COMMENTARY

Time for a change: Rethinking the global renewable energy transition from the Sustainable Development Goals and the Paris Climate Agreement

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The concept of energy transition was initially proposed by the German Academy of Sciences in 1980, advocating for the abandonment of nuclear power and oil in response to the energy crisis. At that time, insufficient attention was given to the energy transition. From 1980 to 1992, the global economy experienced significant growth, with the gross domestic product doubling from 11.34 trillion dollars to 25.41 trillion dollars (data from the World Bank). The widespread consumption of fossil fuels resulted in excessive carbon dioxide (CO_2) emissions to support this rapid economic expansion. This, in turn, led to climate change, prompting the signing of the 1992 United Nations Framework Convention on Climate Change (the UNFCCC). Following the signing of the UNFCCC, the transition to renewable energy gradually became a critical focus for global energy conservation and emission reduction. From 1965 to 2022, the proportion of renewable energy consumption increased from 6.31% to 12.33%, while the total consumption increased by 7.41 times (Figure 1). While this suggests progress in the global energy transition, it is crucial to note that over the same period, CO_2 emissions and fossil energy consumption increased by 3.07 and 3.39 times, respectively. This raises a critical question: is the rise in renewable energy consumption and its share of total energy consumption indicative of an effective energy transition?

Over the past two decades, especially from 2000 to 2019, more than 5 million deaths annually worldwide were linked to non-optimal temperatures caused by climate change, accounting for 9.43% of all deaths (8.52% cold related and 0.91% heat related).[1] A report from the World Meteorological Organization revealed a nearly 5-fold increase in climate-change-induced disasters, such as floods and heatwaves, over the past 50 years (from 1970 to 2019), causing economic losses of $3.64 trillion. The Russia-Ukraine conflict in 2022 profoundly impacted the global energy system, leading to price volatility, natural gas supply shortages, security concerns, and economic uncertainty. This has contributed to the first genuinely global energy crisis, especially in the European Union. More importantly, if coal, oil, and natural gas production continue at 2020 levels, they may be exhausted in 139, 54, and 49 years, respectively. These risks could force all countries to urgently pursue a more aggressive transition to renewable energy, moving away from coal, oil, and natural gas at an accelerated pace.

Generally, regional energy transitions aim to achieve sustainable economic growth, energy security, and green development. For example, European and American countries adhere to the energy transition policy of "less oil, more gas, and low carbon" to attain green development and ensure energy security. Japan's energy transition is geared toward combating the impact of climate change, while China aims to construct a new modern energy system that is safe, efficient, green, and sustainable. Unfortunately, the ongoing renewable energy transition falls short of meeting these essential objectives, signaling the need for a transformative change.

GLOBAL ENERGY TRANSITION AND THE SDGs

The Sustainable Development Goals (SDGs) serve as a comprehensive global initiative to address social, economic, and environmental challenges and enhance the well-being and prospects of people worldwide. Regrettably, the current increase in renewable energy consumption falls short of fully realizing the objectives outlined in several vital SDGs. Specifically, SDG 7, which emphasizes ensuring access to affordable, reliable, sustainable, and modern energy, is not entirely met by the current trajectory of renewable energy consumption. Similarly, the aspirations of SDG 11, which aims to make cities inclusive, safe, resilient, and sustainable, as well as SDG 12, focused on ensuring sustainable consumption and production patterns, are not adequately achieved. Moreover, SDG 13 (i.e., taking urgent action to combat climate change and its impacts) is also not fully addressed, as the rapid growth of fossil energy consumption and carbon emissions contradicts the original intent of the global energy transition. This is particularly concerning given that fossil energy resources are depleting, climate change persists, and the SDGs seem increasingly unattainable by 2030, especially for developing economies.[2] The current trajectory, marked by increased renewable energy consumption, may not constitute a sustainable energy transition but rather a supplementary measure within the energy system.

