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Leveraging regional resources to address regional energy challenges in the transition to a low-carbon future

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Abstract

The transition to a low-carbon future is crucial in addressing global energy challenges and mitigating the impacts of climate change. This review paper explores the role of regional resources in supporting the energy transition, focusing on strategies to overcome specific regional energy challenges. By identifying key regional resources such as renewable energy potential, human capital, and technological infrastructure, the paper highlights opportunities for regions to leverage these assets effectively. It also examines the importance of policy frameworks and governance in facilitating the transition and emphasizes the need for collaboration among public, private, and community stakeholders. Furthermore, the paper outlines future prospects for sustainable energy solutions at the regional level, recommending policy, technological, and economic strategies to enhance the energy transition and ensure long-term sustainability. The paper concludes by presenting a vision of resilient, self-sustaining regional energy systems that contribute to global decarbonization efforts.

Keywords: Low-carbon transition; Regional energy resources; Renewable energy; Energy policy; Sustainable energy

1. Introduction

1.1. Overview of the Global Low-Carbon Transition

The low-carbon transition refers to the global movement to reduce reliance on fossil fuels, such as coal, oil, and natural gas, and replace them with cleaner energy sources, such as wind, solar, hydropower, and geothermal energy (Kabeyi & Olanrewaju, 2022). This transition is driven by international agreements such as the Paris Agreement, which aims to limit global temperature rise to below 2°C and pursue efforts to limit it to 1.5°C. In recent years, many countries have committed to achieving net-zero carbon emissions by mid-century, recognizing that carbon-intensive energy systems are the primary contributors to climate change (Tian, Yu, Xue, Zhuang, & Shan, 2022).

The transition is not solely focused on the energy sector but encompasses the decarbonization of other industries, such as transportation, manufacturing, and agriculture (Nurdiawati & Urban, 2021). The deployment of renewable energy technologies and innovations in energy efficiency are key components of the low-carbon transition. However, the path to decarbonization is not uniform across regions, as different areas face distinct energy challenges related to their geographic location, resource availability, infrastructure, and socioeconomic conditions (Papadis & Tsatsaronis, 2020).

1.2. Importance of Addressing Regional Energy Challenges

Regional energy challenges play a significant role in shaping how the global low-carbon transition unfolds. Each region has unique characteristics that determine its energy needs, resource access, and capacity for change (Sovacool &

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Brisbois, 2019). For instance, developing regions may struggle with inadequate energy infrastructure, limiting their ability to transition to renewable energy. In contrast, developed regions may face challenges related to the integration of renewable energy into already established, fossil-fuel-dependent grids. Similarly, regions rich in fossil fuel resources, such as coal or natural gas, often face economic pressures to continue exploiting these resources despite the global push for cleaner alternatives (Roberts et al., 2018).

Addressing these challenges is vital for ensuring that no region is left behind in the global energy transition. Regional energy access, infrastructure, and resource availability disparities can exacerbate inequalities between developed and developing regions. Moreover, failing to address these challenges could hinder the global effort to reduce carbon emissions and slow progress toward meeting international climate goals. A targeted approach that considers each region's specific needs and resources is essential for achieving a fair and effective low-carbon transition.

1.3. The Role of Regional Resources in Supporting Energy Transitions

Regional resources are critical in enabling energy transitions by providing the foundation for localized energy solutions. Renewable energy potential varies significantly across regions, depending on climate, geography, and natural resources. Regions with abundant sunlight, for example, can harness solar power to meet their energy needs, while coastal areas with high wind speeds can develop offshore wind farms. Similarly, areas with geothermal activity, such as Iceland, can tap into geothermal energy as a sustainable power source (Cantarero, 2020).

Beyond natural resources, human capital and technological capacity are also important regional assets that can support energy transitions. Regions with strong research institutions and a skilled workforce are better positioned to develop and implement innovative energy technologies. Furthermore, local knowledge and expertise are invaluable for adapting global energy solutions to regional contexts, ensuring that they are both effective and sustainable (Lèbre et al., 2020).

In addition to renewable energy potential, regions must consider their energy infrastructure and how it can be adapted to accommodate new energy sources. For example, transitioning from a centralized, fossil-fuel-based energy grid to a decentralized, renewable energy system may require significant investments in grid modernization and energy storage. Regional governments and industries must collaborate to build the necessary infrastructure to support this transition (Noussan, Raimondi, Scita, & Hafner, 2020).

