework: multi-level and politically conditioned innovation

Bringing these perspectives together, the energy crisis can be conceptualised as a multi-dimensional and geopolitically embedded phenomenon that triggers interconnected processes of social innovation, behavioural adaptation and institutional transformation. These processes unfold across multiple levels of the economic system, and are shaped by structural conditions as well as political alignment.

Recent contributions to quantitative sustainability assessment further highlight the importance of incorporating measurable and adaptive indicators into the analysis of complex socio-economic systems. Approaches such as adaptive sustainability metrics provide structured tools for capturing dynamic interactions between environmental, economic and social variables over time (Cirella, Tao, 2009; Cirella, Zerbe, 2014). While this study adopts a qualitative design, such frameworks underscore the value of integrating mixed-method perspectives when analysing sustainability transitions under conditions of uncertainty and rapid structural change. Such approaches align with broader multi-criteria frameworks used to evaluate complex socio-economic systems assessing sustainability (Galik et al., 2022).

Within this framework, social innovation serves as the overarching lens through which new practices, coordination mechanisms and forms of collective action are understood. Resilience theory explains how crises create opportunities for systemic transformation, while behavioural economics highlights micro-level adaptation processes. Institutional theory, in turn, captures how governance structures and policy responses shape and enable these dynamics (Bucio-Mendoza, Solis-Navarrete, 2025; Pacheco et al., 2025).

Crucially, these processes are not uniform across contexts. Rather, they are politically conditioned and structurally differentiated, reflecting variations in energy dependency, institutional capacity and geopolitical positioning. This is particularly evident in the Baltic region, where proximity to the conflict and historical energy dependencies have intensified both the pressures of adjustment and the scope for innovation.

Accordingly, this study adopts a multi-level and comparative analytical framework to examine how social innovation emerges across household, community and institutional levels in four countries, Lithuania, Latvia, Estonia and Poland, while situating these developments within broader European dynamics, including internal divergences in energy policy. This approach enables a more nuanced understanding of how crisis-driven innovation unfolds within regional economic systems, highlighting the interplay between external shocks, internal structures and political factors in shaping pathways of transformation.

3. Methodology

The study adopts a qualitative, exploratory research design to examine how the recent energy crisis, triggered by the Russian invasion of Ukraine, has acted as a catalyst for social innovation and regional economic

transformation in the Baltic region. Given the complex, multi-scalar and politically conditioned nature of the phenomenon under investigation, a qualitative approach is particularly appropriate for capturing the interactions between behavioural, institutional and geopolitical dynamics.

Rather than treating the energy crisis solely as an economic event, this research conceptualises it as a geopolitically embedded systemic shock, requiring an analytical framework capable of integrating multiple dimensions of change. Accordingly, the study employs an interpretive and comparative methodology that combines conceptual analysis with empirical observation derived from secondary data sources.

3.1. Research design and analytical approach

The research is structured around a comparative multi-case study design, focusing on four countries in the Baltic region: Lithuania, Latvia, Estonia and Poland. These countries were selected based on their shared exposure to the energy crisis, geographic proximity to the conflict, and historical dependence on external energy sources, particularly Russian fossil fuels, while also exhibiting variations in energy system structures, institutional capacities and policy responses.

This comparative design enables the identification of both common patterns and country-specific differences in how social innovation emerges under crisis conditions. In addition, the analysis incorporates a contextual reference to Hungary and Slovakia, as contrasting cases within the EU, where continued reliance on Russian energy highlights internal divergences in policy alignment and energy transition pathways. While these latter countries are not analysed in depth, they provide an important comparative backdrop for understanding the broader European context. The analytical approach is guided by a multi-level framework, distinguishing between three interrelated levels of social innovation:

- household level (micro-level): behavioural adaptation, changes in consumption practices, and the emergence of prosumer activity;
- community level (meso-level): collective initiatives, local coordination mechanisms, and the role of social capital; and
- institutional level (macro-level): policy responses, governance innovation, and regulatory transformation.

This framework allows for a systematic examination of how innovation processes unfold across different scales, and how interactions between these levels contribute to broader systemic transformation.

3.2. Data sources and material

The empirical material used in this study consists of secondary qualitative data collected from institutional, policy and academic sources published primarily between 2020 and 2025. The selected timeframe captures the period encompassing the Covid-19 pandemic, the escalation of energy market instability in Europe, and the geopolitical disruptions associated with Russia's full-scale invasion of Ukraine in 2022. These developments provide the broader temporal context within which regional energy transition and social innovation processes intensified.

