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BRINGING SUSTAINABILITY: THE ROLE OF THE GREEN ECONOMY IN ENHANCING RESOURCE EFFICIENCY



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Abstract: This paper explores the effectiveness of resource efficiency and energy intensity strategies in selected countries using a mixed-methods approach. It analyzes how nations such as Sweden and Canada have successfully aligned environmental and economic objectives, while countries like China face complex challenges in transitioning to a green economy. The study highlights the role of institutional capacity, clean energy adoption, and sustainable development policies in reducing material and energy intensity. Results show that higher-income countries demonstrate better performance in energy efficiency, whereas developing countries still face rising material demand. The findings suggest that national policy coherence and investment in green infrastructure are critical to advancing the global green economy.

Key words: resource efficiency, energy intensity, green economy, Sweden, Canada, China, renewable energy, environmental policy, sustainable development.

Annotatsiya: Ushbu maqolada resurslardan samarali foydalanish va energiya intensivligini kamaytirish bo'yicha siyosatlarning samaradorligi tahlil qilinadi. Aralash metodlar asosida olib borilgan tadqiqotda Shvetsiya va Kanada singari mamlakatlar ekologik va iqtisodiy maqsadlarni muvofiqlashtirishga erishgani, Xitoy esa yashil iqtisodiyotga o'tishda murakkab muammolarga duch kelayotgani ko'rsatiladi. Tadqiqot natijalari resurs samaradorligini oshirishda institutsional salohiyat, qayta tiklanuvchi energiya manbalaridan foydalanish va barqaror taraqqiyot siyosatining muhimligini ta'kidlaydi. Yuqori daromadli mamlakatlarda energiya samaradorligi yuqori bo'lsa-da, rivojlanayotgan davlatlarda resurs iste'moli oshishda davom etmoqda. Xulosa qilib aytganda, yashil iqtisodiyotga o'tishda siyosiy uyg'unlik va yashil infratuzilmaga sarmoya kiritish muhim ahamiyat kasb etadi.

Kalit so'zlar: resurs samaradorligi, energiya intensivligi, yashil iqtisodiyot, Shvetsiya, Kanada, Xitoy, qayta tiklanuvchi energiya, ekologik siyosat, barqaror rivojlanish.

Аннотация: В статье рассматривается эффективность стратегий повышения ресурсоэффективности и снижения энергоёмкости в отдельных странах с применением смешанных методов исследования. Анализ показывает, что Швеция и Канада успешно совмещают экологические и экономические цели, в то время как Китай сталкивается со сложностями в переходе к зелёной экономике. Исследование подчёркивает значимость институционального потенциала, внедрения возобновляемых источников энергии и устойчивой государственной политики. Результаты показывают, что страны с высоким доходом добились значительного прогресса в области энергоэффективности, в то время как в развивающихся странах сохраняется рост потребления материалов. Вывод заключается в том, что согласованная государственная политика и инвестиции в зелёную инфраструктуру являются ключевыми факторами для продвижения глобальной зелёной экономики.

Ключевые слова: ресурсоэффективность, энергоёмкость, зелёная экономика, Швеция, Канада, Китай, возобновляемая энергия, экологическая политика, устойчивое развитие.

INTRODUCTION

Low-carbon, resource-efficient, and socially balanced growth are the main goals of the green economy [1]. The purpose of investments and policies in a green economy is to increase resource and energy efficiency while simultaneously promoting social and economic advancement. Lower material use—or higher resource efficiency helps reduce environmental issues and sustains long-term economic growth [2]. Resource efficiency is critical not only for environmental sustainability but also for economic resilience, as inefficient resource use causes severe damage to ecosystems and society (OECD, 2017).

For instance, global material flows could nearly double from approximately 41 billion tonnes in 2010 to about 89 billion tonnes by 2050 due to urbanization and increased consumption levels [3]. This is a serious concern given the sharp rise in global material use over the past few decades. Such a trend has led to considerable environmental impacts, including biodiversity loss, increased greenhouse gas emissions, and ecosystem degradation. As a result, decoupling economic growth from material and energy consumption has become a central objective in the agenda of sustainable development [UNEP and the OECD].

One notable example is the European Union, where resource productivity (GDP per unit of material used) increased by 39% between 2000 and 2017 [4], indicating some success in decoupling economic activity from material consumption. Nevertheless, rising demands for resources remain a pressing challenge, especially in middle- and low-income countries due to ongoing infrastructure development, industrial growth, and population increase [OECD, 2020]. Consequently, the operationalization of green economy principles often varies depending on a country's development priorities, institutional capacity, and governance structures.