1.4. Objectives of the Paper

The primary objective of this paper is to explore how regional resources can be leveraged to address specific energy challenges in the transition to a low-carbon future. The paper aims to highlight the importance of regional approaches to the energy transition, emphasizing the need for localized solutions that take into account regional disparities in energy access, infrastructure, and resource availability. Additionally, the paper seeks to identify strategies for effectively harnessing regional resources, including renewable energy potential, human capital, and technological innovation, to support sustainable energy systems.

This paper will also examine the role of policy and governance in facilitating regional energy transitions. By exploring existing policies and governance frameworks that promote regional resource utilization, the paper aims to provide insights into how governments at the national and regional levels can collaborate to create an enabling environment for energy transitions. Finally, the paper will offer future prospects and recommendations for leveraging regional resources, focusing on the long-term vision for sustainable energy solutions at the regional level.

In conclusion, the low-carbon transition is a global imperative that requires a tailored approach to address different regions' unique energy challenges. By focusing on regional resources and localized solutions, this paper aims to contribute to a more nuanced understanding of how regions can play a critical role in achieving global climate goals. The effective utilization of regional resources, combined with supportive policy frameworks and governance structures, will be key to ensuring a successful transition to a low-carbon future for all regions.

2. Regional Energy Challenges

2.1. Energy Access Disparities

Access to reliable and affordable energy is one of the most pressing energy challenges in many developing regions. According to the International Energy Agency (IEA), nearly 770 million people worldwide still live without electricity, with the vast majority concentrated in Sub-Saharan Africa and parts of Asia (Oh, Hasanuzzaman, Selvaraj, Teo, & Chua, 2018). In these regions, the lack of energy access hampers economic growth and human development, as energy is

essential for basic services such as education, healthcare, and water supply. Without access to electricity, industries cannot thrive, limiting job creation and the overall economic development of communities. Additionally, women and children are often disproportionately affected, as they spend more time gathering firewood or cooking with inefficient fuels, which also contribute to indoor air pollution (Cantarero, 2020).

The disparity in energy access between urban and rural areas further compounds the issue. While urban areas in developing regions are more likely to have access to electricity, rural populations are often left behind. The cost of extending energy infrastructure to remote areas can be prohibitive, and governments may lack the financial resources or political will to prioritize rural electrification. This uneven distribution of energy access deepens socioeconomic inequalities and makes it difficult for rural regions to participate in the broader economic development of their countries (Shahsavari & Akbari, 2018).

2.2. Aging Infrastructure and Energy Reliability

In many developed regions, the energy challenges are different, yet no less significant. Aging energy infrastructure is a major issue in parts of North America, Europe, and other high-income regions. Much of the energy infrastructure in these regions was built during the mid-20th century, when the primary energy sources were fossil fuels like coal, oil, and natural gas. As these systems age, they become less efficient, more prone to breakdowns, and less compatible with modern renewable energy technologies. For example, the electrical grids in the United States and parts of Europe were designed for centralized, large-scale power generation rather than the decentralized and intermittent nature of renewable energy sources like solar and wind (Ahmad & Zhang, 2020).

Energy reliability is also a growing concern, particularly in regions experiencing more frequent and severe weather events due to climate change. Hurricanes, wildfires, floods, and heatwaves are increasingly disrupting energy supply chains and causing blackouts in both developed and developing regions. For example, in 2021, the state of Texas in the United States experienced a severe winter storm that caused widespread power outages, leaving millions of residents without heat or electricity for days. This event highlighted the vulnerabilities of the energy grid in the face of extreme weather and underscored the need for greater resilience in energy systems (Jiang, Van Fan, & Klemeš, 2021).

Similarly, European countries have faced disruptions in energy supplies due to geopolitical factors, such as the dependency on natural gas imports from Russia (Kutcherov, Morgunova, Bessel, & Lopatin, 2020). The 2022 Russian invasion of Ukraine resulted in a major energy crisis in Europe, as many countries had to quickly diversify their energy sources to reduce their reliance on Russian gas (Rokicki, Bórawski, & Szeberényi, 2023). This has sparked renewed interest in renewable energy investments, but it has also highlighted the challenges of transitioning to a low-carbon energy system while ensuring energy security and reliability.

