

Economic Growth and CO₂ Impact for SDG Policy in Asia-Pacific

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Abstract

This study explores the relationship between economic development and CO₂ emissions, with a focus on SDG-oriented policy insights for the Asia-Pacific region. Using Power BI as a visualization tool, the research analyses emissions intensity relative to GDP to identify trends, disparities, and pathways for decoupling economic growth from environmental degradation. Visualizations such as scatter plots, bar charts, line graphs, and maps serve as diagnostic tools to assess progress toward SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities), and SDG 13 (Climate Action). The findings show that while developed regions like Europe demonstrate lower emissions per GDP due to effective renewable energy policies and infrastructure, developing countries in Asia and Africa remain heavily dependent on fossil fuels, highlighting the need for clean energy transitions and inclusive climate action. Urbanization-driven emissions in fast-growing economies like China and India emphasize the importance of sustainable urban planning. Countries with high GDP and low emissions serve as examples of successful decoupling through green finance, innovation, and regulation. Power BI enhances environmental governance by enabling informed decision-making and transparent SDG monitoring. The study demonstrates the value of data-driven tools in aligning economic growth with sustainability goals. Future research should incorporate sector-specific and longitudinal data to support more tailored policy interventions across different regional contexts.

Keywords: Asia-Pacific, CO₂ Emissions, Data Visualization, Economic Development, SDGs.

Introduction

The urgency of sustainable development amid economic growth and environmental degradation remains a critical global concern, as economic expansion often leads to ecological harm, thereby challenging the achievement of sustainability goals. Strategies that effectively decouple economic growth from environmental damage are essential and can be pursued through renewable energy adoption, technological innovation, and robust policy frameworks. Transitioning to renewable energy, such as solar, wind, and hydroelectric power, is highlighted as a key measure in reducing environmental impacts while sustaining development, as seen in Uzbekistan and other newly industrialized countries (1, 2). Technological advancements, particularly in cleaner energy and innovation sectors, have been effective in reducing ecological footprints in developed regions like the G7, demonstrating the transformative role of innovation in sustainability (3). Moreover, sound environmental policies,

including taxation and subsidies, are vital; African countries and China exemplify the importance of integrating dynamic ecological regulations into economic strategies (4, 5). The Environmental Kuznets Curve (EKC) hypothesis further suggests that while early economic growth intensifies environmental degradation, it eventually declines with the adoption of cleaner practices, a trend observed in both African and developing nations (4, 6). Additionally, foreign direct investment (FDI) presents a dual-edged impact—potentially increasing emissions, yet offering avenues for cleaner technologies depending on regulatory contexts (6). However, countries dependent on resource-intensive industries, such as Uzbekistan, must modernize their sectors and shift towards renewables to mitigate harm (1). In Asian emerging markets, financial development and urbanization also significantly drive CO₂ emissions, underscoring the need for sustainable urban and financial planning (7). The Sustainable

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Development Goals (SDGs) 7, 11, and 13 are particularly pertinent to the Asia-Pacific region due to its rapid economic growth, urbanization, and escalating environmental challenges. SDG 7, which emphasizes affordable and clean energy, is vital as the region experiences surging energy demands driven by economic development (8). While progress has been made in expanding energy access, the region must further enhance energy efficiency and integrate renewable energy sources to achieve SDG 7 targets (8). Extractive industries play a supporting role by providing critical materials for energy infrastructure, thereby necessitating more energy-efficient extraction methods (9). Additionally, energy poverty remains a pressing issue, highlighting the need for infrastructure investment to ensure reliable electricity access in underdeveloped areas (9). For SDG 11, which focuses on sustainable cities and communities, the region's fast-paced urbanization underscores the importance of sustainable urban planning to address pollution, waste management, and infrastructure development (10). Advancing climate action in the region also depends on robust international cooperation and national policy initiatives, with countries like China and South Korea taking the lead in renewable energy investments (10).