We argue that many previous studies either focus on single-country cases or present overly broad global overviews. Furthermore, most of them emphasize carbon emission reduction or isolated environmental metrics to assess resource efficiency. Therefore, we contend that it is crucial to conduct comparative research involving diverse economic systems and policy frameworks across regions such as Europe, North America, and Asia.



Our study integrates material use, energy intensity, and economic productivity to provide a more multidimensional assessment of sustainability [UNEP and the OECD]. Quantitatively, we examine key indicators such as energy intensity (energy use per unit of GDP), material productivity (GDP per unit of material consumption), and the share of renewable energy in national energy mixes. Qualitatively, we evaluate national policy frameworks reflecting green economy principles and assess their effectiveness in achieving resource-efficient outcomes.

Ultimately, this study seeks to contribute to a better understanding of how countries at various stages of development can harmonize environmental sustainability with economic performance. We hypothesize that nations with well-established green economy strategies will demonstrate higher levels of resource efficiency compared to those with less comprehensive policy frameworks.

REVIEW OF RELEVANT LITERATURE

The green economy model connects sustainable resource use with economic growth. By definition, the green economy greatly reduces environmental risks and ecological scarcity while increasing social equity and human well-being [5]. Most modern green growth strategies generally focus on resource productivity and efficient use of natural inputs [Februari 2025, Loso Judijanto]. Current strategies prioritize reducing carbon emissions, increasing resource efficiency, and promoting circular economy concepts, according to Judijanto's analysis of green economy policies. Furthermore, the idea of a "green economy" refers to the reduction in the overuse of natural resources even as output and employment continue to grow. Green economy projects such as using renewable energy, promoting green public procurement, and enhancing recycling efforts are essentially geared toward increasing the rate of material reuse and improving resource consumption patterns, in line with SDG 12 on sustainable consumption.

At the international level, policy analyses confirm that enhancing resource efficiency is a central goal of green growth. The OECD [2020] highlights that many countries have developed strategies aimed at achieving a more circular and resource-efficient economy, such as those under the Sustainable Development Goals and the G7 Resource Efficiency Action Plans. However, structural and technological changes alone will not suffice to curb the rising global material consumption unless supplemented by additional policy instruments [OECD, 2019]. This indicates that the decoupling of resource use from economic growth must remain a core focus of green economy frameworks. OECD projections suggest that, without serious interventions, material usage in OECD countries could grow by up to 65% by 2060 [6]. Therefore, the organization emphasizes that well-planned green economic policies that integrate incentives, regulatory mechanisms, and innovation support tend to be more effective, whereas fragmented approaches are typically insufficient to boost resource productivity.

Case studies help illustrate these dynamics. Sweden, widely recognized as a leader in green growth, has long implemented policies such as carbon pricing, renewable energy promotion, and circular economy initiatives. According to the OECD [2025] environmental review, "Sweden successfully decoupled major environmental pressures from economic growth" over the past decade [7]. This decoupling is evident in Sweden's high levels of resource productivity, with greenhouse gas and energy intensities per GDP among the lowest in the European Union [8]. Sweden's long-term climate strategy prioritizes digitalization and smart systems to increase resource efficiency, particularly in energy and waste management. In practice, its green growth policy mix including a comprehensive carbon tax since 1991 and extensive R&D in cleantech—has delivered measurable improvements in material and energy efficiency, in line with international green economy benchmarks.

Canada presents a more mixed scenario. Despite being a resource-rich and historically energy-intensive economy, Canada has made progress in implementing green policies. According to the OECD [2017] environmental review, the country has achieved some decoupling of economic growth from air pollution, energy use, and greenhouse gas emissions. Nevertheless, Canada continues to rank among the most resource-intensive economies globally since 2000 [9]. Empirical studies indicate that green economy strategies can significantly mitigate environmental impacts. For instance, a 2023 study found that improved resource efficiency especially through circular economy initiatives helps reduce ecological harm in Canada [10]. Moreover, Canadian policy documents acknowledge that without stronger efficiency measures, the country's already high per capita resource use (one of the highest in the G8) will hinder its transition to a low-carbon economy [9].

Similarly, China is increasingly integrating resource-efficiency goals into its broader green growth agenda. Recent Five-Year Plans include targets for building an "ecological civilization," promoting circular economy principles, reducing energy intensity, and applying resource taxation. Scholars report that China's policy tools such as mandatory recycling and industrial modernization are beginning to slow the growth of material and energy use. Nonetheless, due to the scale of its economy, China's total material consumption remains very



high. Studies (e.g., Takalo et al., 2021) emphasize the need for innovation in green technologies and financing mechanisms to further accelerate efficiency improvements.