2.3. Economic and Social Impacts

The energy challenges regions face profoundly impact local economies and communities. In regions with limited energy access, economic development is often stifled, leading to a cycle of poverty and underdevelopment. For instance, in many parts of Sub-Saharan Africa, industries struggle to operate due to unreliable power supplies, and businesses face high operational costs from running diesel generators (Nalule, 2018). This limits economic growth and discourages foreign investment in these regions. The lack of reliable energy also affects public services, particularly healthcare. Hospitals and clinics in energy-poor regions often lack the power needed to run medical equipment, store vaccines, or provide emergency care, which can have dire consequences for public health (Salimi & Amidpour, 2022).

In contrast, in developed regions, the economic impact of energy challenges is often felt in the form of higher costs for consumers and businesses. For example, the transition from fossil fuels to renewable energy sources requires substantial investment in new infrastructure, such as wind farms, solar panels, and upgraded transmission lines (Adewuyi et al., 2020). These costs can be passed on to consumers in the form of higher energy prices, which may disproportionately affect low-income households. In addition, industries that rely heavily on fossil fuels, such as manufacturing and transportation, may face higher operational costs as carbon pricing mechanisms and emissions regulations become more stringent (Clausen & Rudolph, 2020).

The social impacts of energy challenges are also significant. In regions with compromised energy reliability, people may experience frequent blackouts, disrupting daily life and business operations (Haes Alhelou, Hamedani-Golshan, Njenda, & Siano, 2019). Energy poverty—defined as the inability to afford adequate heating, cooling, and lighting—remains a widespread issue even in high-income countries. In the European Union, for example, around 34 million people could not afford to adequately heat their homes in 2020, an exacerbated situation by rising energy prices. Energy poverty disproportionately affects vulnerable populations, including the elderly, low-income families, and those living in poorly

insulated homes, leading to negative health outcomes such as respiratory illnesses and increased mortality during extreme weather conditions (Mastrucci, Byers, Pachauri, & Rao, 2019).

2.4. Examples of Challenges in Different Regions

Both developed and developing regions face unique energy challenges. In the developing world, countries like India and Nigeria illustrate the ongoing struggle with energy access. India has made significant progress in recent years through its rural electrification efforts, yet millions still experience unreliable electricity, particularly in rural areas. Nigeria, Africa's largest economy, faces chronic energy shortages despite being a major oil producer. Its reliance on a dilapidated power grid and widespread use of diesel generators has resulted in one of the highest energy costs in the world, severely limiting its economic potential (Sanni, Oricha, Oyewole, & Bawonda, 2021).

On the other hand, developed regions such as the European Union and North America face the challenge of modernizing aging energy systems. The European Green Deal, an ambitious plan to make the EU climate-neutral by 2050, aims to decarbonize the energy sector while ensuring energy security (Hafner & Raimondi, 2020). However, the high costs of transitioning to renewable energy and the political complexity of energy policy in a union of 27 countries present significant challenges. Similarly, in the United States, efforts to transition away from coal have been hindered by political polarization, regulatory challenges, and the need for large-scale investments in renewable energy infrastructure (Bäckstrand, 2022).

3. Leveraging Regional Resources

3.1. Identification of Regional Resources

Regions around the world possess a wide array of resources that can be tapped to support their energy transitions. These resources can be broadly categorized into natural resources, renewable energy potential, and human capital. One of the most significant regional resources is renewable energy potential. Different regions are endowed with varying capacities for renewable energy generation based on their geographic and climatic conditions. For example, countries in the Middle East and North Africa (MENA), as well as Sub-Saharan Africa, benefit from an abundance of solar energy due to high solar irradiance levels (Abdelrazik, Abdelaziz, Hassan, & Hatem, 2022). The Sahara Desert, for instance, has the potential to generate enough solar energy to power entire countries if the proper infrastructure is put in place. Similarly, coastal regions in Northern Europe, parts of the United States, and China have considerable wind energy potential due to strong and consistent wind patterns. In Latin America, Brazil has long capitalized on its vast hydropower resources, providing the majority of its electricity through this renewable source (Alfredsen et al., 2022). Recognizing these renewable energy potentials is the first step toward utilizing them effectively.

Beyond renewable energy potential, regions may have other valuable natural resources that can play a role in the energy transition. For example, some regions possess large reserves of critical minerals and metals such as lithium, cobalt, and rare earth elements, which are essential for the production of batteries and other clean energy technologies. Chile and Bolivia, for instance, are rich in lithium, which is vital for electric vehicle batteries and energy storage systems (Cantarero, 2020).