The study applies a comparative qualitative document analysis based on a purposive selection of materials directly related to energy security, energy transition, governance responses, and regional adaptation in the Baltic region. The analysed material includes:

- EU policy documents and strategic frameworks, particularly those associated with REPowerEU, energy diversification, sanctions policy and regional energy transition;
- national energy strategies, policy plans, and legislative documents from Lithuania, Latvia, Estonia and Poland;
- reports, datasets and analytical publications produced by international organizations, including the International Energy Agency, OECD, World Bank and UNDP;

- academic literature addressing social innovation, resilience, institutional adaptation, energy transition and geopolitical change; and
- publicly available statistical and contextual data related to energy dependency, diversification, pricing and infrastructure development.

In total, the analysis incorporated more than 50 individual documents and reports, including strategic policy papers, institutional assessments, energy security analyses and scholarly publications. The selected documents were chosen based on three criteria: (1) relevance to the research question and regional focus; (2) analytical value in explaining adaptation and innovation processes; and (3) temporal relevance to the evolving European energy crisis.

The collected material was treated as qualitative empirical evidence, rather than solely contextual background literature. Documents were systematically reviewed and categorised according to recurring themes related to crisis response, behavioural adaptation, governance transformation, energy diversification and forms of social innovation. Particular attention was given to identifying evidence of institutional change, collective initiatives, decentralised energy practices, and shifts in regional policy orientation.

The use of multiple data sources enabled triangulation across institutional, academic and policy perspectives, strengthening the analytical reliability of the study. This approach also allowed the research to capture both macro-level structural developments and meso- and micro-level adaptation processes in the selected countries.

3.3. Case selection and comparative logic

The selection of Lithuania, Latvia, Estonia and Poland reflects a deliberate attempt to capture variation in a shared regional context. While all four countries are located in the Baltic region, and have been directly affected by the energy crisis, they differ in key structural dimensions:

- energy mix and dependency: ranging from Lithuania's diversified system to Poland's coal reliance;
- institutional capacity and policy responsiveness: varying levels of administrative flexibility and reform speed;
- scale and economic structure: from small, agile economies (in the Baltic States) to a larger, more complex system (in Poland); and
- historical exposure to geopolitical risk: particularly in relation to Russia.

This variation allows for a most-similar systems design, where countries share key contextual features, but differ in outcomes, making it possible to identify the factors shaping divergent pathways of social innovation. The inclusion of Hungary and Slovakia as reference cases further strengthens the analytical framework, by introducing a contrastive dimension, highlighting how continued dependence on Russian energy can constrain adaptation and generate internal tensions within the EU.

3.4. Analytical strategy

The study applies a comparative thematic analysis to examine how the energy crisis stimulated different forms of social innovation and regional adaptation across the selected cases. The analytical strategy combines qualitative document analysis with cross-case comparison, allowing the identification of both shared regional dynamics and country-specific trajectories of transformation.

The analysis proceeded in three stages. First, the collected empirical material was systematically reviewed, to identify recurring themes associated with the energy crisis and regional adaptation. During this stage, documents were categorised according to key analytical dimensions, including energy security, diversification strategies, governance responses, behavioural adaptation, institutional change and collective

initiatives. Particular attention was given to references describing new forms of coordination, decentralised energy practices and policy innovation, which were interpreted as indicators of social innovation processes.

Second, the identified themes were organised in the study's multi-level analytical framework, distinguishing between:

- micro-level adaptation, including household behavioural change, energy-saving practices and prosumer activity;
- meso-level adaptation, including community initiatives, local coordination mechanisms and cooperative forms of action; and
- macro-level adaptation, including institutional reform, governance innovation and national energy transition strategies.

This thematic categorisation enabled the systematic comparison of adaptation processes across Lithuania, Latvia, Estonia and Poland.

Third, a cross-case comparative analysis was conducted to examine how structural and geopolitical differences shaped divergent pathways of transformation. The cases were compared according to five principal criteria: (1) the degree of energy dependency on Russian energy imports prior to 2022; (2) the level of energy diversification and infrastructure flexibility; (3) the institutional capacity and speed of policy response; (4) the forms and intensity of social innovation observed across different levels; and (5) geopolitical positioning and exposure to regional security pressures.