Data-driven decision-making tools, such as Power BI, are pivotal in advancing environmental governance by enhancing data analysis, predictive capabilities, and informed decision-making processes. These tools allow for the integration and analysis of large and complex datasets, which is essential for addressing multifaceted environmental challenges and ensuring the efficient management of natural resources. Through advanced data analytics, environmental governance becomes more proactive, transparent, and effective. For instance, such tools facilitate the uncovering of hidden patterns and enable predictive modelling crucial for early issue detection and improved management (11). In Environmental Impact Assessments (EIAs), they enhance analytical precision and forecasting without undermining human judgment in complex decision-making (12). The integration of artificial intelligence and data analytics supports the analysis of diverse datasets, including time series and geospatial information, helping to bridge technical skill gaps in public administration and

enabling more informed policy decisions (13). Technologies like big data, GIS, and remote sensing further contribute to accurate environmental monitoring and adaptive governance (14). Moreover, these tools promote transparency and accountability by offering evidence-based insights that can be shared with stakeholders, fostering public trust and policy compliance (14, 15). Aligning with sustainable development goals, data-driven approaches empower eco-conscious practices by modelling climate change, tracking wildlife, detecting pollution, and managing ecosystems effectively (16). In sectors like transportation, they help agencies assess the environmental and economic impacts of projects, thereby promoting liveable communities and sustainability (17).

Climate-smart development is a holistic framework that integrates climate change adaptation and mitigation with the broader objectives of sustainable development, aiming to address complex climate challenges while fostering economic growth and social equity. Particularly relevant to climate-sensitive sectors like agriculture, this approach emphasizes context-specific solutions that are responsive to local socio-economic and environmental conditions, thereby ensuring interventions are both effective and equitable (18, 19). At its core, climate-smart development incorporates strategies that concurrently enhance resilience to climate impacts and reduce greenhouse gas emissions, aligning with key Sustainable Development Goals (SDGs) such as food security, health, and economic growth (20, 21). Climate-Smart Agriculture (CSA) exemplifies this model, operating on three foundational pillars: increasing productivity, enhancing resilience, and reducing emissions (21, 22). Effective CSA implementation depends on the integration of scientific, technical, and policy dimensions through decision-support tools that guide trade-off analysis and policy coherence (23, 24). However, CSA has faced criticism for potential green washing and elite capture, prompting calls to ensure its genuine alignment with smallholder needs and sustainable development goals (19, 23). More broadly, climate-smart development demands cross-disciplinary research that reflects the socio-economic and political contexts of diverse stakeholders in both developed and developing nations (25, 26). Equally important is

the need for inclusive governance and active participation from governments, NGOs, and local communities to ensure that climate-smart interventions are just, transparent, and tailored to those most vulnerable to climate change impacts (23, 26).

The objective of this research is to investigate the relationship between economic development and CO₂ emissions in the Asia-Pacific region through the lens of sustainable development, with a particular focus on SDGs 7 (Affordable and Clean Energy), 11 (Sustainable Cities and Communities), and 13 (Climate Action). By utilizing Power BI as a data-driven decision-making tool, the study aims to visualize and analyse regional patterns of emissions and GDP, providing actionable insights that support SDG-oriented policy formulation. The research seeks to contribute to climate-smart development by identifying areas where economic growth can be decoupled from environmental degradation, thereby informing strategies that promote resilience, low-carbon transitions, and inclusive sustainability in rapidly developing contexts.

The Environmental Kuznets Curve (EKC) hypothesis proposes an inverted U-shaped relationship between environmental degradation and economic development, suggesting that environmental impacts increase during the early stages of economic growth but eventually decline as income levels rise, due to greater investment in cleaner technologies and stricter regulations (27, 28). The hypothesis, often associated with the foundational work of Grossman and Krueger, is grounded in economic models such as optimal and endogenous growth theories that integrate environmental factors into production processes (27, 29). Despite its widespread use in analysing environmental indicators like carbon emissions and ecological footprints, the EKC hypothesis has faced substantial criticism. Empirical limitations arise from the reliance on cross-sectional data that fail to capture country-specific dynamics (30), and methodological concerns relate to inconsistent variable measurement and questionable robustness of statistical techniques (29, 30). Moreover, the EKC has been criticized for implying that economic growth alone will lead to environmental improvements, potentially fostering policy complacency, especially in developing regions (27). In relation to Sustainable

Development Goals (SDGs), research shows that their implementation in G20 countries has contributed to a reduction in ecological footprints, indicating a shift towards sustainable development (31). Key factors such as renewable energy adoption and foreign direct investment (FDI) have played notable roles in mitigating environmental harm, though the effects of FDI and population growth remain mixed (31). Future directions call for EKC research to incorporate broader environmental and economic indicators, advanced econometric techniques, and sector-specific or historical analyses to provide more nuanced insights into the relationship between growth and environmental quality (32, 33).

