EDITORIAL

Uniting Geo-Energy and Environment Science for a Sustainable Future

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Abstract

Against the backdrop of a profound global energy transition and escalating ecological and environmental risks, the *Journal of Geo-Energy and Environment* (*JGEE*) is launched to build a high-level scholarly platform at the intersection of 'Geo-Energy–Environment–Ecology'. *JGEE* focuses on conventional fossil energy, geothermal energy, and natural gas hydrates, as well as new energy sources such as hydropower, photovoltaics, and hydrogen, and advocates a closed-loop and cross-scale integration of theory–technology–numerical simulation–experiment. It concentrates on energy–environment coupling and resource management, including Carbon capture, utilization, and storage (CCUS), methane mitigation, subsurface energy storage, and systems optimization under the "Water–Energy–Land" nexus; it strengthens the constraining and enabling roles of ecological and environmental science in energy development, with attention to biodiversity, land and water resource management, ecosystem services, and nature-based solutions. We extend an invitation to the academic, engineering, policy, and industrial communities to promote cross-disciplinary collaboration and evidence-based decision-making, to advance synergistic co-benefits in high-efficiency, low-carbon energy utilization and ecological environmental protection, and to provide methods, evidence, and pathways for a sustainable future.

Keywords: geo-energy, fossil energy, subsurface energy storage, environment, ecosystems, biodiversity.

1 Introduction

The world today is facing unprecedented dual challenges in energy and the environment [1]. On the one hand, societal demand for energy continues to rise, while excessive consumption of conventional fossil energy has intensified climate risk. The growth rate of global energy consumption has surpassed the historical average; the rebound in coal and natural gas use has pushed carbon dioxide emissions back up, and the global energy system has yet to achieve substantive decoupling from economic growth [2]. Although installed capacity of renewable energy has repeatedly reached new highs, its growth remains

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insufficient to offset the emissions gap caused by fossil energy. According to the latest climate assessments, under current policy scenarios the average global temperature increase in the 21st century may reach 3.2°C, with the critical threshold of 1.5°C possibly being crossed as early as 2030–2035, while human activities have already caused about 1.1°C of warming [3, 4]. The impacts of climate change—such as extreme weather and sea-level rise—are becoming more severe, posing tremendous challenges to human survival and development.

On the other hand, the ecological and environmental crisis is equally alarming. Biodiversity and ecosystems are declining at unprecedented rates. Authoritative reports indicate that human activities have significantly altered approximately 75% of terrestrial and 66% of marine environments, with nearly one million species worldwide facing extinction. The loss of critical ecological elements—clean air, safe water, pollinating insects, forests—poses a threat to human well-being no less than climate warming. The scientific community warns that we are witnessing the onset of the planet's sixth mass extinction. Ecosystem degradation not only weakens nature's capacity to respond to climate change, but also directly imperils the resource base on which human survival depends. For example, healthy ecosystems such as forests and wetlands can function as massive carbon sinks and climate regulators; once degraded, they exacerbate greenhouse gas accumulation and reduce environmental carrying capacity. Therefore, the energy and climate crises are intertwined with the ecological and environmental crisis, and a holistic, systems-level solution is required.

In this context, the *Journal of Geo-Energy and Environment* (*JGEE*) has emerged to address urgent challenges in the global energy and environmental domains. The practical significance of this journal's founding lies in providing a high-level scholarly platform for the cross-disciplinary field of geo-energy and environment, aggregating global wisdom to drive the coordinated development of energy science and technology and ecological environmental protection. In the face of the wave of climate change and energy transition, establishing a journal focused on energy–environment cross-cutting issues not only responds to the call for global sustainable development, but also meets the academic and industrial need for a platform to disseminate integrated research outputs. The birth of *JGEE* aims to lead new directions in geo-energy and environmental research, to build bridges for cross-disciplinary integration, and to contribute ideas and solutions for easing the energy crisis, achieving climate targets, and protecting the ecological environment.

2 Journal Mission and Editorial Positioning

The mission of *JGEE* is to promote cross-integration between conventional geo-energy systems and new energy fields, advancing energy science and technology innovation in service of the global sustainable development agenda. The journal focuses on "geo-energy" systems, including conventional fossil energy (oil, natural gas, coal) and unconventional resources such as geothermal energy and natural gas hydrates, as well as the coordinated development of new energy technologies such as hydropower, solar, wind, and hydrogen. We fully recognize that fossil energy will remain an important component of the global energy supply for a considerable period, but its utilization must become more efficient and cleaner, and gradually complement renewable energy. Overreliance on non-renewable fossil fuels cannot fundamentally resolve the energy crisis and will inevitably exact environmental costs. Therefore, the journal advocates breaking disciplinary silos in the energy field and promoting deep integration among geoscience, energy engineering, and environmental science, exploring new pathways for the seamless transition between traditional energy and new energy. We encourage combining geological energy development such as oil and natural gas with emerging resources such as geothermal and hydrogen, and achieving high-efficiency complementarity among energy sources through technological innovation, thereby progressively reducing dependence on high-carbon energy in response to global warming and the demands of energy transition.

