



# Yashil iqtisodiyotga o'tishda energetik inqilobning ahamiyati

Gulchekhra J. Allayeva

DSc, prof., Toshkent davlat texnika universiteti, Toshkent, 100095, O'zbekiston; [allaeva74@mail.ru](mailto:allaeva74@mail.ru)  
<https://orcid.org/0000-0001-1177-7512>

**Dolzarlighi:** Hozirgi global sharoitda energetik inqilob XXI asrning eng muhim o'zgarishlaridan biri bo'lib, iqtisodiy tizimlar va rivojlanish yo'nalishlarini tubdan o'zgartirmoqda. 2024 yilda qayta tiklanadigan energiya quvvatlarining rekord 15,1% o'sishi va global miqyosda 4 448 gigavatt ga erishishi, sohada bandlik 16,2 million ish o'ringacha kengayishi bilan, fotoil yoqil'isiga bog'liq tizimlardan toza energiya manbalariga o'tish yashil iqtisodiyot rivojlanishining muhim harakatlantiruvchisi bo'ldi. Biroq, jiddiy muammolar, jumladan, joylashtirish bo'yicha mintaqaviy nomutanosibliklar saqlanib qolmoqda, bunda Osiyo yangi quvvatlarning uchdan ikki qismidan ko'pini ta'minlaydi, Markaziy Amerika va Karib havzasi kabi mintaqalar esa atigi 3,2% hissa qo'shadi. Joriy taraqqiyot va 2030 yil iqlim maqsadlari o'rtasidagi barqaror bo'shliq, bu holda hozirgi o'sish sur'atlarini saqlab qolish ham dunyoni qayta tiklanadigan energiya quvvatlarini uch baravar oshirish maqsadlaridan 7,2% orqada qoldiradi, bu tadqiqotni ayniqsa dolzarb qiladi. Energetik inqilobning yashil iqtisodiyotga o'tishda ko'p qirrali rolini tushunish barqaror rivojlanish murakkabliklarini hal qilishga va barcha mintaqalar hamda jamiyatlarda foyda teng taqsimlanishini ta'minlashga intilayotgan siyosatchilar, investorlar va xalqaro tashkilotlar uchun juda muhimdir.

**Maqsad:** Ushbu tadqiqotning asosiy maqsadi energetik inqilobning yashil iqtisodiyotga o'tishda ko'p qirrali rolini joriy tendensiyalar, texnologik innovatsiyalar, bandlikka ta'sir va siyosiy asoslarni tizimli baholash orqali har tomonlama o'rganish va tahlil qilishdir. Tadqiqot transformatsiyaning asosiy harakatlantiruvchilarini aniqlash, xalqaro maqsadlarga erishishdagi taraqqiyotni baholash, joylashtirish va investitsiyadagi mintaqaviy nomutanosibliklarni baholash hamda barcha manfaatdor tomonlar va geografik mintaqalar o'rtasida foyda adolatli taqsimlanishini ta'minlagan holda o'tishni tezlashtirish uchun faktlarga asoslangan tavsiyalar berishga qaratilgan..

**Usullari:** Ushbu tadqiqot energetik o'tish ma'lumotlarining miqdoriy tahlili bilan siyosiy asoslar va iqtisodiy ta'sirlarni sifat jihatdan baholashni birlashtiruvchi aralash uslubiy yondashuvni qo'llaydi. Asosiy ma'lumot manbalari Xalqaro qayta tiklanadigan energiya agentligi (IRENA), Xalqaro energiya agentligi (IEA), Jahon iqtisodiy forumi va BMT atrof-muhit dasturi (UNEP)ning so'nggi hisobotlarini, so'nggi tendentsiyalarni aks ettirish uchun 2022-2024 yillar ma'lumotlariga e'tibor qaratishni o'z ichiga oladi. Metodologiya texnologik innovatsiyalar, iqtisodiy ta'sirlar, siyosiy asoslar, investitsiya oqimlari va mintaqaviy o'zgarishlar kabi ko'p o'lchovlarni o'rganuvchi tizimli fikrlash yondashuvini o'z ichiga oladi. Tahliliy asos qayta tiklanadigan energiyani joylashtirish naqshlarining qiyosiy tahlili, bandlik ma'lumotlarini baholash, xarajat raqobatbardoshligini baholash va turli mintaqalar va mamlakatlarda siyosat samaradorligini tahlil qilishni o'z ichiga oladi.