Sustainable urbanization (SDG 11) and clean energy transitions (SDG 7) are closely interlinked and vital for achieving global sustainability, as urban areas—home to over half of the world's population—are major contributors to both economic growth and greenhouse gas emissions. Case studies from cities such as Copenhagen, Curitiba, Singapore, Stockholm, and Melbourne illustrate successful strategies including efficient public transportation, waste recycling programs, and the integration of green spaces to promote urban sustainability (34). Nonetheless, many urban initiatives lack integrated visions and measurable targets, though they offer opportunities for promoting circular economies and sustainable job creation (35). Transitioning to clean energy in urban contexts is essential for reducing carbon emissions and enhancing environmental protection, yet it requires overcoming technological, economic, and social barriers (36). Legal and policy reforms are also necessary, as illustrated in the Arab world, where complex regulatory frameworks impede energy transitions (37). Moreover, access to clean energy positively influences human development, with evidence from South Asia showing that technological innovation and energy access significantly contribute to economic growth (38). The synergy between SDG 11 and SDG 7 is evident, as urban sustainability strategies increasingly integrate renewable energy solutions, thereby supporting broader goals like climate action (SDG 13) (36). However, the aspirational nature of the SDGs and the fragmented coordination among sectors pose on-going challenges, necessitating a holistic and integrated approach that balances

environmental, economic, and social dimensions (34, 39).

Economic growth in the Asia-Pacific region has a multifaceted impact on carbon emissions, exhibiting clear distinctions between developing and developed countries. In developing economies such as China and India, economic expansion is closely linked to increased CO₂ emissions due to reliance on fossil fuels and energy-intensive industries, compounded by weak environmental regulations and a prioritization of growth over ecological concerns (40–42). However, the integration of renewable energy sources offers a viable path toward sustainable development, with studies showing that renewable energy adoption significantly reduces emissions in these contexts (40). Conversely, developed countries like Japan and Australia display a more nuanced relationship, often aligning with the Environmental Kuznets Curve (EKC) hypothesis—where emissions rise during initial economic growth but decline as technological innovation and stringent environmental policies take effect (41, 43, 44). These nations typically achieve higher energy efficiency and make substantial investments in green technologies that help decouple growth from emissions (45). Across the broader Asia-Pacific region, the growth-emissions dynamic is shaped by varying energy use patterns, trade frameworks, and levels of financial development, reflecting significant regional heterogeneity (46, 47). Policies that promote energy efficiency, technological innovation, and renewable energy transitions are critical for enabling both economic and environmental progress, particularly in developing countries seeking balanced development (42).

The integration of green finance, technological innovation, and policy frameworks is fundamental to supporting low-carbon development and achieving carbon neutrality, as it combines financial resources, innovative solutions, and regulatory structures to drive sustainable transformation. Empirical evidence confirms its role in enhancing low-carbon economic growth by facilitating industrial restructuring and encouraging green technological advancement (48, 49). Technological innovation is equally critical, enabling energy-efficient advancements that directly contribute to emission reductions and sustainable development goals (50). The synergy

between finance and technology is especially evident in sectors like logistics, where innovation supported by green finance boosts efficiency and reduces carbon output (51). Policy frameworks underpin this integration by setting regulatory thresholds, offering green incentives, and requiring environmental disclosures that guide capital toward low-carbon industries and enhance market competitiveness (51). Initiatives like green financial reform and innovation pilot zones have further proven effective in strengthening scientific and technological innovation to support low-carbon transitions (52). The combined effect of these three components mobilizes resources, drives sustainable economic growth, and supports carbon emission reductions (50). Thus the effectiveness of this integrated approach also varies across regions and economic contexts, indicating a need for tailored and adaptive policy strategies to ensure inclusive and effective low-carbon development (51). While past studies have examined economic-environmental linkages in regional blocs like ASEAN, SAARC, and Pacific microstates, few have integrated cross-regional data with advanced visualization tools for real-time policy insight. This study uniquely leverages Power BI to link SDG progress to economic and emission indicators, providing interactive diagnostics not previously reported in the Asia-Pacific context.