The journal welcomes submissions spanning basic theoretical research, laboratory experiments, numerical simulation, and engineering applications. We value cross-fertilization among traditional disciplines such as petroleum geology and mining engineering and fields such as climate science, environmental engineering, and new energy materials. Only by combining theoretical models with field practice, and mutually validating experimental observations and numerical computations, can the complex challenges of energy–environment coupling be tackled. To this end, *JGEE* encourages work in the following areas:

High-efficiency development and utilization of

geo-energy systems: covering subsurface occurrence and production mechanisms of conventional fossil energy (oil, natural gas, coal); extraction technologies for unconventional resources such as tight oil and gas, oil shale, and natural gas hydrates; geothermal energy and ground-source utilization; and energy recovery in mining areas. Innovative experimental evaluation, numerical simulation, and mechanistic studies will help improve the efficiency of fossil energy development and reduce environmental impacts—these are key areas of focus for the journal. At the same time, we also pay attention to the clean and efficient utilization of mineral resources such as coal, with the aim of providing scientific guidance for cleaner and more efficient development of traditional energy.

Integration of new energy with fossil energy: exploring technologies and models that combine renewable energy with traditional energy. For example, introducing geothermal energy and hydrogen into hydrocarbon reservoir development to realize 'oil & gas + geothermal' or 'oil & gas + hydrogen' synergistic production; developing underground coal gasification in coal-rich regions in conjunction with carbon capture and utilization to reduce carbon intensity; using curtailed wind and solar power to produce hydrogen and injecting it into formations for storage, serving as an enhanced oil/gas recovery or energy storage approach. Such multi-energy complementarity and integrated optimization will become an important component of future energy systems. Developing and utilizing renewable energy in geological reservoirs, such as geothermal and hydrogen, holds great potential; it can progressively substitute traditional fossil energy while effectively alleviating global warming and energy shortages [5]. The journal hopes to drive innovation in the corresponding theories and technologies so that different energy forms can achieve complementary advantages and integrated deployment, building an efficient, clean, and reliable future energy system.

Energy system modeling and numerical methods: energy and environmental systems are often complex and variable, involving multi-physics and multi-phase coupling [6, 7]. The journal encourages the development of new numerical simulation methods (e.g., high-performance computing, AI-assisted simulation) to characterize complex processes such as oil and gas exploration and development, geothermal heat transfer, fluid phase behavior, and geomechanical responses. We also focus on fusing data and models across industries, for example, coupling subsurface reservoir models with power-system models to study integrated "source–grid–load–storage" energy systems.

Overall, *JGEE* is positioned to serve cross-disciplinary innovation in the geo-energy and environment field: paying attention both to technological breakthroughs during the low-carbon transition of traditional energy science and to the geological and environmental constraints encountered in the large-scale deployment of new energy technologies. We hope the journal will become a convergence platform for knowledge in geoscience, engineering, and environmental science, promoting the coordinated development of energy technology and ecological environmental science, and contributing new ideas to global energy transition and environmental governance.

3 Frontiers in Energy–Environment Coupling and Resource Management

The journal places a high priority on the coupling between energy development and utilization and environmental protection and resource management. Modern energy engineering inevitably affects ecological and environmental elements such as the atmosphere, water bodies, and soils, and environmental changes, in turn, profoundly influence the sustainable operation of energy systems. Under climate change, how to coordinate energy development with environmental protection and how to realize integrated resource management and optimization constitute major global challenges.

Carbon capture, utilization, and storage (CCUS) is one of the important technological pathways in the realm of energy–environment coupling. Numerous studies and reports by international organizations emphasize that CCUS is indispensable to achieving carbon-neutral goals [8, 9]. The International Energy Agency clearly states that "without CCUS, it is almost impossible to reach net-zero emissions." By capturing carbon dioxide produced by industrial processes and combustion and safely storing it in deep geological formations or putting it to beneficial use, CCUS can significantly reduce emissions from the energy system. Especially in hard-to-abate sectors such as power generation, steel, cement, and chemicals, CCUS is regarded as the most realistic and feasible mitigation option at present. The journal regards CCUS-related research as a key focus, including subsurface storage mechanisms of CO2, storage integrity monitoring, CO2-EOR, mineral carbonation, novel sorbents/membranes, and carbon

dioxide utilization (e.g., synthetic fuels and chemical feedstocks).