**Natijalar:** tadqiqot shuni ko'rsatadiki, global qayta tiklanadigan energiya quvvatlari 2024 yilda rekord 15,1% o'sishga erishdi va 4 448 gigavatt ga yetdi, bunda quyosh energiyasi yangi o'rnatishlarda ustunlik qildi va qayta tiklanadigan manbalar kengayishining 73% ni tashkil etdi. Qayta tiklanadigan energiya bandligi butun dunyo bo'ylab 16,2 million ish o'ringacha kengaydi, bu sektor tarixidagi eng yuqori yillik o'sish sur'atini ifodalaydi. Osiyo yangi quvvatlarning uchdan ikki qismidan ko'pini qo'shadi, bu asosan Xitoyning energetik o'tishga 818 milliard dollar investitsiyasi tufayli, Markaziy Amerika va Karib havzasi atigi 3,2% hissa qo'shganda mintaqaviy nomutanosibliklar saqlanib qoldi. Texnologik yutuqlar 30% dan ortiq samaradorlikka erishgan perovskit quyosh batareyalari va kengaytirilgan geotermal tizimlarning tijorat jihatdan hayotiyeligini o'z ichiga oladi. Rekord o'sishga qaramay, hozirgi traektoriyalar 2030 yil maqsadlariga yetmaydi, 2024 yil o'sish sur'atlarini saqlab qolish dunyoni qayta tiklanadigan quvvatlarni uch baravar oshirish maqsadlaridan 7,2% orqada qoldiradi. Qayta tiklanadigan energiya endi ko'pgina stsenariylarda fotoil yoqil'isidan arzonroq bo'lish bilan xarajat raqobatbardoshligi erishildi, rivojlanmagan mamlakatlarda, ayniqsa, kapital xarajatlari rivojlangan mamlakatlardan yetti baravar yuqori bo'lgan holda moliyalashtirish bo'shliqlari saqlanib qolmoqda.

**Kalit so'zlar:** energetik inqilob, yashil iqtisodiyot, qayta tiklanadigan energiya, energetik o'tish, barqaror rivojlanish, yashil ish o'rinlari, iqlim o'zgarishi, quyosh energiyasi, shamol energiyasi, toza texnologiyalar, iqtisodiy transformatsiya, ekologik barqarorlik

**For citation:** Allayeva G.J. The role of energy revolution in the transition to green economy. Scientific and technical journal of Problems of Energy and Sources Saving, 2025, no. 3, pp. 213-219.

<https://doi.org/10.5281/zenodo.16938966>

Received: 13.02.2025

Revised: 17.05.2025

Accepted: 24.07.2025

Published: 23.08.2025

**Copyright:** © Gulchekhra J. Allayeva, 2025. Submitted to Problems of Energy and Sources Saving for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## Роль энергетической революции в переходе к зеленой экономике

Гульчехра Ж. Аллаева

DSc, проф., Ташкентский государственный технический университет, Ташкент, 100095, Узбекистан; [tstu\\_energy@mail.ru](mailto:tstu_energy@mail.ru)  
<https://orcid.org/0009-0002-0761-0787>

**Актуальность:** В современном глобальном контексте энергетическая революция представляет одну из самых значительных трансформаций XXI века, коренным образом изменяющую экономические системы и пути развития. При росте мощностей возобновляемой энергетики на рекордные 15,1% в 2024 году и достижении 4 448 гигаватт в мировом масштабе, при расширении занятости в секторе до 16,2 миллиона рабочих мест, переход от систем, зависящих от ископаемого топлива, к источникам чистой энергии стал критическим драйвером развития зеленой экономики. Однако сохраняются значительные проблемы, включая региональные диспропорции в развертывании, когда Азия обеспечивает более двух третей новых мощностей,