Despite growing attention to the nexus between economic growth and environmental sustainability, significant research gaps remain in understanding how data-driven tools can inform SDG-oriented policies, particularly in the Asia-Pacific context. While existing studies explore the Environmental Kuznets Curve (EKC), renewable energy transitions, and the roles of green finance and technological innovation, few have integrated these elements into a regional analysis using advanced visualization tools like Power BI to support real-time policy insights. Moreover, limited research addresses how economic-environmental data can be practically aligned with SDGs 7, 11, and 13 to guide low-carbon development in both developed and developing Asia-Pacific countries. This leads to the central research question: How can data visualization of the relationship between economic growth and CO₂ emissions using Power BI support SDG-

oriented policy insights and climate-smart development strategies in the Asia-Pacific region?

Methodology

Data Sources and Variables

Two internationally recognized and publicly accessible data repositories were used: Our World in Data and the World Bank's World Development Indicators (WDI). From these sources, key economic and environmental indicators were extracted, including GDP per capita (adjusted for purchasing power parity in constant international dollars), total GDP, and CO₂ emissions (measured in metric tons per capita and total emissions). This study covers the period from 2000 to 2023. Our World in Data was selected for its comprehensive historical datasets on energy use, CO₂ emissions, and environmental metrics, offering robust temporal coverage (53). The World Bank's WDI database ensured data uniformity and comparability across nations and time periods (54). These indicators are critical for evaluating the Environmental Kuznets Curve (EKC) hypothesis and for assessing decoupling patterns between growth and emissions.

Data Cleaning and Pre-processing

Prior to analysis, the dataset underwent several pre-processing steps to enhance quality and reliability. Discrepancies and duplicate entries were removed to avoid analytical distortions. Measurement units were standardized across variables and countries to maintain consistency. Missing values were addressed using linear interpolation, especially for intermediate years where data gaps existed. The dataset was then filtered to retain only variables pertinent to GDP and CO₂ emissions, ensuring analytical focus. To enable structured comparative analysis, data were aggregated at both national and continental levels, which facilitated regional evaluations of emissions intensity. These pre-processing methods align with best practices in environmental-economic research.

Analytical Tool: Microsoft Power BI

Microsoft Power BI served as the core analytical and visualization platform for this study due to its dynamic interaction capabilities and advanced visual analytics. The tool allowed for the integration of complex datasets and the generation of intuitive dashboards that effectively communicated observed patterns to diverse

stakeholders. Bar charts compared annual CO₂ emissions and GDP across regions; clustered column charts illustrated emission distributions across continents; stacked column charts visualized GDP growth alongside emissions patterns for key regions such as Asia, Europe, and North America. Line graphs were used to track long-term GDP-emissions trajectories and decoupling trends, while scatter plots enabled the visualization of emission intensity. Geospatial maps with bubble sizes highlighted regional disparities and emissions hotspots. These visuals served as diagnostic tools to detect SDG progress and gaps, guiding where policy interventions are most needed.

Statistical Analysis

To support the visual analyses, statistical measures such as correlation coefficients were computed to assess the strength and direction of the relationship between economic development and CO₂ emissions. These quantitative measures provided a numerical foundation for interpreting the visual trends, especially in relation to the EKC hypothesis and the concept of decoupling. The use of these statistics enhanced the study's analytical rigor by substantiating observed patterns with measurable evidence.

Analytical Focus Areas

The study concentrated on several thematic dimensions crucial to understanding sustainable development trends. It analysed emissions intensity per unit of GDP to evaluate environmental efficiency, conducted continental comparisons to reveal policy successes and areas needing attention, and traced development-emission trajectories to determine nations' alignment with SDG targets. Additional focus was given to policy implications concerning renewable energy investment, emissions regulations, and green finance, particularly in low-income and emerging economies. These focus areas enabled a multidimensional understanding of the trade-offs and synergies between development and environmental sustainability.