Subsurface energy storage and resource dispatch are also important directions in energy–environment coupling. As the share of renewables rises, the spatiotemporal unevenness and variability of energy become more pronounced. How to use geological space for large-scale energy storage and achieve temporal and spatial shifting of energy is one of the frontier topics currently being explored. For example, converting surplus wind and solar power into hydrogen via electrolysis and storing it in subsurface reservoirs for later retrieval during peak demand is an effective means of addressing renewable intermittency. Beyond hydrogen, underground thermal energy storage, compressed air energy storage, and pumped storage are also attracting attention. The journal focuses on site selection, engineering methods, and environmental impact assessments for subsurface energy storage, including reservoir properties, surrounding rock mechanics, seal integrity, and interactions among energy carriers, rocks, and fluids.

Land and water resource management are closely tied to energy development and utilization and are also core concerns of *JGEE*. Energy projects often consume significant land and water resources: large hydropower projects affect basin-scale water and sediment balances; bioenergy cultivation occupies arable land and consumes water and fertilizer; traditional mining and unconventional oil and gas development may trigger land degradation and water pollution. Therefore, implementing integrated land and water resource management within energy development to reduce ecological disturbance and achieve sustainable resource use is a major issue. Studies point out that climate change and population growth are making water, energy, and land increasingly scarce, with intensifying competition and interlinkages across sectors. In response to the complex "water–energy–land–climate" nexus, the journal encourages research adopting a "resource–environment coupling" perspective, such as quantitative analyses of the "water–energy–food" nexus, integrated resource-optimization models at the watershed scale, and assessments of how land-cover change impacts regional climate and energy production, providing scientific evidence for policymaking [10, 11]. Through forward-looking research, we hope to foster coordinated planning of energy development and resource conservation, achieving win–win resource management strategies.

In sum, the frontiers of energy–environment coupling and resource management range from single technologies (e.g., CCUS, methane mitigation) to integrated strategies (e.g., cross-sectoral resource planning). *JGEE* takes these topics as focal areas with the aim of shifting energy engineering and environmental management from traditional fragmentation to integration, achieving co-benefits in pollution reduction and carbon mitigation through systemic innovation. Under the global sustainable development agenda, the transformation of energy production and consumption must be integrated with environmental protection and land and water resource management to truly chart a green and low-carbon development path.

4 The Role of Ecological and Environmental Science in *JGEE*

In an era of increasingly urgent energy and environmental issues, ecological and environmental science has an essential place within *JGEE*. Solving energy problems cannot focus solely on energy and technology; it must also consider ecosystem health and the sustainable use of natural resources. Research in ecological and environmental science—including biodiversity conservation, sustainable land and water management, and assessment of ecosystem service functions—will provide optimal solutions under environmental constraints for energy development, ensuring that energy strategies complement ecological civilization.

Biodiversity conservation is a core topic in the ecological and environmental domain. Humanity's use of energy and resources from nature must respect the carrying capacity and resilience of ecosystems. Large-scale energy development (e.g., mine excavation, oil sands extraction, dam construction for hydropower) often disturbs local ecosystems, potentially causing habitat loss, species displacement, and even extinction risk. Given that global biodiversity is already in a critical state, *JGEE* encourages research integrating energy development with biodiversity conservation. Examples include how to implement ecological flow regimes in hydropower development to mitigate impacts on river habitats; how to avoid critical species migration corridors in siting wind and solar projects; and how to restore original ecological functions in post-mining reclamation. We believe energy-project planning should incorporate biodiversity impact assessment and explore new

models of "development–protection" balance. We also welcome discussions on policies for clean energy development in protected areas—for instance, appropriately developing wind and solar under strict ecological safeguards to reduce exploration pressure for fossil energy in undeveloped regions.

Ecosystem services and nature-based solutions (NbS) are important concepts that have emerged in recent years, emphasizing the use of natural ecological processes to address environmental and development challenges. Healthy ecosystems provide numerous services—clean water, carbon sequestration and oxygen release, climate regulation, soil and water conservation, windbreak and sand fixation, pollination—the value of which is comparable to that of engineered infrastructure. The journal welcomes research on quantitative assessment of ecosystem services and their application in energy and environmental management decision-making. For example, evaluating changes in ecosystem service value under different land-use or energy-development scenarios to provide intuitive references for policymakers; exploring the feasibility of restoring natural ecosystems such as forests and grasslands to sequester greenhouse gases and improve the environment, i.e., nature-based climate solutions. *JGEE* looks forward to publishing cutting-edge studies that integrate ecology with energy and environmental management.