тогда как такие регионы, как Центральная Америка и Карибский бассейн, вносят лишь 3,2%. Устойчивый разрыв между текущим прогрессом и климатическими целями на 2030 год, при котором поддержание нынешних темпов роста все равно оставит мир на 7,2% позади целей утроения мощностей возобновляемой энергетики, делает данное исследование особенно актуальным. Понимание многогранной роли энергетической революции в содействии переходу к зеленой экономике имеет важное значение для политиков, инвесторов и международных организаций, стремящихся справиться со сложностями устойчивого развития и обеспечить справедливое распределение выгод во всех регионах и сообществах.

**Цель:** Основная цель данного исследования заключается в комплексном изучении и анализе многогранной роли энергетической революции в содействии переходу к зеленой экономике через систематическую оценку текущих тенденций, технологических инноваций, влияния на занятость и политических рамок. Исследование направлено на выявление ключевых драйверов трансформации, оценку прогресса в достижении международных целей, анализ региональных диспропорций в развертывании и инвестициях, а также предоставление основанных на фактах рекомендаций для ускорения перехода при обеспечении справедливого распределения выгод между всеми заинтересованными сторонами и географическими регионами.

**Методы:** Данное исследование использует смешанный методологический подход, сочетающий количественный анализ данных энергетического перехода с качественной оценкой политических рамок и экономических воздействий. Основные источники данных включают недавние отчеты Международного агентства по возобновляемой энергии (IRENA), Международного энергетического агентства (IEA), Всемирного экономического форума и Программы ООН по окружающей среде (UNEP), с фокусом на данные 2022-2024 годов для отражения последних тенденций. Методология включает системный подход, изучающий множественные измерения, включая технологические инновации, экономические воздействия, политические рамки, инвестиционные потоки и региональные вариации. Аналитическая основа включает сравнительный анализ моделей развертывания возобновляемой энергии, оценку данных о занятости, оценку конкурентоспособности по стоимости и анализ эффективности политики в различных регионах и странах.

**Результаты:** Исследование показывает, что глобальные мощности возобновляемой энергии достигли рекордного роста в 15,1% в 2024 году, достигнув 4 448 гигаватт, при этом солнечная энергия доминирует в новых установках, составляя 73% расширения возобновляемых источников. Занятость в возобновляемой энергетике расширилась до 16,2 миллиона рабочих мест по всему миру, что представляет самый высокий годовой темп роста в истории сектора. Азия внесла более двух третей новых мощностей, в первую очередь благодаря инвестициям Китая в размере 818 миллиардов долларов в энергетический переход, в то время как значительные региональные диспропорции сохраняются с Центральной Америкой и Карибским бассейном, вносящими лишь 3,2%. Технологические прорывы включают перовскитные солнечные элементы, достигающие более 30% эффективности и коммерческую жизнеспособность улучшенных геотермальных систем. Несмотря на рекордный рост, текущие траектории не достигают целей на 2030 год, при поддержании темпов роста 2024 года мир останется на 7,2% позади целей утроения мощностей возобновляемых источников. Достигнута конкурентоспособность по стоимости с возобновляемой энергией, которая теперь дешевле ископаемого топлива в большинстве сценариев, в то время как пробелы в финансировании сохраняются, особенно в развивающихся странах, где затраты на капитал в семь раз выше, чем в развитых странах.

**Ключевые слова:** энергетическая революция, зеленая экономика, возобновляемая энергия, энергетический переход, устойчивое развитие, зеленые рабочие места, изменение климата, солнечная энергия, ветровая энергия, чистые технологии, экономическая трансформация, экологическая устойчивость.