The comparative analysis was not intended to rank countries according to performance, but rather to identify patterns of variation in adaptation processes, and to explain how different structural conditions influenced the emergence of socially embedded innovation.

The analytical interpretation was further informed by the study's theoretical framework, particularly concepts derived from resilience theory, institutional adaptation and social innovation literature. This allowed the findings to be interpreted not only as isolated policy responses, but as interconnected processes of regional transformation unfolding under conditions of geopolitical uncertainty and systemic disruption. Overall, the analytical strategy provides a structured framework for understanding how crisis-driven innovation emerges unevenly across regional contexts, and how behavioural, institutional and political factors interact in shaping pathways of economic adaptation and sustainability transition.

3.5. Limitations and scope

As a qualitative and exploratory study, this research does not aim to provide statistically generalisable findings. The reliance on secondary data may limit the ability to capture micro-level dynamics in detail, particularly with regard to individual behaviour and informal practices. However, this approach allows for a broad and integrative analysis of regional transformation processes across multiple levels and contexts.

Furthermore, while the focus on four countries enables meaningful comparison, it necessarily excludes other relevant cases in the EU. Future research could expand this framework by incorporating additional countries, or by employing mixed-method approaches, including primary data collection through interviews or surveys.

3.6. Methodological contribution

Despite these limitations, the methodological approach offers several contributions. First, it integrates comparative regional analysis with multi-level social innovation theory, providing a structured way to examine complex adaptation processes. Second, it explicitly incorporates geopolitical factors into the analysis of economic transformation, addressing a gap in existing literature. Third, it demonstrates how qualitative, secondary-data-based research can generate valuable insights into rapidly evolving crisis contexts.

Overall, the methodology provides a flexible yet rigorous framework for analysing how crisis conditions, particularly those driven by geopolitical conflict, can stimulate socially embedded innovation and reshape regional economic systems.

4. Results: geopolitical energy shock and uneven social innovation in the Baltic region

4.1. The 2022 energy crisis as a geopolitical turning point

The energy crisis that intensified across Europe after 2022 did not emerge in isolation, nor did it initiate the European energy transition process. Rather, Russia's full-scale invasion of Ukraine acted as a major geopolitical accelerator that intensified pre-existing structural vulnerabilities and significantly increased the urgency of energy diversification and transition policies already under way within the EU.

Prior to 2022, European energy systems were already experiencing mounting pressures associated with decarbonisation targets, climate policy commitments, supply chain instability, and growing concerns regarding long-term dependence on external energy suppliers. Earlier geopolitical tensions involving Russian gas transit disputes, together with broader debates surrounding energy security and strategic autonomy, had already stimulated discussions concerning diversification and resilience within the EU energy framework. In addition, the Covid-19 pandemic generated substantial disruptions in global supply chains and energy markets, contributing to price volatility, inflationary pressures and increased awareness of systemic vulnerability across interconnected economic systems.

Against this backdrop, the Russian invasion of Ukraine represented a critical geopolitical rupture that transformed energy from a primarily economic issue into a strategic and security-oriented policy domain. The abrupt reduction of Russian gas supplies, combined with escalating political tensions and sanctions regimes, forced European states to rapidly reassess existing energy dependencies and infrastructure configurations. In this sense, the war did not create the transition itself, but dramatically accelerated ongoing processes of diversification, renewable energy expansion and institutional adaptation.

The Baltic region was particularly exposed to these developments, due to its historical dependence on Russian fossil fuels and geographic proximity to the conflict. The crisis revealed structural vulnerabilities related to supply security, energy pricing and infrastructure dependency. Sharp increases in electricity and heating costs affected households, firms and public institutions simultaneously, intensifying economic pressure throughout the region (UNDP, 2022; World Bank, 2026). Energy-intensive industries faced rising operational costs, while governments were forced to implement emergency support mechanisms alongside long-term transition policies.

At the same time, the crisis generated conditions for rapid systemic transformation. Existing energy transition initiatives gained renewed political legitimacy, while diversification strategies that had previously advanced gradually became urgent strategic priorities. Investment in LNG infrastructure, regional grid synchronisation, renewable energy expansion and decentralised energy systems accelerated across the Baltic region and Poland. Consequently, the energy crisis can be understood not simply as a temporary disruption, but as a geopolitically induced structural turning point that intensified and reshaped broader processes of economic and institutional transformation.