In addition to natural resources, human capital is a critical resource that varies across regions. Countries with a skilled workforce, strong research institutions, and robust industrial bases have a comparative advantage when it comes to developing, deploying, and maintaining renewable energy technologies (Chang et al., 2021). For instance, Germany's advanced engineering expertise and leadership in renewable energy technologies have enabled it to become a global leader in the development of wind turbines and solar photovoltaic systems. Similarly, countries with strong educational institutions, like the United States, Japan, and South Korea, have the human capital necessary to drive innovation in energy efficiency, smart grids, and advanced storage technologies (Kabeyi & Olanrewaju, 2022).

3.2. Strategies for Harnessing These Resources Effectively

Effectively leveraging regional resources requires strategic planning and investment. A key strategy for harnessing renewable energy potential is the development of region-specific energy infrastructure. For example, regions with abundant solar energy potential can focus on developing large-scale solar farms (Di Castelnuovo & Biancardi, 2020). Morocco's Noor Ouarzazate Solar Complex, one of the world's largest concentrated solar power plants, is an example of how regions with high solar irradiance can capitalize on this resource to reduce their reliance on fossil fuels. Similarly, countries with strong wind energy potential, such as Denmark and the United Kingdom, have invested in offshore wind farms, which can generate significant amounts of electricity without taking up valuable land (Irowarisima, 2021).

Another important strategy is fostering regional collaboration. In cases where renewable energy resources are abundant but unevenly distributed, regional cooperation can allow neighboring countries to share resources. For example, the European Union has developed interconnected energy grids that allow for the efficient distribution of renewable energy across borders. This ensures that surplus wind or solar energy produced in one country can be exported to another, maximizing the use of regional renewable resources. Regional energy markets, supported by intergovernmental agreements, can also promote cross-border investments in energy infrastructure and facilitate the sharing of technological expertise (Xiangchengzhen & Yilmaz, 2020).

In regions with abundant natural resources, strategies for harnessing these resources should focus on the sustainable extraction and processing of critical minerals and metals. Countries rich in these materials can develop value-added industries by investing in processing facilities and manufacturing capabilities, allowing them to move up the clean energy value chain (Ayuk et al., 2020). For example, Australia, which is rich in rare earth elements, has begun to invest in the local processing of these materials to reduce its reliance on foreign supply chains and enhance its role in the global energy transition (Sovacool et al., 2020).

Human capital development is another essential strategy for effectively leveraging regional resources. Regions that invest in education and training programs can build the skilled workforce needed to support the development, installation, and maintenance of renewable energy technologies. For example, countries like India and South Africa have launched programs to train workers in solar and wind energy technologies, creating new job opportunities while advancing their energy transition goals. Partnerships between governments, educational institutions, and private companies can further enhance these efforts by aligning training programs with the needs of the renewable energy industry (Boon, Eckardt, Lepak, & Boselie, 2018).

3.3. Benefits of Localized Energy Solutions

Harnessing regional resources to develop localized energy solutions offers economic and social benefits. One of the key advantages is energy security. Regions that rely on locally available renewable energy resources, such as solar, wind, or hydropower, reduce their dependency on imported fossil fuels, which can be subject to price fluctuations and geopolitical tensions (Paravantis & Kontoulis, 2020). By developing indigenous energy resources, regions can enhance their energy independence and reduce their vulnerability to global energy market disruptions (Hamed & Bressler, 2019).

Localized energy solutions also contribute to economic development by creating new industries and job opportunities. The renewable energy sector is labor-intensive, particularly during the construction and installation phases. Regions investing in renewable energy infrastructure, such as solar farms or wind turbines, can generate significant employment opportunities in rural and urban areas. Additionally, the growth of renewable energy industries can spur the development of ancillary industries, such as manufacturing, maintenance, and research and development, further boosting local economies (Leal Filho et al., 2022).

Another important benefit of localized energy solutions is the potential for improving energy access in underserved areas. In regions where extending traditional grid infrastructure is challenging, such as remote rural areas, decentralized renewable energy systems like solar mini-grids or small-scale wind turbines can provide reliable and affordable electricity. This improves the quality of life for residents and supports local economic development by enabling access to modern services like refrigeration, lighting, and communication (Berka & Creamer, 2018). Localized energy solutions also have significant environmental benefits. By harnessing regionally available renewable energy resources, regions can reduce their carbon footprints and contribute to global climate goals. For example, transitioning from coal-fired power plants to solar or wind energy reduces greenhouse gas emissions, mitigates air pollution, and decreases reliance on water resources, which are often used in cooling fossil fuel plants. The decentralized nature of renewable energy systems also makes them more resilient to climate impacts, such as extreme weather events, which can disrupt centralized fossil fuel-based energy systems (Tushar et al., 2021).