GLOBAL ENERGY TRANSITION AND THE PARIS CLIMATE AGREEMENT

The increasing prominence of renewable energy in the global energy system is not necessarily leading to the replacement of fossil fuels but is contributing to the overall expansion of total energy consumption. This perspective is supported by a growing body of research, highlighting that, despite the proliferation of renewable energy generation, the pace of the low-carbon transition has been slow.[3] The Paris Agreement, with 194 parties having joined by 2022, presents an unprecedented opportunity for a global energy transition. In this context, there might be an objective belief that an effective energy transition is being realized, with renewable energy replacing fossil energy. However, since the 2008 financial crisis, many economies are still exploring diverse energy development models for economic growth, and the integration of renewable energy is seen as a necessity for sustained economic development. Moreover, many countries still recovering from the impact of the COVID-19 pandemic may lean toward using more fossil energy to drive economic growth. The future global energy transition depends on the intended nationally determined contributions (INDCs), especially in major energy-consuming nations, such as China, the United States, Russia, India, and Japan. The Lima Call for Climate Action emphasizes that all INDCs should be based on principles of fairness and ambition. Fairness should address environmental and social considerations, while ambition should strive to balance development capacity, ecological vulnerability, and adaptation to climate impacts.

FOSTERING ENERGY TRANSITION FROM "RENEWABLE" TO "SUSTAINABLE"

Sustainable development challenges are multifaceted, encompassing concerns about a viable economy, human health, energy security, and climate change. Traditional analyses focused on the proportion of renewable energy in the energy system, constituting the renewable energy transition, provide only limited insights. To address these challenges comprehensively, a shift to a new energy transition model, namely the sustainable energy transition, is crucial. This approach aims to achieve sustainable economic and environmental development and energy security. To successfully attain the SDGs and meet the objectives of the Paris Climate Agreement, it is imperative to move beyond merely examining changes in renewable energy proportions, placing emphasis instead on reaffirming the urgency of sustainable development. For all economies, there is a need for a "sustainable" energy transition mode that addresses imperatives such as economic growth, energy security and access, and environmental sustainability.

PROMPTLY FORESTALL AND DEFUSE RISKS OF GLOBAL SUSTAINABLE ENERGY TRANSITION

The climate crisis necessitates an accelerated energy transition, but a radical transition introduces potential risks. With the gradual reduction of coal power and the increasing reliance on renewable sources such as wind power and