## The role of energy revolution in the transition to green economy

Gulchekhra J. Allayeva

DSc, prof., Tashkent State Technical University, Tashkent, 100095, Uzbekistan; [allaeva74@mail.ru](mailto:allaeva74@mail.ru) <https://orcid.org/0000-0001-1177-7512>

**Relevance:** The global energy revolution represents one of the most significant economic and environmental transformations of the 21st century. With renewable energy capacity growing by a record-breaking 15.1% in 2024 and reaching 16.2 million jobs worldwide, the energy sector is fundamentally reshaping economic structures and creating new pathways for sustainable development. Despite this progress, significant challenges remain, including regional disparities in deployment, financing gaps in developing economies, and the need for enhanced infrastructure. Understanding the multifaceted relationship between energy transformation and green economic development is crucial for policymakers, business leaders, and international organizations navigating the complexities of sustainable development. The urgency is heightened by the gap between current progress and 2030 climate targets, making research on effective strategies for accelerating the green transition highly relevant.

**Aim:** The primary aim of this research is to comprehensively examine and analyze the multifaceted role of energy revolution in facilitating the transition to a green economy through systematic evaluation of current trends, technological innovations, employment impacts, and policy frameworks. The study seeks to identify key drivers of transformation, assess progress toward international targets, evaluate regional disparities in deployment and investment, and provide evidence-based recommendations for accelerating the transition while ensuring equitable distribution of benefits across all stakeholders and geographic regions.

**Methods:** This research employs a mixed-methods approach combining quantitative analysis of energy transition



data with qualitative assessment of policy frameworks and economic impacts. Primary data sources include recent reports from the International Renewable Energy Agency (IRENA), International Energy Agency (IEA), World Economic Forum, and United Nations Environment Programme (UNEP), focusing on 2022-2024 data to capture recent trends. The methodology incorporates systems thinking approach examining multiple dimensions including technological innovation, economic impacts, policy frameworks, investment flows, and regional variations. Analytical framework includes comparative analysis of renewable energy deployment patterns, employment data assessment, cost-competitiveness evaluation, and policy effectiveness analysis across different regions and countries.

**Results:** The research reveals that global renewable energy capacity achieved record growth of 15.1% in 2024, reaching 4,448 gigawatts, with solar energy dominating new installations accounting for 73% of renewable expansion. Renewable energy employment expanded to 16.2 million jobs worldwide, representing the highest annual growth rate in the sector's history. Asia contributed over two-thirds of new capacity additions, primarily driven by China's \$818 billion investment in energy transition, while significant regional disparities persist with Central America and Caribbean contributing only 3.2%. Technological breakthroughs include perovskite solar cells achieving over 30% efficiency and commercial viability of enhanced geothermal systems. Despite record growth, current trajectories fall short of 2030 targets, with maintaining 2024 growth rates leaving the world 7.2% short of tripling renewable capacity goals. Cost competitiveness has been achieved with renewable energy now cheaper than fossil fuels in most scenarios, while financing gaps persist particularly in developing countries where capital costs are up to seven times higher than in developed nations.

**Keywords:** energy revolution, green economy, renewable energy, energy transition, sustainable development, green jobs, climate change, solar energy, wind energy, clean technology, economic transformation, environmental sustainability.

## 1. Introduction

The concept of a green economy has emerged as a central paradigm for sustainable development in the 21st century. A green economy is defined as low carbon, resource efficient and socially inclusive. In a green economy, growth in employment and income are driven by public and private investment into such economic activities as infrastructure and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services [1]. This definition highlights the interconnected nature of environmental sustainability and economic prosperity, positioning energy transformation as a fundamental driver of this transition.

The global energy system stands at a critical juncture. Energy consumption and production contribute to two-thirds of global emissions, and 81% of the global energy system is still based on fossil fuels, the same percentage as 30 years ago [2]. This persistent dependence on carbon-intensive energy sources presents both challenges and opportunities for the transition to a green economy.