4. Policy and Governance Frameworks

4.1. The Role of Regional and National Governments in Facilitating Energy Transitions

Governments at both the national and regional levels are central to shaping the direction and pace of the energy transition. Their role extends beyond setting energy targets or regulations; they must create an enabling environment that encourages investment, innovation, and collaboration across various sectors. This involves the formulation of

comprehensive energy policies that align with national development goals, climate commitments, and regional priorities. (Shahbaz, Wang, Dong, & Zhao, 2022)

National governments are primarily responsible for setting long-term climate and energy targets that guide the overall trajectory of the energy transition. This includes commitments to reduce carbon emissions, as seen in the Paris Agreement and setting renewable energy targets to meet these goals. For example, the European Union (EU) has established ambitious goals to achieve climate neutrality by 2050, with specific targets for reducing greenhouse gas emissions and increasing the share of renewable energy in its energy mix. These high-level commitments create the framework within which regional governments and local authorities can implement more localized energy policies (Cherp, Vinichenko, Jewell, Brutschin, & Sovacool, 2018).

Regional governments, on the other hand, are better positioned to address the unique energy challenges and opportunities within their jurisdictions. They play a crucial role in tailoring national energy policies to their regions' specific needs and conditions. For example, a coastal region with significant wind energy potential may prioritize policies that incentivize the development of offshore wind farms, while a region rich in solar potential may focus on promoting rooftop solar installations (Cantarero, 2020). Regional governments are also responsible for land-use planning, infrastructure development, and local regulatory approvals, all of which are essential for successfully deploying renewable energy projects (Petersen & Heurkens, 2018).

Both regional and national governments must also ensure that their energy policies are designed to support a just transition. This means that policies should prioritize creating new jobs in the renewable energy sector, support communities dependent on fossil fuel industries, and ensure that the benefits of the energy transition are distributed equitably. For example, in Germany, the government’s coal phase-out policy includes substantial investments in retraining programs for coal workers and economic diversification initiatives for coal-dependent regions (Furnaro et al., 2021).

4.2. Existing Policies that Promote Regional Resource Utilization

Many countries have already implemented policies that aim to promote the utilization of regional resources for energy generation (Qadir, Al-Motairi, Tahir, & Al-Fagih, 2021). These policies typically focus on incentivizing renewable energy development, encouraging energy efficiency, and supporting innovation in clean energy technologies. One of the most widely adopted policy mechanisms for promoting renewable energy is the feed-in tariff (FiT) system. FiTs guarantee renewable energy producers a fixed price for the electricity they generate over a specified period. This policy has been particularly successful in countries like Germany, which has used FiTs to rapidly expand its solar and wind energy capacity. By providing financial certainty to renewable energy developers, FiTs help stimulate investment in renewable energy projects, particularly in regions with significant renewable energy potential (Majid, 2020).

Renewable portfolio standards (RPS) are another common policy tool used to promote the utilization of regional resources. RPS mandates that utilities source a specific percentage of their electricity from renewable energy sources, which encourages the development of regional renewable energy projects (Zhou & Solomon, 2020). In the United States, states like California and Texas have implemented RPS policies that have driven the growth of their solar and wind energy industries. These policies are particularly effective in regions with abundant renewable energy resources, as they create a market for locally generated clean energy (Heeter, Speer, & Glick, 2019).

In addition to national policies, some regions have developed their own energy policies tailored to their unique resources and needs. For example, Scotland has set ambitious renewable energy targets and has implemented policies to support the development of its offshore wind industry, which leverages the country’s strong wind potential in the North Sea. Similarly, countries like Iceland, which has abundant geothermal resources, have implemented policies supporting the expansion of geothermal energy for electricity generation and heating (O'Hanlon & Cummins, 2020).

Policies that promote energy efficiency are also crucial for maximizing the potential of regional resources. By reducing overall energy consumption, regions can meet their energy needs with a higher share of renewable energy, reducing their reliance on fossil fuels. Energy efficiency standards for buildings, appliances, and industrial processes are commonly used to achieve this goal. For example, the EU has implemented stringent energy efficiency regulations for new buildings, which require them to meet nearly zero-energy standards. These regulations ensure that buildings make the most of regional renewable energy resources, such as solar power, by minimizing energy consumption.