Results

There are notable trends in the relationship between economic growth and environmental effect when CO₂ emissions and GDP are analysed across different locations. The study looks at how different nations and continents contribute to

global carbon emissions in relation to their economic development using Power BI data visualization tools. The results shed light on the differences in emissions intensity, the effects of industrialization, and how economic policies influence environmental outcomes by examining patterns across several locations. Key findings from the data are presented in this section, emphasizing correlation patterns, geographical variances, and possible ramifications for sustainable development. Figure 1 show how economic output and carbon emissions relate to one another in various geographical areas. Total GDP is represented by the blue bars, and CO₂ emissions are shown by the dark blue line. With a GDP of over 1000 trillion tons, Asia has the biggest

GDP of any continent. It also emits the most CO₂, demonstrating the close relationship between economic activity and environmental effects. Although the GDP levels of the Americas and Europe are comparable, their CO₂ emissions are lower than those of Asia, indicating that their industrialization tactics and patterns of energy consumption differ. In contrast, the GDP and CO₂ emissions of Africa and Oceania are much lower, indicating a lower degree of economic productivity and industrialization. In contrast to Asia, where fast industrial growth continues to drive emissions higher, economic powerhouses like Europe and the Americas may have embraced more sustainable practices, as evidenced by the downward trend of the CO₂ emissions line relative to GDP.

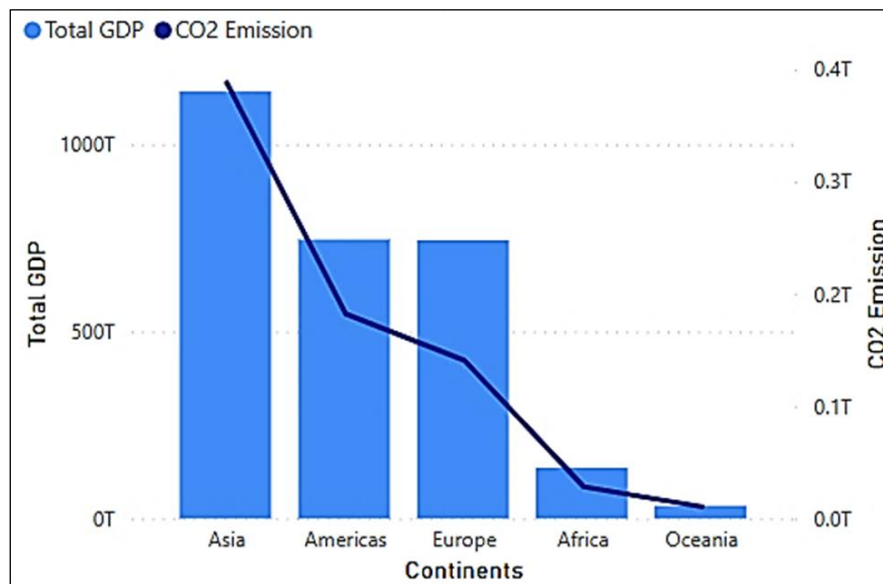


Figure 1: Comparison between Total GDP and CO₂ Emission by Continents

Economic output and carbon emissions from different countries are compared in figure 2. Total GDP is represented by the blue bars, and CO₂ emissions are shown by the dark blue line. China, which also has the largest CO₂ emissions, is not far behind the United States, which has the highest GDP and surpasses all other nations. This implies that a substantial portion of world emissions are caused by China's manufacturing and industrial operations. With differing amounts of CO₂ emissions, which reflect variations in energy sources and industrial activities, India, Japan, and Russia come in second and third in terms of GDP. European countries with modest GDPs, such as Germany, France, and the United Kingdom, have

relatively lower CO₂ emissions, suggesting that they may implement cleaner energy policies and more advanced technology efficiency. In line with their smaller industrial footprints, developing countries like South Africa, Brazil, and Indonesia have comparatively lower GDP and CO₂ emissions. Low GDP and low CO₂ emissions are seen in the graph's rightmost region, which includes nations like Norway, Portugal, and Ireland. This indicates either a lack of economic activity or robust sustainability measures. In some nations, the trend of decreasing CO₂ emissions in relation to GDP points to a move toward more sustainable and energy-efficient models of economic growth.