Importantly, these developments also altered the relationship between energy policy and regional governance. Energy transition became increasingly linked to issues of national sovereignty, geopolitical alignment and regional resilience. As a result, the crisis not only transformed energy systems themselves, but also reconfigured broader social, institutional and political dynamics across the Baltic region.

4.2. Diverging European responses: cohesion and fragmentation

While the EU initially presented a unified response to the energy crisis, significant divergences emerged among member states in terms of policy orientation and strategic alignment. These differences reflect

varying levels of dependency on Russian energy, domestic political priorities and institutional capacity for rapid transition.

A clear distinction can be observed between two groups of countries. On one hand, the Baltic States (Lithuania, Latvia and Estonia) and Poland pursued rapid decoupling from Russian energy sources, framing energy transition as a matter of national security and political sovereignty. These countries implemented aggressive diversification strategies, accelerated renewable energy deployment, and strengthened regional cooperation mechanisms.

On the other hand, countries such as Hungary and Slovakia maintained a continued reliance on Russian oil and gas, citing economic constraints and infrastructural limitations. This divergence has introduced a degree of fragmentation within the EU, revealing tensions between collective policy objectives and national interests.

From an analytical perspective, this fragmentation is significant, because it demonstrates that the energy crisis is not only an external shock, but also an internal stress test for European integration. It highlights how geopolitical pressures can produce uneven responses, shaping different pathways of adaptation, and consequently different forms of social innovation.

4.3. National pathways of adaptation: a four-country comparison

To understand how social innovation emerges under crisis conditions, it is necessary to examine how national contexts shape responses. The four countries analysed, Lithuania, Latvia, Estonia and Poland, share exposure to the same external shock, but differ significantly in their structural conditions, institutional capacities and energy system configurations (Table 1).

Table 1. Comparative forms of social innovation in the Baltic region

Country	Main energy vulnerability	Key policy response	Main social innovations	Transition characteristics
Lithuania	Russian gas dependency	LNG diversification, grid synchronisation	Prosumer solar expansion, decentralised participation, rapid institutional adaptation	Rapid, security-driven transition
Latvia	Infrastructure vulnerability	Regional coordination and storage integration	Community energy initiatives, municipal coordination, local support mechanisms	Cooperative and regionally integrated
Estonia	Oil shale dependency	Hybrid diversification strategy	Adaptive governance, hybrid energy transition practices	Security-oriented and structurally constrained
Poland	Coal dependence and system scale	Infrastructure modernisation, renewable investment	Household renewable adoption, energy-efficiency programmes, regulatory transition reforms	Gradual and path-dependent transition

4.3.1. Lithuania: rapid decoupling and institutional agility

Lithuania represents one of the most adaptive cases in the region. Prior investment in energy diversification, including liquefied natural gas infrastructure and integration into European energy networks, enabled the country to rapidly eliminate its dependence on Russian gas. This structural preparedness was complemented by strong institutional responsiveness, allowing for swift policy implementation and regulatory adaptation.

Social innovation in Lithuania is particularly evident in the expansion of decentralised energy systems and increased citizen participation in energy production. The crisis accelerated both behavioural change and institutional transformation, reinforcing the transition towards a more resilient and flexible energy system.

4.3.2. Latvia: intermediary adaptation and regional integration

Latvia occupies an intermediary position in the regional landscape. While also committed to reducing dependence on Russian energy, its transition has been shaped by a combination of national policies and regional cooperation, particularly in relation to energy storage and cross-border infrastructure.

Social innovation in Latvia has emerged through community-based initiatives and local coordination mechanisms, reflecting a gradual but steady adaptation process. The country's reliance on regional integration highlights the importance of networked resilience, where collective solutions complement national strategies.

4.3.3. Estonia: energy security and structural tensions

Estonia presents a unique case, due to its historical reliance on oil shale as a domestic energy source. This has provided a degree of energy independence, but also created tensions between security objectives and sustainability goals.

In response to the crisis, Estonia has pursued diversification strategies, while maintaining elements of its existing energy system. Social innovation in this context is shaped by the need to balance competing priorities, leading to hybrid solutions that combine traditional energy sources with emerging renewable technologies. This reflects a more complex and contested pathway of transformation.