4.3. Key Partnerships Between Public, Private, and Community Stakeholders

The energy transition requires collaboration across multiple sectors, and partnerships between public, private, and community stakeholders are essential for success. Each of these groups plays a unique role in the transition and brings different strengths to the table. Public-private partnerships (PPPs) are a common approach to financing and developing large-scale renewable energy projects. Governments provide the regulatory framework and financial incentives, while private companies bring the technical expertise and capital needed to implement projects. For example, Denmark's offshore wind industry has thrived thanks to strong collaboration between the Danish government, private wind energy developers, and financial institutions. The government's support for research and development, combined with private sector innovation, has made Denmark a global leader in wind energy technology (Othman & Khallaf, 2022).

Community involvement is also critical to the energy transition, particularly in regions where renewable energy projects are being developed. Communities often have a deep understanding of the local environment and can provide valuable input on how to utilize regional resources best. Community energy projects, where local residents own and operate renewable energy installations, are becoming increasingly popular in Europe and North America. These projects provide a source of clean energy and generate economic benefits for the community, creating jobs and revenue that can be reinvested locally (Tang et al., 2019).

Partnerships between educational institutions, governments, and industry are also essential for fostering innovation and building the workforce needed for the energy transition. Universities and research institutions play a key role in developing new clean energy technologies and improving the efficiency of existing ones. Governments can support this research through grants and funding programs, while private companies can provide practical applications for these innovations. For example, the United Kingdom's Catapult Network facilitates collaboration between academia, industry, and government to accelerate the commercialization of new technologies, including those related to renewable energy (Vassileva, 2022).

5. Conclusion and Recommendations

The shift toward a low-carbon future opens up new opportunities for regions to harness renewable energy sources like wind, solar, geothermal, and hydropower. For instance, regions with significant wind resources could further develop offshore or onshore wind farms, creating a reliable source of clean energy while boosting local economies. Similarly, regions with high solar irradiance have the potential to establish large-scale solar farms, which could meet both local demands and contribute to national or even international energy grids.

In addition to renewable energy generation, regions can also explore innovations in energy storage, smart grid technologies, and energy efficiency. By investing in energy storage solutions, such as advanced batteries, regions can ensure a stable energy supply even when renewable sources are intermittent. Smart grids optimize electricity distribution and enhance efficiency and reliability, enabling regions to manage energy resources more effectively. Moreover, increasing energy efficiency at both household and industrial levels offers another avenue for reducing overall demand and minimizing carbon emissions.

Several recommendations are essential to fully realize the potential of regional resources in supporting the low-carbon transition. From a policy perspective, governments should continue to develop frameworks that incentivize renewable energy development and provide financial support for innovation. Carbon pricing, tax credits, and subsidies for clean energy projects can help drive investment in renewable technologies and energy infrastructure. In addition, governments should establish long-term energy goals, including binding commitments to reduce carbon emissions, to provide clear direction for regional energy strategies.

Technologically, research and development (R&D) should be prioritized to accelerate advancements in renewable energy technologies and energy storage systems. The public and private sectors must collaborate to invest in the commercialization of new technologies that can make clean energy more efficient and cost-effective. For example, ongoing research into hydrogen as a clean fuel source could provide a breakthrough in regions where electrification is difficult. Furthermore, integrating digital technologies, such as artificial intelligence (AI) and machine learning, into energy management systems could enhance energy forecasting and optimize renewable energy use.

From an economic standpoint, regions should explore the potential of public-private partnerships (PPPs) to fund large-scale renewable projects. By attracting private investment, regions can share the financial burden of transitioning to clean energy while benefiting from the expertise and innovation of private companies. Additionally, creating green job

programs can help local economies transition by retraining workers from fossil fuel sectors and providing new employment opportunities in renewable industries.

The long-term vision for regional energy solutions should focus on creating self-sustaining, resilient, and low-carbon energy systems. This involves generating renewable energy and developing systems that ensure energy equity, where all communities have access to affordable and reliable energy sources. By integrating renewable energy into local economies, regions can foster sustainable development, reduce dependency on fossil fuels, and contribute to global efforts to combat climate change. Moreover, regions should aim to become energy hubs, where local resources are maximized for energy production, consumption, and export. By exporting surplus renewable energy to neighboring regions or countries, energy-rich areas can strengthen their economic position while supporting global decarbonization efforts. In this scenario, regions would serve as both drivers of innovation and key players in the global energy transition.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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