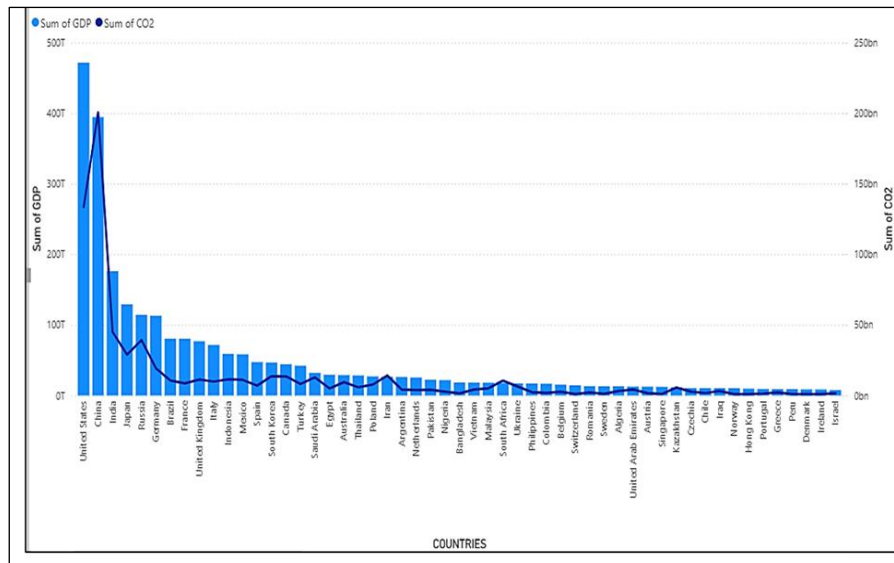


Figure 2: Country Wise CO₂ Emissions and GDP

Figure 3 offers a geographic visualization of country-level CO₂ emissions. Notably, larger bubbles over China and India highlight regions of concentrated emissions, whereas smaller bubbles in African and Pacific states reveal lower emissions. The world map is a colourful representation of the economic data concerning different continents- while Africa is painted in blue, the Americas are in dark blue, Asia is in orange, Europe in purple, and Oceania in pink. The bubbles on the map represent some numbers like GDP, population, emission, and so forth. These values are directly proportional to the diameter of the bubbles: the bigger the bubble, the higher the number. In North America and Europe, especially

the U.S. and certain parts of Western Europe, we can see huge bubbles representing these regions having high economic or industrial activities. Asian bubbles in orange in China and India show they are also quite strong in these areas. In contrast, Africa and South America show smaller bubbles dispersed, indicating fewer economic activities than other areas. There are fewer bubbles overall in Oceania, while Australia does stand out with a significant-sized one, presumably for a good reason- the economy. This map efficiently highlights concentrations of economic or industrial power across the world and shows sharp contrasts between different continents.

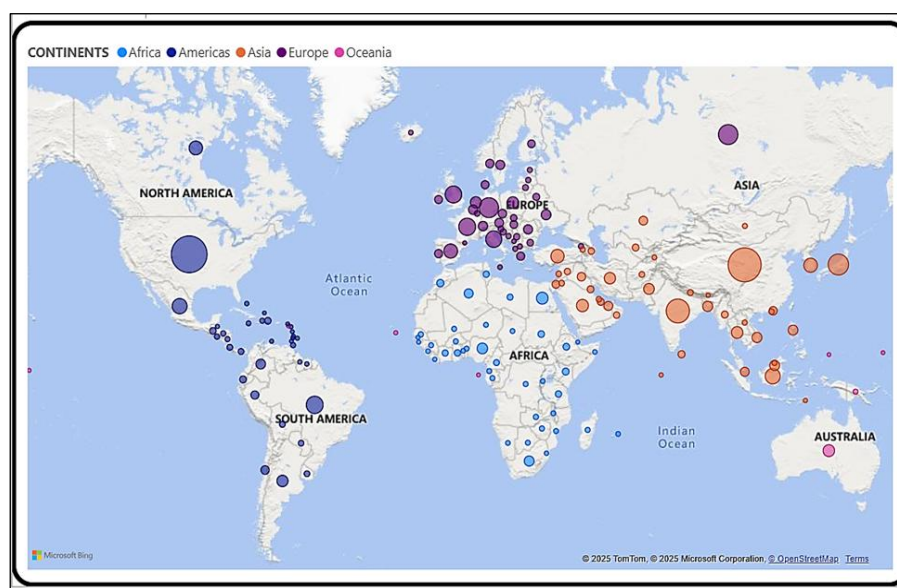


Figure 3: Country Wise CO₂ Emissions

Figure 4 presents a scatter plot linking CO₂ emissions to GDP, visually reinforcing the relationship between economic output and environmental impact. The figure illustrates that higher GDP is often associated with increased emissions, though some advanced economies serve as outliers, achieving lower emissions intensity through policy interventions. The scatter plot achieves the study's goals through showing global CO₂ output and its GDP link. The chart clearly depicts the multiple ways that many CO₂ emissions and GDP can considerably vary across different continents, with each bubble representing a specific region's special contribution to both metrics. The aggregate size of the bubbles highlights quite clearly the extent of CO₂ emissions along with GDP, showing that regions having a higher economic output tend to have more higher carbon emissions. This specific pattern actively reinforces the clear correlation