4.3.4. Poland: scale, constraint and strategic transition

Poland represents the largest and most structurally complex case in the region. Its energy system is heavily dependent on coal, creating significant challenges for a rapid transition. At the same time, Poland has played a central role in regional energy security, positioning itself as a key actor in efforts to reduce dependence on Russian energy.

The crisis has accelerated policy reforms, investment in infrastructure, and renewable energy development. However, social innovation in Poland is emerging within the context of structural constraint, where legacy systems and economic considerations limit the pace of change. This results in a more gradual and uneven transformation process, highlighting the importance of scale and path dependency.

4.4. Social innovation across levels: behavioural, collective and institutional dynamics

Across the four analysed countries, the energy crisis stimulated multiple forms of social innovation, operating simultaneously at household, community and institutional levels. Rather than emerging as isolated responses, these innovations formed interconnected adaptation processes, shaped by economic pressure, geopolitical uncertainty and the accelerating need for energy transition.

At the household level, one of the most visible forms of social innovation involved changes in energy consumption practices, and the expansion of decentralised energy participation. Rising electricity and heating costs encouraged households to reduce consumption, improve energy efficiency and adopt alternative energy solutions. Across Lithuania and Poland in particular, the crisis accelerated the installation of rooftop solar photovoltaic systems, and increased participation in prosumer energy schemes, where households both consume and generate electricity. In Estonia and Latvia, energy-saving campaigns and public awareness initiatives contributed to broader behavioural adaptation, including reduced heating consumption and increased monitoring of household energy use. These developments represent forms of behavioural social innovation because they involve changes in social practices, consumption norms and citizen engagement with energy systems.

At the community level, the crisis stimulated collective forms of coordination and locally embedded adaptation mechanisms. In Latvia and Lithuania, municipalities and local communities expanded cooperative approaches related to energy management, infrastructure coordination and support for vulnerable households facing rapidly rising energy costs. Community-level initiatives included the development of local energy cooperatives, municipal energy-sharing arrangements, public advisory programmes on energy efficiency, and coordinated local heating support measures. In several cases, regional cooperation surrounding storage capacity and energy infrastructure also intensified, particularly in relation to Baltic interconnection projects. These developments illustrate how social innovation can emerge through collective action and networked forms of resilience, rather than solely through market-based mechanisms.

At the institutional level, governments implemented significant governance and policy innovations aimed at accelerating diversification and reducing strategic vulnerability. Lithuania expanded LNG-based diversification and accelerated synchronisation with European electricity networks, while Estonia pursued hybrid transition strategies balancing energy security with renewable expansion. Poland introduced large-scale infrastructure modernisation programmes, expanded renewable energy incentives, and accelerated investment in strategic energy corridors. Across the Baltic region more broadly, governments streamlined regulatory procedures for renewable energy projects, expanded financial support mechanisms for households and firms, and strengthened regional coordination on energy security issues. These measures represent institutional forms of social innovation, because they altered governance structures, regulatory frameworks and patterns of coordination between public institutions, markets and civil society actors.

Importantly, the interaction between these levels created reinforcing dynamics of adaptation. Institutional reforms enabled community initiatives and household participation, while behavioural shifts increased public acceptance of transition policies and decentralised energy systems. In this sense, social innovation in the Baltic region was not limited to technological change alone, but involved broader transformations in governance, collective organisation and social practice.

At the same time, the forms and intensity of these innovations varied across countries. Lithuania demonstrated the most rapid and coordinated transformation, due to prior diversification investment and institutional flexibility. Latvia emphasised cooperative and regionally integrated adaptation mechanisms. Estonia pursued more hybrid and security-oriented approaches, shaped by its oil shale dependency; while Poland's larger and more path-dependent energy structure produced a more gradual and uneven transition trajectory. These differences show that social innovation under crisis conditions is highly context-dependent, and is shaped by structural constraints, institutional capacity and geopolitical positioning.

4.5. Internal EU tensions and constraints on transformation

While the Baltic region has demonstrated significant adaptive capacity, its efforts are influenced by broader European dynamics. The continued reliance of some EU member states on Russian energy introduces structural inconsistencies that affect the overall trajectory of energy transition.

These internal tensions create challenges for policy coordination, market integration and collective resilience. They also highlight the limits of regional adaptation in the absence of fully aligned political and economic strategies at the European level. From a social innovation perspective, this suggests that innovation processes are not only shaped by local conditions, but also constrained by supranational institutional and political dynamics.