DATA AND METHODOLOGY

In our study, we applied a mixed-methods framework combining data analysis and policy review. Quantitatively, we gathered published indicators of resource efficiency and productivity from sources such as Eurostat/EEA, IEA, and the World Bank database (e.g., GDP per unit of domestic material consumption, energy use per GDP, and renewable energy share). Qualitatively, we examined strategic policy documents and national strategies, such as Sweden's Climate Policy Framework as assessed by OECD [2025] [11], Canada's Pan-Canadian Framework on Clean Growth and Climate Change [12], and China's 14th Five-Year Plan (2021–2025) [13]. These policies encompass measures such as carbon pricing, efficiency standards, and technology investments that influence resource-use outcomes.

By triangulating trends in quantitative data with insights from policy analyses, we aim to highlight general global trends and illustrative regional experiences.

Resource efficiency is inherently the result of both technical and policy-driven processes, shaped by strategic governance frameworks, investments, and institutional capacities. Therefore, analyzing this topic from a single methodological perspective would be insufficient.

The metrics we utilize from databases such as Eurostat/EEA, IEA, and the World Bank provide comparative insight into how different economies are performing relative to one another and in relation to global sustainability benchmarks.

However, quantitative metrics alone cannot fully capture the institutional and policy mechanisms driving these trends. Hence, we supplement the analysis with a review of policy documents that serve as authoritative articulations of governmental intent and action within the green economy transition.

RESULTS AND DISCUSSION

Resource efficiency metrics show mixed progress. Energy intensity (energy use per GDP) has generally declined, but unevenly. For example, recent analyses find a modest 1% drop in global energy intensity in 2023 far below the historical average of 1.8% per year recorded in the 2010s [14]. Within the OECD, however, improvements were much stronger: 2023 saw a 3.1% fall in energy intensity, including a 4.7% drop in the EU and more than 2% declines in the US and Canada [14].

By contrast, many nonOECD regions saw little change or even an increase. Notably, China's energy intensity rose by approximately 1.3% in 2023 [14]. Globally, material use remains high and is projected to grow further. Developed countries still consume significantly more per capita than low-income countries, and the fastest growth in material demand is occurring in Asia and Africa.

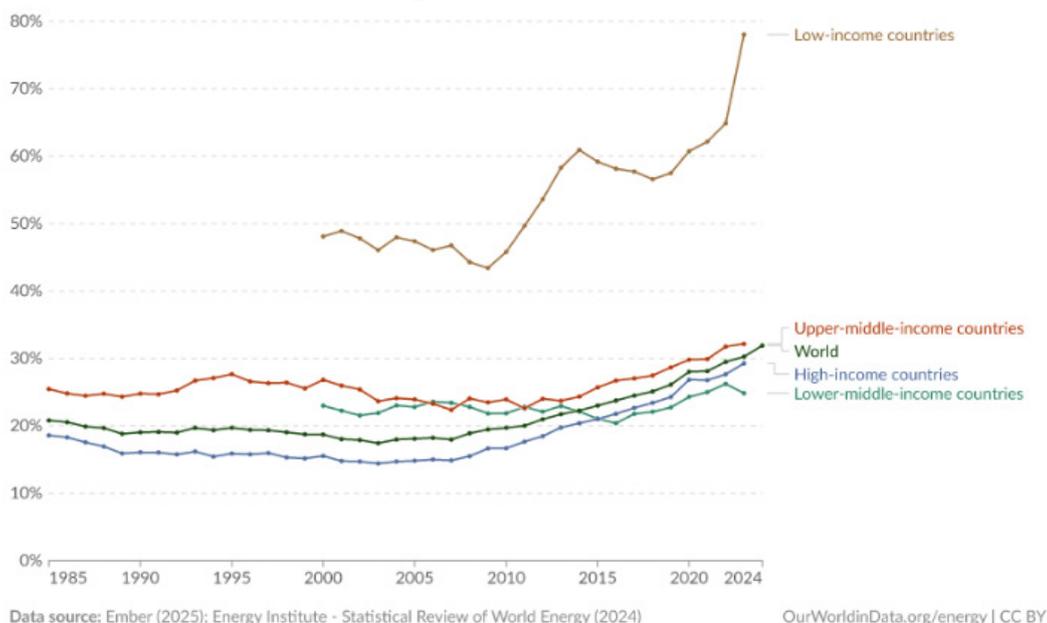


Figure 1: Share of electricity production from renewables (1985–2024) by country income group (source: Our World in Data, CC BY).