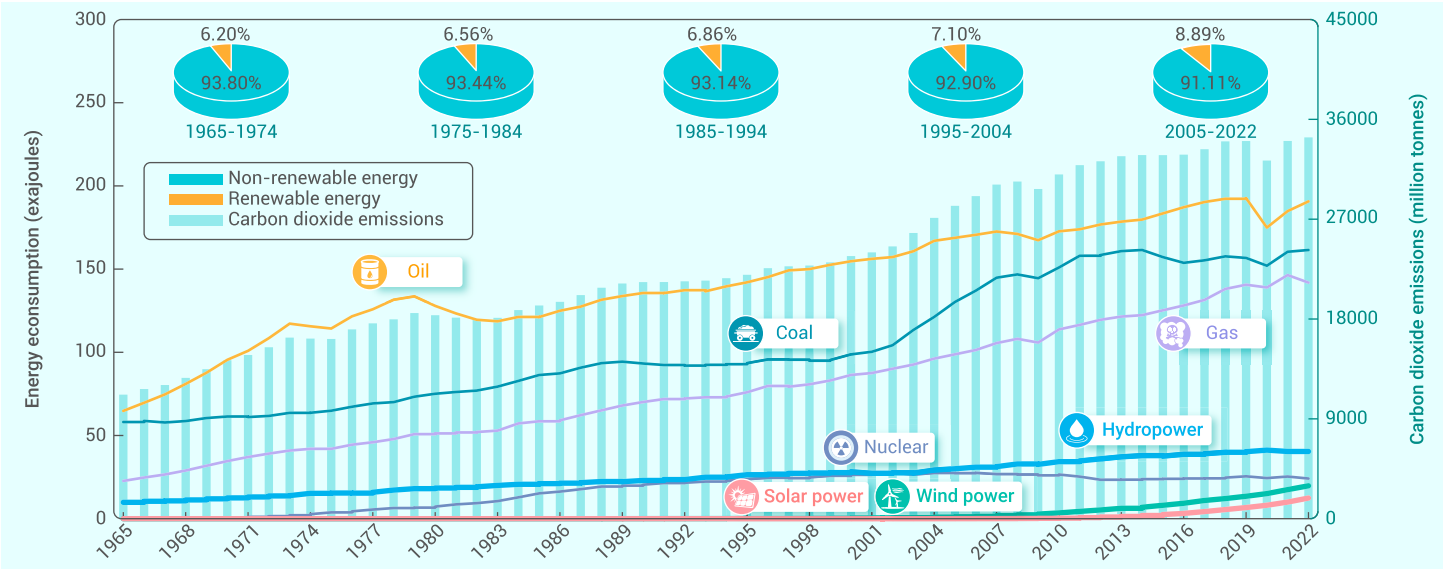

Figure 1. Global energy consumption and CO_2 emissions from 1965 to 2022 Source: data from Statistical Review of World Energy 2023, https://www.energyinst.org/statistical-review/resources-and-data-downloads.

photovoltaic access, economies face typical risks of economic and social systems. These risks include allocation issues related to metal mineral resources for renewable energy infrastructure, technical and cost challenges associated with renewable energy storage, and investment and price risks tied to traditional fossil energy. Additionally, there are supply-demand imbalances in the new energy structure, along with various industrial, institutional, employment, operational, and health-related risks. In 2021, more than 4.5 million households and enterprises in Texas (the United States) suffered large-scale power outages due to extreme weather, while three provinces in northeast China implemented power rationing due to insufficient power supply. To prevent and address these risks, discussions on possible solutions encompass technical means and international cooperation.

DEEP INTEGRATION OF EMERGING TECHNOLOGIES AND GLOBAL SUSTAINABLE ENERGY TRANSITION

The scientific and technological revolution, centered around digital, renewable, and carbon-negative technologies, fundamentally reshapes the global energy transition. Digital technologies, in particular, enable the multidimensional integration and deep interconnection of the energy system, carbon system, and intelligent system, incorporating energy flow, carbon flow, and information flow. Global carbon-negative solutions include both natural and technological means. Natural methods involve leveraging bioenergy with carbon capture and storage technologies to increase carbon removal through biological processes and store it in forests, soils, or wetlands. On the other hand, technological means, such as direct air carbon capture and storage technologies, aim to remove carbon directly from the air or control natural carbon removal processes to accelerate carbon storage.[4] These approaches hold promise in playing a vital role in mitigating climate risks. In addition, renewable energy technologies, especially large-scale energy storage technologies, can effectively address the challenges posed by the intermittent nature of renewable sources like wind power and photovoltaics, contributing to the stability and reliability of the energy transition.[5]

PARTNERSHIPS AND COOPERATION IN GLOBAL SUSTAINABLE ENERGY TRANSITION

The urgency of accelerating sustainable energy transitions underscores the importance of collaborative efforts, recognizing that no single country or region can navigate the complexities of this transition alone. As stated in SDG 17, a successful development agenda requires inclusive global, regional, and national partnerships. Given the significant challenges of climate change, energy security, and human health, fostering partnerships and international cooperation become critical in the context of a sustainable energy transition. Regrettably, recent global events, such as the Russia-Ukraine conflict, the Israeli-Palestinian conflict, and the Sino-US trade war, have precipitated a worldwide energy crisis. The Russia-Ukraine conflict and the Israeli-Palestinian conflict have severely disrupted the international energy market, significantly impacting global energy security, settlement systems, resident safety, and economic development. Given these challenges at hand, it is imperative to eliminate biases and conflicting interests while establishing a mutually beneficial global energy system that capitalizes on China's leadership role alongside other major countries. Additionally, enhancing international dialogue becomes crucial for driving sustainable energy transition and effectively combating climate change.

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DECLARATION OF INTERESTS

The authors declare no competing interests.