

Criteria and Indicators for Assessing Environmental Performance

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Annotation: Environmental efficiency is a core concept in sustainable development, environmental economics, and green growth policy. It reflects the capacity of economic systems, organizations, and technologies to generate value while minimizing pressure on the environment. This article provides a comprehensive scientific analysis of the criteria and indicators used to assess environmental efficiency. Drawing on international methodologies, standards, and academic literature, the study develops a structured system of indicators applicable at micro-, meso-, and macro-levels. The results demonstrate that environmental efficiency assessment requires an integrated, multi-criteria approach combining resource productivity, emission intensity, waste management performance, and ecosystem impact indicators. The proposed framework contributes to improving the analytical basis for environmental policy design and sustainability-oriented decision-making.

Keywords: environmental efficiency,

sustainability indicators, eco-efficiency, environmental performance, green economy.

INTRODUCTION

In recent decades, accelerating environmental degradation has become one of the most critical challenges facing the global economy. Climate change, depletion of natural resources, loss of biodiversity, and increasing levels of pollution threaten long-term economic stability and social well-being. [1] Traditional models of economic growth, focused primarily on maximizing output and profit, have proven insufficient to address these challenges, as they often neglect environmental costs and externalities.

In response, the concept of environmental efficiency has emerged as an important analytical and practical tool for aligning economic activity with environmental sustainability. [2] Environmental efficiency reflects the relationship between economic value creation and environmental impact, emphasizing the need to achieve more output with fewer natural resources and lower levels of pollution. This concept is closely linked to eco-efficiency, resource efficiency, and environmentally adjusted productivity.

Environmental efficiency indicators are increasingly used by governments, international organizations, and businesses to monitor progress toward sustainability goals, evaluate environmental performance, and support evidence-based policymaking. [3] However, the diversity of existing approaches has resulted in methodological fragmentation and a lack of unified assessment criteria. Different studies prioritize different indicators depending on scale, data availability, and policy objectives.

The purpose of this article is to systematize the main criteria and indicators used to assess environmental efficiency and to present a scientifically grounded framework suitable for academic research and practical application. By synthesizing international experience and theoretical approaches, the study seeks to enhance the methodological consistency of environmental efficiency assessment.

METHODS AND ANALYSIS

The study is based on a qualitative and analytical research methodology combining literature review, comparative analysis, and conceptual synthesis. The research focuses on identifying widely used criteria and indicators that capture the multidimensional nature of environmental efficiency. [4]

The primary sources of information include peer-reviewed scientific publications, methodological guidelines developed by international organizations, and sustainability assessment frameworks applied in environmental economics and management. Particular attention is paid to approaches proposed by the Organisation for Economic Co-operation and Development, the United Nations Environment Programme, the World Bank, and the International Organization for Standardization.

The analytical process involved three main stages. First, key conceptual definitions of environmental efficiency were identified and compared. Second, assessment criteria were classified according to their functional role in reflecting environmental pressure and economic performance. [5] Third, specific indicators were systematized based on input–output relationships and environmental impact pathways. This approach allows for a comprehensive and flexible assessment framework adaptable to different analytical levels.

RESULTS

Conceptual Criteria of Environmental Efficiency

The analysis of scientific literature indicates that environmental efficiency assessment is built upon several interrelated criteria that together reflect the interaction between economic activity and the environment. [6]

The first criterion is **resource use efficiency**, which characterizes how effectively natural resources such as energy, water, and raw materials are transformed into economic output. Improving resource efficiency reduces pressure on natural systems and enhances long-term economic resilience.

The second criterion is **pollution and emission intensity**, which reflects the amount of pollutants released into air, water, and soil per unit of output. This criterion is central to climate policy and pollution control strategies, as it directly links production processes to environmental degradation. [7]

The third criterion is **waste generation and circularity**, which evaluates the extent to which economic systems minimize waste and promote recycling, reuse, and recovery of materials. Circular economy principles are increasingly integrated into environmental efficiency assessments.

The fourth criterion is **ecosystem impact**, capturing the effects of economic activities on biodiversity, land use, and ecological stability. Although more difficult to quantify, ecosystem-related indicators provide critical insight into long-term sustainability. [8]

The fifth criterion is **technological and innovation efficiency**, reflecting the role of clean technologies, eco-innovation, and environmental management systems in improving environmental performance.

System of Environmental Efficiency Indicators

Based on the identified criteria, environmental efficiency indicators can be grouped into several categories.

Resource-based indicators measure input efficiency and include energy intensity, water intensity, and material intensity indicators. These indicators are commonly expressed as resource consumption per unit of gross domestic product or value added. [9]

Emission-related indicators focus on environmental pressure and include carbon intensity, air pollutant emissions per unit of output, and wastewater discharge indicators. These measures are widely used in environmental regulation and international reporting.

Waste and circular economy indicators include waste generation rates, recycling shares, and the proportion of secondary raw materials in total material use. These indicators reflect progress toward closed-loop production systems.

Integrated and composite indicators combine multiple dimensions of environmental efficiency into a single metric. [10] Examples include eco-efficiency ratios, environmentally adjusted productivity measures, and composite environmental performance indices.

Levels of Application

Environmental efficiency indicators are applied at different analytical levels. At the micro-level, they are used to assess firms, technologies, and products. At the meso-level, they support the evaluation of industries, regions, and supply chains. At the macro-level, they are employed to compare national economies and monitor progress toward sustainable development goals.

CONCLUSION

This article has presented a comprehensive scientific analysis of the criteria and indicators used to

assess environmental efficiency. The findings highlight that environmental efficiency assessment requires an integrated, multi-criteria framework reflecting resource use, emissions, waste management, ecosystem impacts, and technological innovation. The proposed system of indicators can support more consistent environmental performance assessment and contribute to the design of effective sustainability policies.

Further research should focus on improving ecosystem-related indicators, enhancing data comparability, and integrating social dimensions into environmental efficiency assessment frameworks.

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