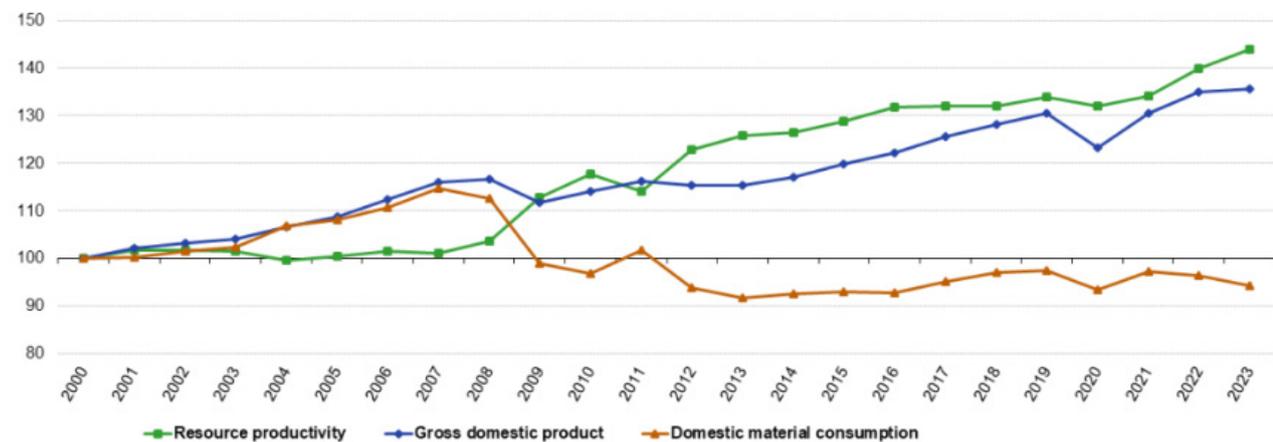
Figure 1 illustrates that high- and upper-middle-income countries reached approximately 25–30% renewable share of electricity by the mid-2020s (including hydro, wind, solar, etc.), with the world average share approaching ~28%. Low-income countries appear much higher (reflecting hydropower dependence), but these are small economies. The continuing rise in renewable shares indicates substantial efficiency gains. For example, many European countries and Canada have extensive hydro and wind installations, while China is currently the leader in solar and wind installations.

Case – Sweden (Europe): Sweden is an example of an ambitious green economy approach. Its climate framework and the recent OECD review explicitly call for making “energy and resource efficiency a fundamental component” of climate transition policies [11]. This aligns with strong performance: Sweden’s energy intensity fell by ~38% from 2005 to 2023, roughly matching EU trends [15]. The country has world-class district heating and combined heat-and-power systems which reuse waste heat [15]. Sweden is also a leading nation in recycling and circular policies; among its national goals are high municipal recycling rates and a halving of material intensity between 2005 and 2030.

Case – Canada (North America): Canada’s clean growth strategy connects economic and environmental goals in a similar way. Key measures include carbon pricing, support for clean technology, and efficiency standards. Canada already operates a mostly non-emitting grid: approximately 80% of its electricity comes from hydro, nuclear, wind, and solar sources, and the government has committed to reaching 90% non-emitting power by 2030 [16]. Energy intensity has also fallen: OECD data indicate that North America saw a decline in energy intensity of over 2% in 2023 [14].

Case – China (Asia): China’s 14th Five-Year Plan (2021–2025) prioritizes “green development” and resource efficiency. Combining heavy industries into current industrial parks (for improved energy management), modifying the steel and building sectors, and implementing large-scale renewable energy projects are key measures included [13]. Indeed, China is driving global renewable expansion: an IEA forecast estimates that China will supply ~40% of all new renewable capacity between 2019 and 2024 [17]. However, China also faces constraints its economy still relies heavily on coal (China uses approximately 25% of the world’s coal for power). In 2023, China’s energy intensity unexpectedly increased (+1.3%) [14†], suggesting that the pace of economic growth and existing infrastructure can offset potential efficiency gains.

Development of resource productivity in comparison with GDP and DMC, EU, 2000-2023
(2000 = 100)



Note: GDP in chain-linked volumes, reference year 2015. Y-axis does not start at 0
Source: Eurostat (online data code: nama_10_gdp; env_ac_mfa; env_ac_rp)

eurostat

Figure 2: Resource productivity in comparison with GDP and DMC, EU, 2000-2023
Source: Eurostat [18] [19] [20].