Recent developments in renewable energy technologies and supportive policy frameworks have accelerated what many scholars and practitioners term the "energy revolution." China is the birthplace of the global green industrial revolution [3], with the country accounting for over 40% of global renewable energy capacity and investing \$818 billion in its energy transition in 2024. This demonstrates the scale and pace of transformation occurring in the energy sector.

The relationship between energy revolution and green economy transition is multidimensional, encompassing technological innovation, economic restructuring, employment transformation, and policy evolution. Understanding this relationship is crucial for policymakers, business leaders, and international organizations seeking to navigate the complexities of sustainable development.

## 2. Methods and materials

This research employs a mixed-methods approach combining quantitative analysis of energy transition data with qualitative assessment of policy frameworks and economic impacts. The methodology is structured around four primary components:

### Data Collection

Primary data sources include recent reports from the International Renewable Energy Agency (IRENA), the International Energy Agency (IEA), the World Economic Forum, and the United Nations Environment Programme (UNEP). The research focuses on data from 2022-2024 to capture the most recent trends in energy transition and green economy development.

Key datasets analyzed include:

- IRENA's Renewable Energy Statistics 2024 and 2025
- World Energy Transitions Outlook 2024
- Renewable Energy and Jobs Annual Review 2024
- Various national and regional energy transition reports

### Analytical Framework

The analysis employs a systems thinking approach, examining the energy revolution's role in green economy transition across multiple dimensions:



- Technological innovation and deployment
- Economic impacts and job creation
- Policy and regulatory frameworks
- Investment flows and financing mechanisms
- Regional and national variations

#### **Geographic and Temporal Scope**

The study adopts a global perspective while highlighting regional variations and national case studies. The temporal focus spans from 2020 to 2024, with projections extending to 2030 based on current policy trajectories and announced commitments.

### **3. Results**

The global energy revolution has demonstrated remarkable momentum in recent years. Global renewable energy capacity grew by a record-breaking 15.1% in 2024 to reach 4,448 gigawatts (GW). Around the world, an additional 585 GW of power was added, largely due to solar and wind energy expansion [4]. This represents the highest annual growth rate in renewable energy deployment to date.

Solar energy continues to dominate new capacity additions. Solar continues to exceed market expectations, reinforcing its role as a key driver of the renewable energy transition. Ember's analysis published in September estimated that the world will install 593 GW of solar panels this year. That's 29% more than was installed last year, maintaining strong growth even after an estimated 87% surge in 2023 [5].

Despite global growth, significant regional disparities persist in renewable energy deployment. Asia contributed the greatest share – over two-thirds – of the increase, mostly driven by China. Asia is now home to over half of the world's renewable energy capacity. Central America and the Caribbean sit at the other end of the scale, contributing just 3.2% of the growth [3].

In 2024, China accounted for over 40% of global renewable energy capacity and invested \$818 billion in its energy transition – more than double any other economy [4]. This concentration of capacity and investment highlights both the potential for rapid deployment and the challenges of ensuring equitable global distribution.

The energy revolution has generated substantial employment opportunities. Jobs in renewable energy record highest annual growth rate, reaching 16.2 million [6]. This represents a significant expansion from previous years and demonstrates the sector's capacity for job creation.

The distribution of renewable energy employment follows geographic patterns of investment and deployment. China dominates employment in most renewable energy sectors; however Brazil has the most biofuel jobs. The energy crisis is impacting billions of people around the world, as soaring prices have made it more expensive to power homes and businesses. However, the current crisis has also accelerated the rush for renewable energy, as countries across the world scramble to develop more secure, as well as more sustainable power sources [7].

Significant technological breakthroughs are driving the energy revolution forward. One of the most promising advancements in solar energy is the development of perovskite solar cells. These cells, made from a unique crystal structure, offer higher efficiency rates compared to traditional silicon-based cells. In 2024, researchers have achieved perovskite solar cells with efficiency rates exceeding 30%, making them highly competitive [8].

Enhanced geothermal systems represent another frontier. Enhanced geothermal systems have been in development since the 1970s. Recent advances show that they could dramatically increase production of renewable energy. Fervo Energy tested one such system last year in Nevada and proved its commercial viability [9].