Sustainable land-use and water-resource management are also indispensable components of ecological and environmental science, closely linked to the aforementioned energy–environment coupling. For example, land degradation and desertification are not only ecological issues but may be exacerbated by the expansion of bioenergy cultivation or mining activities, thereby affecting local livelihoods and regional development. The journal focuses on assessments of land-use change, land-restoration technologies, and spatial planning based on landscape ecology. In the water domain, energy production is tightly coupled with water security—whether traditional energy (water for hydraulic fracturing in oil and gas development, water consumption in refining and chemicals) or new energy (impacts of hydropower on basin hydrology, water for hydrogen production and power-plant cooling). The journal encourages work on integrated water-resource management, including watershed-scale modeling of water quantity and quality and the utilization of unconventional water sources (e.g., treatment and reuse of produced water and pit water associated with energy development), to provide scientific support for achieving a "win–win" of energy production and water protection.

In short, energy science and technology innovation must be premised on avoiding environmental damage; integrating ecological and environmental science can provide new pathways to solve energy problems. On the journal's platform, we hope ecologists and energy scholars will engage in dialogue—for example, incorporating ecological risk assessment into CCUS site selection; adding ecological-sensitivity constraints into renewable-energy system planning; and embedding ecosystem-service valuation into regional energy strategies. Ecological civilization is the necessary path of human development, and green transformation of energy use is a key link in this path. By strengthening the role of ecological and environmental science on the *JGEE* platform, we look forward to contributing to the maintenance of Earth's life-support systems and the realization of harmony between humanity and nature.

5 Publication Norms and Scholarly Standards

As a scholarly journal, *JGEE* strictly follows internationally accepted publication norms and ethical standards, and is committed to building a fair, rigorous, and transparent platform for academic exchange. In terms of peer-review mechanisms, manuscripts are independently evaluated by senior experts from academia and industry for scientific soundness, originality, and completeness. Open access is an important publication policy of *JGEE*. Published by the press under an open-access model, the journal allows readers to freely read, download, and share full-text articles online, expanding the reach of research outputs.

With respect to publication ethics, *JGEE* strictly adheres to academic publishing standards and resolutely curbs misconduct. We require authors to ensure the originality of their work, to accurately list all author contributions and funding acknowledgments, and to refrain from plagiarism, duplicate submission, and data fabrication. Once misconduct is identified, stringent measures such as retraction will be taken in accordance with the publisher's policy. The journal also follows COPE guidelines, upholding integrity and fairness in editorial decisions. Reviewers must observe confidentiality and objectivity and may not use unpublished information obtained through peer review for personal gain or to infringe upon authors' rights. For potential ethical issues (e.g., research

involving humans or animals, conflicts of interest), we have clear policies for authors and reviewers to follow.

With the development of big data and open science, making research data publicly available has become an important initiative to enhance transparency and reproducibility. *JGEE* actively encourages authors to share the underlying data, code, and methodological details associated with their articles where feasible. We recommend that authors deposit data in reliable public repositories or publish them as supplementary materials. Of course, we also respect restrictions on confidential and sensitive information and intellectual-property protections; in such cases, authors should state data availability or access routes in the manuscript.

Regarding article types, *JGEE* accepts a variety of submissions to meet the needs of different readerships and contributors. The main types include: Research Articles—reporting original scientific research and technological advances; Reviews—systematically summarizing the state of the art and trends in a given field; Communications or Short Notes—brief reports of preliminary innovative findings; and Perspectives and Commentaries—presenting insights or discussions on topical issues.

6 Invitation and Acknowledgments

As a newly launched scholarly journal, we fully understand that the development of *JGEE* depends on the support and participation of readers, authors, peer reviewers, and members of the editorial board. At this inaugural moment, we sincerely extend an invitation to all parties and express our heartfelt thanks.

Through arduous pioneering work, new paths are opened. The birth of every new journal is inseparable from the collective efforts of the academic community. *JGEE* has merely erected a platform; what will truly give it vitality and vibrancy are all those who participate. In the years to come, we look forward to working closely with scholars, engineers, decision-makers, and practitioners in the global energy and environmental fields, jointly witnessing the journey by which new discoveries and technologies in this cross-disciplinary arena move from concept to reality. We firmly believe that by pooling collective wisdom and drawing on the ideas of many, greater progress will be made on the road to sustainable energy utilization and environmental protection.

On the occasion of this launch, we once again extend our sincere gratitude to all who care for and support *JGEE*! Let us join hands, with enthusiasm for science and hopes for the future, to compose a new chapter in geo-energy and environment. Welcome to join the journey of *JGEE*—we look forward to your participation and contributions!

Yours sincerely,

Founding Editor-in-Chief

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Conflicts of Interest

The author declares no conflicts of interest.

Ethical Approval and Consent to Participate

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