4.6. Synthesis: uneven and politically conditioned innovation

The analysis demonstrates that social innovation in response to the energy crisis is both multi-level and uneven. While all countries examined have experienced forms of adaptation, the nature and intensity of these processes vary, according to structural conditions, institutional capacity and geopolitical positioning.

Rather than representing a uniform transition, the energy crisis has produced differentiated pathways of transformation. In some cases, it has accelerated innovation and strengthened resilience. In others, it has

exposed constraints and reinforced existing dependencies. This suggests that social innovation should be understood not as a homogeneous process, but as a politically conditioned and regionally differentiated phenomenon, shaped by the interaction of external shocks, internal structures and strategic choices.

5. Discussion

The findings of this study demonstrate that the recent energy crisis in Europe, triggered by the Russian invasion of Ukraine, should be understood not merely as a disruptive economic event, but as a geopolitically driven catalyst for uneven and multi-level transformation. By examining the Baltic region through a comparative lens, the analysis reveals how crisis conditions generate both innovation and fragmentation, reshaping regional economic systems in differentiated ways. This section situates these findings within broader theoretical debates, and reflects on their implications for energy transition, regional development and European integration.

5.1. Crisis as a geopolitical catalyst and critical juncture

A central insight emerging from this study is that crises, particularly those rooted in geopolitical conflict, can act as critical junctures that disrupt existing path dependencies and enable systemic transformation. Consistent with resilience theory, the energy shock destabilised established energy regimes, exposing structural vulnerabilities and creating space for alternative practices, governance arrangements and institutional reforms (Capano et al., 2026; Ioannou, Charalambous, 2025).

However, unlike conventional economic crises, the current energy shock is deeply embedded in geopolitical dynamics. The weaponisation of energy by Russia transformed supply disruptions into issues of sovereignty, security and political alignment. As a result, responses in the Baltic region were not driven solely by economic rationality, but also by strategic considerations, accelerating the decoupling from Russian energy sources and reinforcing regional cooperation.

The findings suggest that the crisis has not simply accelerated pre-existing transitions, but has qualitatively altered their direction. Energy transition has become more closely linked to security imperatives, resulting in a reconfiguration of priorities towards diversification, decentralisation and resilience. At the same time, the extent of transformation varies significantly across countries, indicating that crisis-induced change is contingent upon structural conditions, institutional capacity and political will.

5.2. Social innovation beyond the technological paradigm

A second key contribution of this study lies in demonstrating that energy transition cannot be adequately understood through a purely technological lens. While policy debates often emphasise renewable energy deployment and infrastructure development, the empirical analysis highlights the central role of socially embedded innovation processes (Radtke, 2025; Radtke, Renn, 2024).

Across the four countries examined, social innovation manifests in multiple forms: behavioural adaptation at the household level, collective initiatives at the community level, and governance innovation at the institutional level. These processes reflect shifts in social norms, coordination mechanisms and patterns of participation, rather than solely technological change.

Importantly, the findings reinforce the view that energy transitions are inherently socio-technical transformations, in which technological systems are shaped by, and dependent on, social practices and institutional frameworks. The emergence of prosumer models, community energy initiatives and adaptive policy instruments illustrates how social dynamics play a critical role in enabling or constraining technological adoption.

This perspective also highlights a potential limitation in current policy approaches, which often prioritise infrastructure and market mechanisms, while underestimating the importance of behavioural change, social acceptance and collective action. Ignoring these dimensions risks producing incomplete or uneven transition outcomes.

5.3. Multi-level interaction and systemic complexity

The study further demonstrates that social innovation emerges through interactions across multiple levels of the economic system, rather than within isolated domains. Household-level behavioural changes influence demand patterns, which in turn shape market dynamics and policy responses. Similarly, institutional reforms create enabling conditions for community initiatives and individual action.

This multi-level interaction underscores the importance of adopting a systems perspective when analysing regional adaptation. Effective transformation depends not only on changes at individual levels, but also on the alignment and reinforcement between them. The Baltic cases illustrate how coordinated developments across behavioural, social and institutional domains can enhance adaptive capacity.