Renewable energy has achieved significant cost advantages. Generating energy from solar and wind is now cheaper than oil and gas in most scenarios, and investment in renewables is set to double investment in fossil fuels this year [10]. This cost competitiveness is fundamental to the economic viability of the green transition.

Despite record growth, current trajectories remain insufficient to meet global climate targets. Despite setting a new high in annual capacity expansion, the growth still fails to reach the levels needed to deliver on the global goal to triple available renewable energy by 2030, IRENA cautions. This would require growing capacity at 16.6% each year until 2030 [3].

If we were to maintain the growth rate seen in 2024 we would still fall 7.2% short of the target; following the five-year growth trend since 2018 would leave us 27.9% short [4]. This gap underscores the need for accelerated deployment and enhanced policy support.

### **4. Discussion**



The evidence demonstrates that the energy revolution serves as a fundamental catalyst for green economy transition through multiple pathways. First, the massive scale of renewable energy deployment is reshaping global energy markets and creating new economic opportunities. The record 15.1% growth in renewable capacity in 2024 represents not merely technological advancement but a fundamental economic transformation that is redirecting capital flows, creating new industries, and generating employment across the value chain.

The employment impacts are particularly significant for green economy transition. With renewable energy employment reaching 16,2 million jobs globally, the sector is demonstrating its capacity to generate decent work opportunities while contributing to environmental objectives. This aligns with the UNEP definition of green economy, which emphasizes that growth in employment and income should be driven by investments that reduce environmental risks and enhance resource efficiency.

The technological breakthroughs observed in 2024, particularly in perovskite solar cells achieving over 30% efficiency and the commercial viability of enhanced geothermal systems, indicate that the energy revolution is entering a new phase of maturity. These innovations are not merely incremental improvements but represent paradigm shifts that can dramatically reduce costs and expand deployment opportunities.

Thurbon describes North-East Asia's green transitions as a form of Schumpeterian "creative destruction", in which traditional processes are dismantled to make way for more innovative methods. China is rapidly building up green energy industries – the "creative" side – while phasing down fossil fuels – the "destructive" side [3]. This concept of creative destruction is essential to understanding how the energy revolution facilitates broader economic transformation.

The concentration of renewable energy deployment and investment in Asia, particularly China, highlights both opportunities and challenges for global green economy transition. While China's leadership demonstrates the potential for rapid scaling, the limited progress in regions such as Central America and the Caribbean indicates that the benefits of the energy revolution are not yet globally distributed.

While global renewable energy investment is abundant, only one fifth is being allocated to EMDEs (excluding China), leaving the world at risk of falling short of climate and development targets – failing to propel a fair global energy transition [11]. This disparity poses significant challenges for achieving an inclusive green economy transition.

The analysis reveals that technological progress alone is insufficient to achieve the scale of transformation required. The report identifies three key pillars that form the foundations for the actions needed to realign the global energy transition with climate objectives: building the necessary infrastructure; advancing a policy and regulatory architecture that can facilitate targeted investments, and improve socio-economic and environmental outcomes; and the strategic realignment of institutional capacities [12].

The European Union's experience provides insights into policy effectiveness. In 2023, renewable energy accounted for 50% of the EU's electricity production. We steadily move away from polluting fossil fuels, replacing them with clean alternatives, while Gross Domestic Product (GDP) continues to rise, showcasing what is possible on the path to achieving the European Green Deal [13]. This demonstrates that economic growth and environmental sustainability can be mutually reinforcing when supported by appropriate policy frameworks.

The energy revolution's contribution to green economy transition extends beyond job creation to fundamental workforce transformation. Green skills come in a wide spectrum, from general knowledge of sustainability and the circular economy to specific skills in areas such as electric vehicle manufacturing, renewable energy, climate science, chemical engineering and digital [14]

However, challenges remain in ensuring equitable access to green employment opportunities. Older workers and those without a college education appear less likely to make transitions to green jobs and more likely to other dirty jobs, other jobs, or non-employment (University of Chicago Press, 2024). This highlights the need for comprehensive workforce development strategies that ensure inclusive participation in the green economy transition.