Figure 2 illustrates that resource productivity is measured as gross domestic product (GDP) over domestic material consumption (DMC). The latter measures the total amount of materials directly consumed in an economy by businesses for economic production and by households. The former is a basic measure for the overall size of a country’s economy. It is obvious from the graph that DMC has been keeping up with the development of resource productivity, while GDP has shown a downward trend since 2000.



Energy intensity measured in terms of primary energy and GDP

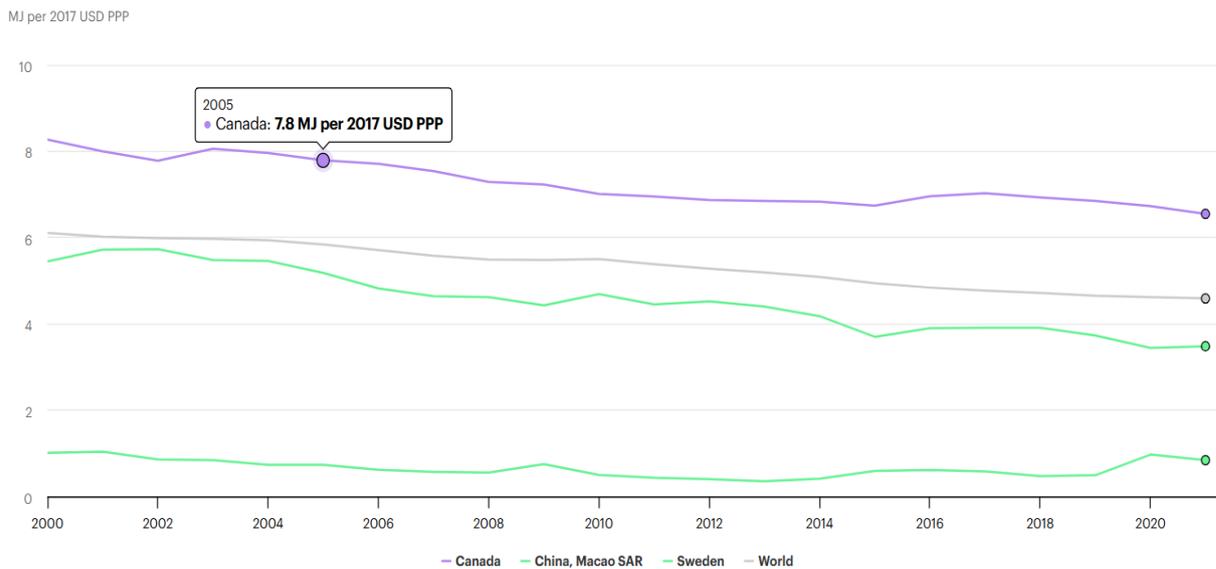


Figure 3: Energy intensity levels measured in terms of primary energy and GDP

Source: This indicator is derived from energy data sourced on a joint dataset built by the International

Energy Agency (<https://www.iea.org/data-and-statistics/>) and the United Nations Statistics Division (<https://unstats.un.org/unsd/energystats/>).

Figure 3, sourced from the IEA, illustrates energy intensity in terms of primary energy consumption relative to GDP. Since 2000, energy intensity in both Canada and Sweden has declined steadily over the years, while China has experienced an uptick. Notably, only Canada's energy intensity exceeded the world average (4.6 MJ per 2017 USD PPP), reaching 6.6 MJ per 2017 USD PPP in 2021. In contrast, Sweden and China recorded 3.5 MJ and 0.8 MJ per 2017 USD PPP, respectively.

CONCLUSION AND RECOMMENDATIONS

Using a mixed-methods approach, we found that countries with well-developed policy-making structures—such as Sweden and Canada have achieved significant improvements in energy and material efficiency, effectively aligning environmental goals with economic growth. China, on the other hand, presents a dynamic yet complex case: despite leading global efforts in renewable energy expansion, its continued reliance on coal and rapid industrialization hinder substantial efficiency gains.

Although global energy intensity is generally declining, much of this progress is concentrated in higher-income economies. In contrast, emerging economies continue to experience rising material consumption, which underscores the necessity for deeper structural reforms and long-term policy commitments.

These findings provide strong support for the hypothesis that robust institutional frameworks, targeted investments, and comprehensive sustainability strategies are critical to enhancing resource efficiency.

To conclude, the green economy should be viewed not as a one-size-fits-all solution, but rather as a flexible policy framework whose success depends on a nation's capacity for coherent planning, governance, and adaptation to local economic and environmental realities.

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