At the same time, these interactions introduce new forms of complexity and tension. For instance, rapid policy shifts may exceed the adaptive capacity of households or local communities, while unequal access to resources can lead to differentiated participation in innovation processes. These dynamics suggest that transformation is not inherently smooth or linear, but involves trade-offs, feedback loops, and potential points of friction.

5.4. Divergence, path dependency and uneven transformation

The comparative analysis of Lithuania, Latvia, Estonia and Poland highlights the importance of path dependency and structural differentiation in shaping responses to crisis conditions. Despite facing a common external shock, the four countries exhibit distinct trajectories of adaptation, reflecting differences in energy system configuration, institutional flexibility and economic scale.

Lithuania's rapid decoupling and institutional agility contrast with Poland's more gradual and constrained transition, while Latvia and Estonia occupy intermediate and hybrid positions. These variations demonstrate that social innovation is not a uniform process, but is shaped by historically embedded structures and context-specific conditions.

Moreover, the broader European context reveals an additional layer of divergence. The continued reliance of Hungary and Slovakia on Russian energy illustrates how national priorities and structural constraints can lead to fragmented policy responses within the EU, limiting collective coherence and potentially weakening overall resilience.

These findings suggest that energy transition should be understood as an uneven and politically conditioned process, rather than a linear or harmonised trajectory. Path dependency can both enable and constrain innovation, depending on how existing structures interact with new pressures.

5.5. Implications for regional development and European policy

The results of this study have several important implications for regional development and policy design. First, they highlight the need to reconceptualise resilience, not as a return to stability, but as the capacity for transformation under crisis conditions. Regions that are able to leverage crisis conditions to stimulate innovation may achieve more sustainable and competitive outcomes in the long term (OECD, 2024; World Bank, 2026).

Second, the findings emphasise the importance of integrating social innovation into energy policy frameworks. Policies that support behavioural change, community engagement and participatory governance can complement technological investment and enhance the effectiveness of transition strategies.

Third, the analysis underscores the importance of policy coherence at the European level. Internal divergences in energy strategy, particularly regarding continued reliance on external suppliers, can undermine collective efforts and create structural vulnerabilities. Strengthening coordination mechanisms and aligning national policies with broader EU objectives will be critical for achieving long-term energy security and sustainability.

5.6. Limitations and directions for future research

Despite its contributions, this study has several limitations. The reliance on secondary data, and a qualitative, interpretive approach, limits the ability to provide detailed empirical measurement or causal inference. Future research could build on this work by incorporating primary data, such as interviews or surveys, to explore micro-level behavioural dynamics and institutional processes in greater depth.

Additionally, while the focus on four countries allows for a meaningful comparison, expanding the analysis to include a wider range of European cases would provide a more comprehensive understanding of regional variation and policy divergence. Comparative studies across different geopolitical contexts could further illuminate the conditions under which social innovation emerges and is sustained.

Finally, longitudinal research would be valuable in assessing the durability of crisis-induced changes. It remains an open question whether the innovations observed represent a lasting transformation or a temporary adaptation to exceptional circumstances.

Conclusion

This paper has examined the recent energy crisis, triggered by the Russian invasion of Ukraine, as a catalyst for social innovation and regional economic transformation in the Baltic region. Moving beyond conventional interpretations of crisis as disruption, the analysis demonstrates that energy shocks can stimulate adaptive responses across multiple levels of the economic system, encompassing behavioural change, collective action and institutional reform.

The findings highlight that energy transition is not driven by technological change alone, but by the interaction between social practices, governance structures and political-economic conditions. The comparative analysis of Lithuania, Latvia, Estonia and Poland illustrates how shared exposure to a geopolitical shock can produce differentiated pathways of adaptation, shaped by structural constraints, institutional capacity and strategic orientation.

At the same time, the study reveals that the crisis has exposed internal divergences within the EU, where uneven responses to energy dependency create challenges for policy coherence and collective resilience. In this context, social innovation emerges both as an adaptive mechanism and a politically conditioned process. Overall, the paper argues that crises can function as transformative moments, not only accelerating innovation, but also reshaping the structural and political foundations of regional economic systems towards more resilient and sustainable configurations.