The scale of investment required for the energy revolution presents both opportunities and challenges for green economy development. The UNEP 2011 Green Economy Report informs that "based on existing studies, the annual financing demand to green the global economy was estimated to be in the range US\$1.05 to US\$2.59 trillion. To place this demand in perspective, it is about one-tenth of total global investment per year, as measured by Global Gross Capital Formation" [15].

The financing gap is particularly acute in developing countries. Increased levels of risks – whether real or perceived – and uncertainties in policy and regulatory frameworks can deter investors from working with developing countries, where the cost of capital is up to seven times higher than that of developed nations [14].

The empirical evidence from the energy revolution provides important insights for green economy theory and practice. The rapid growth in renewable energy capacity and employment demonstrates that



environmental sustainability and economic development can be mutually reinforcing when supported by appropriate technologies, policies, and institutions.

However, the persistent regional disparities and the gap between current progress and 2030 targets indicate that market forces alone are insufficient to achieve the scale and pace of transformation required. This supports arguments for more active government intervention and international cooperation in facilitating green economy transition.

## 5. Conclusion

This research demonstrates that the energy revolution plays a pivotal role in facilitating the transition to a green economy, serving as both a driver of economic transformation and a pathway to environmental sustainability. The record-breaking growth in renewable energy capacity, reaching 4,448 gigawatts globally in 2024, and the expansion of renewable energy employment to 16.2 million jobs worldwide, provide compelling evidence of the sector's capacity to generate economic value while addressing environmental challenges.

Key findings include the emergence of cost-competitive renewable technologies, significant technological breakthroughs in solar and geothermal systems, and the development of new industrial sectors centered on clean energy production and deployment. The energy revolution has demonstrated its potential to create decent employment opportunities, stimulate innovation, and redirect capital flows toward sustainable investments.

However, the analysis also reveals significant challenges that must be addressed to realize the full potential of the energy revolution for green economy transition. Regional disparities in deployment and investment, particularly the concentration of progress in Asia while other regions lag behind, threaten the inclusivity of the transition. The financing gap in developing countries, where the cost of capital can be up to seven times higher than in developed nations, poses particular challenges for global equity.

The gap between current progress and 2030 targets is substantial. Despite record growth of 15.1% in 2024, maintaining this rate would still leave the world 7.2% short of the tripling target, while following historical trends would result in a 27.9% shortfall. This indicates that unprecedented acceleration is required, necessitating enhanced policy support, increased investment, and stronger international cooperation.

The research highlights three critical requirements for maximizing the energy revolution's contribution to green economy transition. First, infrastructure development must be prioritized, including grid modernization, energy storage systems, and transmission networks capable of integrating variable renewable energy sources. Second, policy and regulatory frameworks must be strengthened to facilitate targeted investments, reduce barriers to deployment, and ensure equitable distribution of benefits. Third, institutional capacities must be realigned to support workforce development, technology transfer, and financial mechanisms that can bridge the investment gap, particularly in developing countries.

The employment implications of the energy revolution extend beyond job creation to fundamental workforce transformation. The development of green skills across the spectrum from general sustainability knowledge to specialized technical capabilities is essential for ensuring inclusive participation in the green economy. However, attention must be paid to addressing barriers faced by older workers and those without higher education, who appear less likely to transition to green employment.

Looking forward, the energy revolution's role in green economy transition will likely intensify as technologies mature, costs continue to decline, and policy support strengthens. The integration of artificial intelligence and smart grid technologies is already optimizing energy production and distribution, while breakthroughs in energy storage and green hydrogen production promise to address key challenges of renewable energy integration.

