Bioeconomy Strategies for Energy Security: Building Resilience under Global Uncertainty

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Recent oil price volatility and geopolitical uncertainty highlight the need for more resilient energy production models. This study examines the bioeconomy as a strategic framework to address instability in global energy and material supply chains. Historical and recent oil crises demonstrate how fluctuations in fuel markets disrupt industrial competitiveness, particularly in energy-intensive sectors, while propagating impacts across downstream value chains. The bioeconomy offers an alternative pathway through the valorization of biobased resources. Current estimates place its contribution at approximately 3.5 to 4% of global gross domestic product (GDP), with significant growth projected by 2050. However, expansion remains constrained by challenges related to technological scale-up, regulatory fragmentation, investment risk, and limited standardization. Regional analysis reveals heterogeneous development patterns, with strong potential in resource-rich regions such as Latin America to promote localized value creation and reduce external dependencies. Key strategic priorities include strengthening regional value chains, advancing scalable biorefinery platforms, improving regulatory coherence, and expanding investment frameworks. These measures position the bioeconomy as a critical component for enhancing energy security, increasing industrial resilience, and supporting sustainable economic development in conditions of global uncertainty.

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Bioeconomy Challenges in Uncertain Contexts

Current oil price volatility, partly driven by tensions in the Persian Gulf, highlights the exposure of global energy markets. Approximately 20 to 25% of the world's seaborne oil transits through the Strait of Hormuz, making it a vital route for global oil supply. This situation highlights the importance of developing strategies to improve energy security and resilience under uncertain conditions, as localized geopolitical disruptions can impact global economies.

Oil price shocks have repeatedly disrupted industrial development by causing sudden and substantial increases in energy costs. Historically, the rise in oil prices has driven the development of more energy-efficient and self-sufficient technologies, underscoring the exposure of industrial systems to fluctuations in oil markets.

Currently, some important decisions and discussions are being developed with their origin in the recent oil crisis related to the conflict in the Middle East, which has

resulted in oil prices increasing by more than 50%, reaching values of about USD 120 per barrel (USD 72/ barrel before the conflict). Natural gas was also affected, with its prices increasing by nearly 70%. Specific products, such as aviation fuel, were also highly affected; in some cases, the increase reached 140%. Additionally, European and UK buyers face a jet fuel supply-at-risk exposure of close to 80% of normal import flows from the region. Asia reduces its flight frequency and increases ticket sales due to price increases and oil supply generated by the conflict in the Middle East.

Also, petrochemical feedstocks such as naphtha and LPG are disrupted and are commonly used in the production of polymers, plastics, and chemicals. Beyond fossil-based feedstocks, other crucial materials, such as fertilizers, are expected to experience disruptions and price increases due to the ongoing war. Prices are expected to increase 30-40% around the world, highlighting the need for value creation at origin through the valorization of regional sources as a critical strategy for energy and material independence of countries and regions.

The need to address the situation has led to different responses around the world. The United Arab Emirates (UAE) announced its withdrawal from OPEC and the OPEC+ alliance, effective May 1, 2026, to achieve economic diversification. The Netherlands has banned advertising for the use of conventional energy sources, including for flights and cruises. From our Latin American perspective, we believe there are other answers.

Bioeconomy as a Response

The bioeconomy is emerging as a strategic response to oil dependence and price volatility, offering a pathway to strengthen energy security by integrating bio-based industries into national economies. Utilizing biobased resources offers an alternative to conventional energy sources, decreasing exposure to oil market fluctuations. Although still in its early stages globally, its consolidation depends on improved policies, regulatory frameworks, standardization, and education, as well as stronger international collaboration. Global initiatives emphasize the need to embed the bioeconomy within broader economic strategies and foster partnerships to accelerate its development. Economically, its current contribution to the global economy is projected to grow significantly, reinforcing its role as a key pillar in reducing oil reliance and supporting more resilient and sustainable energy systems.

At the same time, the bioeconomy presents both challenges and opportunities that can guide strategic roadmaps for its advancement. Experiences such as the expansion of biofuel blends and the consolidation of mature bioethanol markets demonstrate how bio-based systems can buffer the impacts of oil price fluctuations and enhance energy resilience. Key drivers for growth include more stable and coherent regulatory frameworks, improved access to financing, stronger intellectual property protection, expanded market access, and increased education across the value chain. In parallel, international strategies highlight the need to address technological scaling, prioritize the highest-value uses of limited biomass resources, and streamline standardization processes. As a result, the bioeconomy is increasingly positioned not only as an environmental alternative but also as a strategic instrument for economic development and geopolitical stability.

New Strategies and Opportunities for Latin American Countries

Regions such as Latin America are highly promising due to the availability of natural resources and extensive agricultural and forestry systems. Strategic approaches

should prioritize domestic value creation through the development of bioproducts, biopharmaceuticals, composite materials, polymers, and nanomaterials, while also strengthening infrastructure, policy frameworks, and emerging concepts such as the urban bioeconomy. Despite this potential, the advancement of the bioeconomy in Latin American countries faces structural challenges, including the geographic dispersion of biomass, competition with food systems, the predominance of pilot-scale technologies, high capital costs, and fragmented regulatory environments.

At the same time, the region offers significant opportunities to valorize agricultural and forestry residues, promote regional value chains, and leverage advances in biotechnology and modular processing. Key priorities include establishing biomass use hierarchies, fostering public–private partnerships for scale-up, and standardizing processes and bioeconomy metrics. Latin America also holds a strategic geopolitical position, with the potential to advancing from raw material exportation toward domestic production of higher-value-added bioproducts, thereby strengthening energy security and regional industries. Achieving this potential requires coherent regulatory frameworks, improved access to blended finance, and investment strategies aligned with local risk profiles. Additionally, there is a need for stronger education, interdisciplinary training, and enhanced collaboration among academia, industry, and government.

Some examples indicate that we are on the right track. In this context, Brazil stands out as the most successful case thanks to its maturity in the bioeconomy. While gasoline prices in some regions rose by more than 30% in March 2026 due to the conflict in the Middle East, in Brazil, the increase was only 5%, thanks to its technological development and sustained strategies in biofuels. The Brazilian government is considering increasing the mandatory bioethanol blend in gasoline to 32% by the first half of 2026. This example demonstrates the strategic value of sustained investment in bioeconomy. In less than two decades, Uruguay has consolidated a highly diversified electricity matrix, with more than 90% of its electricity coming from sources like hydroelectric, biomass, wind, and solar.

Argentina's energy matrix towards 2025-2026 is undergoing a structural transformation, characterized by the dominance of conventional energy sources (natural gas and oil) alongside sustained growth in energy systems, covering more than 50% of total electricity generation, including conventional hydroelectric power.

Northeastern Argentina (NEA) has a strong forestry and agro-industrial profile, positioning it as a strategic region for bioeconomy development. Misiones and Corrientes concentrate most of the electricity generation by biomass, with 9 operational plants nationwide that add up to about 76 MW of installed capacity by March 26, covering about 5 to 10% of the combined electricity consumption of both provinces. The abundant biomass can also be used for producing liquid biofuels and a wide range of bioproducts, including chemicals, food, and pharmaceuticals. Unlocking this potential requires integrated strategies based on public policies, infrastructure investment, and the strengthening of technical capacities. Regional initiatives, such as BioNA (Northern Argentina Biorefineries), illustrate concrete progress in transforming local resources and integrating them into the national productive matrix. In this context, the bioeconomy emerges not as an alternative but as a central development strategy, enabling production and energy diversification, reducing exposure to external crises, generating local employment, and adding value at the source, while positioning the region as a competitive actor in a biobased economy.