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NUO ENERGETINIO ŠOKO IKI SOCIALINIŲ INOVACIJŲ: GEOPOLITINĖ KRIZĖ, REGIONINĖ DIVERGENCIJA IR EKONOMINĖ TRANSFORMACIJA BALTIJOS REGIONE

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Santrauka

Šiame straipsnyje nagrinėjama, kaip pastaroji energetikos krizė Baltijos regione paspartino socialinių inovacijų ir regioninės ekonominės transformacijos procesus. Nors 2022 m. Rusijos invazija į Ukrainą tapo reikšmingu geopolitiniu lūžio tašku, tyrime teigiama, kad krizės nereikėtų suprasti kaip Europos energetinės transformacijos pradžios, veikiau tai stiprus katalizatorius, paspartinęs jau anksčiau vykusius struktūrinius pokyčius, susijusius su energetiniu saugumu, dekarbonizacija ir regioniniu atsparumu. Krizė išsivystė platesniame kontekste, kurį formavo ankstesnės geopolitinės įtampos, augantis susirūpinimas priklausomybe nuo rusiško iškastinio kuro bei COVID-19 pandemijos sukelti ekonominiai sutrikimai.

Tyrime taikomas kokybinis ir lyginamasis tyrimo metodai, orientuoti į keturias Baltijos regiono valstybes – Lietuvą, Latviją, Estiją – ir Lenkiją. Šios šalys pasirinktos kaip patyrusios tą patį išorinį energetinį sukrėtimą, tačiau reikšmingai skiriasi instituciniu pajėgumu, energetikos sistemų struktūra ir transformacijos kryptimis. Tyrimas grindžiamas lyginamąja kokybine dokumentų analize bei temine antrinių duomenų analize, apimančia Europos Sąjungos politikos dokumentus, nacionalines energetikos strategijas, tarptautinių organizacijų ataskaitas ir akademinę literatūrą energetikos transformacijos, socialinių inovacijų ir regioninės plėtros tematika.

Straipsnyje plėtojama daugiapakopė analitinė sistema, integruojanti socialinių inovacijų ir atsparumo teorijas, elgsenos ekonomikos ir institucinės analizės perspektyvas. Socialinės inovacijos suprantamos kaip naujų koordinavimo, valdymo ir kolektyvinio veikimo formų atsiradimas, leidžiantis prisitaikyti krizės ir sisteminių sutrikimų sąlygomis. Analizėje išskiriami namų ūkių lygmens elgsenos pokyčiai, bendruomeninio lygmens kolektyvinės iniciatyvos ir institucinio lygmens valdymo transformacijos.

Tyrimo rezultatai atskleidė, kad energetikos krizė paskatino reikšmingas socialines inovacijas visose keturiose šalyse, nors jų intensyvumas ir pobūdis skyrėsi. Namų ūkių lygmeniu augančios energijos kainos paskatino energijos taupymo praktikų plėtrą, prosumerių veiklą ir decentralizuotą atsinaujinančios energetikos technologijų diegimą. Bendruomeniniu lygmeniu savivaldybės ir vietos veikėjai kūrė kooperacines iniciatyvas, dalijimosi energija mechanizmus ir vietos atsparumą stiprinančias paramos sistemas. Instituciniu lygmeniu valstybės spartino diversifikacijos politiką, investicijas į atsinaujinančią energetiką, SGD infrastruktūrą bei regioninio koordinavimo mechanizmus.

Lyginamoji analizė atskleidžia reikšmingus regioninius skirtumus prisitaikymo procesuose. Lietuva pademonstravo sparčiausią transformaciją dėl ankstesnių investicijų į diversifikaciją ir institucinio lankstumo. Latvija akcentavo regioninį bendradarbiavimą ir tinklinį atsparumą. Estija pasirinko hibridines strategijas, derindama energetinį saugumą su tvarumo tikslais, o didesnė ir labiau nuo ankstesnių struktūrų priklausoma Lenkijos energetikos sistema lėmė lėtesnę transformaciją.

Straipsnyje daroma išvada, kad socialinės inovacijos Baltijos regione yra netolygios, politiškai nulemtos ir glaudžiai susijusios su geopolitiniu spaudimu bei instituciniu pajėgumu. Todėl energetikos krizė veikia ne tik kaip sutrikimų šaltinis, bet ir kaip transformacinis momentas, galintis pakeisti regionines ekonomines sistemas, valdymo struktūras ir ilgalaikes tvarumo trajektorijas.

RAKTAŽODŽIAI: *energetikos krizė, energetinis saugumas, geopolitika, regioninė plėtra, socialinės inovacijos.*

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