For decision-makers, the findings suggest that while the energy revolution offers tremendous opportunities for green economy development, realizing these opportunities requires proactive intervention. This includes establishing supportive regulatory frameworks, mobilizing public and private finance, investing in infrastructure and skills development, and ensuring that the benefits of transition are equitably distributed across regions and communities.

For entrepreneurs and investors, the energy revolution represents both a market opportunity and a strategic imperative. The cost competitiveness of renewable energy, combined with supportive policy trends and growing demand for sustainable solutions, creates favorable conditions for investment in clean energy and related technologies.

In conclusion, the energy revolution is not merely a technological transformation but a fundamental economic and social transition that offers a pathway to sustainable development. However, achieving the full potential of this transition requires unprecedented coordination between governments, businesses, and international organizations to address persistent challenges and ensure that the benefits of the green economy are accessible to all. The window for achieving 2030 targets remains open, but it is narrowing rapidly, demanding immediate and sustained action across all sectors of society.



## REFERENCES

1. United Nations Environment Programme. (2024). Green Economy. <https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/green-economy>
2. World Economic Forum. (2024, November). Energy efficiency and clean energy both key to green transition. <https://www.weforum.org/stories/2024/11/why-we-need-to-follow-the-soft-energy-path-of-greater-efficiency/>
3. World Economic Forum. (2025, April). Renewable energy capacity surged around the world in 2024. <https://www.weforum.org/stories/2025/04/renewable-energy-transition-wind-solar-power-2024/>
4. World Economic Forum. (2025, July). China's green transition: Remarkable but also sustainable? <https://www.weforum.org/stories/2025/07/chinas-green-transformation/>
5. Ember. (2024). Six highlights of the global energy transition in 2024. Retrieved from <https://ember-energy.org/latest-insights/six-highlights-of-the-global-energy-transition-in-2024/>
6. International Labour Organization. (2024, October 1). Renewable Energy and Jobs - Annual Review 2024. <https://www.ilo.org/publications/renewable-energy-and-jobs-annual-review-2024>
7. World Economic Forum. (2023, January). How renewable energy transition is creating a green jobs boom. <https://www.weforum.org/stories/2023/01/renewable-energy-transition-green-jobs/>
8. World of Renewables. (2024, June 12). The Latest Renewable Energy Technologies In 2024: Innovations Driving A Greener Future. <https://worldofrenewables.com/the-latest-renewable-energy-technologies-in-2024-innovations-driving-a-greener-future/>
9. MIT Technology Review. (2024, January 8). Enhanced geothermal systems: 10 Breakthrough Technologies 2024. <https://www.technologyreview.com/2024/01/08/1085112/enhanced-geothermal-systems-renewable-energy-drilling-breakthrough-technologies/>
10. TriplePundit. (2024). Solar Breakthroughs Bring Us Closer To a Renewable Energy Future. <https://www.triplepundit.com/story/2024/solar-energy-breakthroughs/808451>
11. World Economic Forum. (2024, December). A four-step plan to closing the global green skills gap. <https://www.weforum.org/stories/2024/12/green-skills-gap-four-step-plan/>
12. International Renewable Energy Agency. (2024, November). World Energy Transitions Outlook 2024. <https://www.irena.org/Publications/2024/Nov/World-Energy-Transitions-Outlook-2024>
13. European Commission. (2024, November 18). In focus: EU leading the global energy transition. [https://energy.ec.europa.eu/news/focus-eu-leading-global-energy-transition-2024-11-18\\_en](https://energy.ec.europa.eu/news/focus-eu-leading-global-energy-transition-2024-11-18_en)
14. World Economic Forum. (2024, December). Unlocking renewable energy future in emerging markets. <https://www.weforum.org/stories/2024/12/clean-energy-in-emerging-markets/>
15. Wikipedia. (2024). Green economy. [https://en.wikipedia.org/wiki/Green\\_economy](https://en.wikipedia.org/wiki/Green_economy)
16. University of Chicago Press. (2024). Workers and the Green-Energy Transition: Evidence from 300 Million Job Transitions. *Environmental and Energy Policy and the Economy*, Vol 5.