between industrialization and overall economic activity. There is truly a clear correlation that exists between that activity and ecological effect. Asia, with all of the Americas, both having global economies that are quite large, show notable CO₂ emissions, which suggests growth that is economic and ecological problems have a very strong link. The increasing presence within several smaller bubbles that are having relatively low rates of emissions and GDP further stresses global disparities, under which less industrialized regions contribute less to both the economic output and the emissions. This figure strengthens the goal of assessing patterns in global CO₂ output and offers strong evidence of the relationship between economic growth and carbon footprints. By construing such understandings, officials may seek tactics of lasting fiscal gain which lessen ecological effect while increasing world progress.

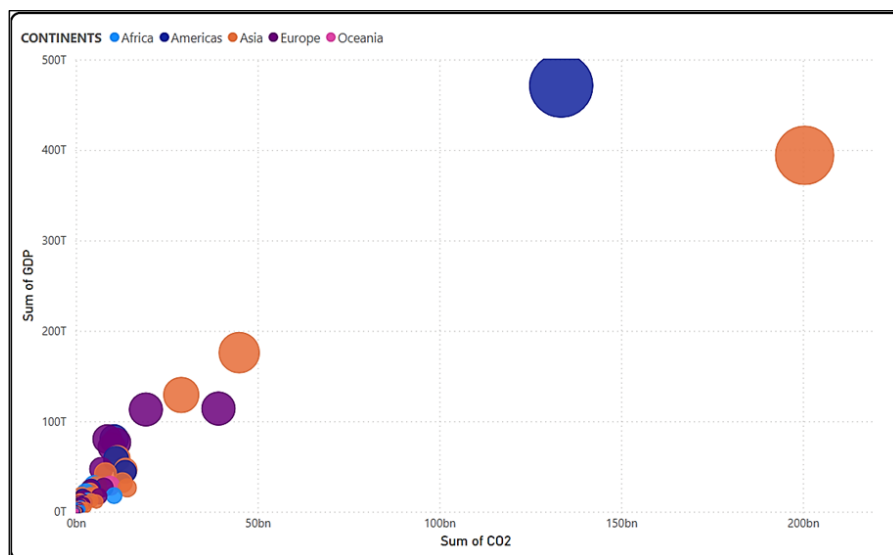


Figure 4: Comparison between CO₂ Emissions and GDP

Discussion

Power BI visualizations serve as powerful diagnostic tools for identifying progress and gaps in achieving SDGs 7 (Affordable and Clean Energy), 11 (Sustainable Cities and Communities), and 13 (Climate Action) across the Asia-Pacific region. The use of bar charts and line graphs in this study reveals clear trends in CO₂ emissions relative to GDP, enabling the assessment of how economic development correlates with environmental impact. For instance, countries like China and India display high emissions intensity alongside rapid GDP growth, suggesting urgent policy attention is

needed to integrate renewable energy and sustainable urban planning (40, 41). In contrast, developed nations such as Germany, France, and the UK exhibit lower emissions despite economic productivity, pointing to effective energy transitions and urban sustainability measures (45). The scatter plots and bubble maps visualize these disparities vividly, highlighting where decoupling has occurred and where reliance on fossil fuels persists. These visual insights align with findings that emphasize the importance of clean energy adoption, technological innovation, and policy frameworks in mitigating emissions and advancing SDG outcomes (36, 51). Such tools not

only inform policymakers about emission hotspots but also support evidence-based decision-making in designing targeted sustainability interventions (13, 14).

The Power BI visualizations in this study reveal distinct regional patterns in energy consumption and the progress of clean energy transitions, central to achieving SDG 7 (Affordable and Clean Energy). Regions like Asia exhibit high CO₂ emissions relative to GDP, indicating a persistent dependence on fossil fuels for industrial and economic activities, particularly in countries such as China and India where rapid economic growth outpaces clean energy adoption (41). In contrast, Europe demonstrates lower emissions intensity despite substantial economic output, reflecting the effectiveness of clean energy policies, technological innovation, and regulatory frameworks aimed at reducing carbon footprints (44). These differences underscore the urgency for Asia and Africa to implement targeted renewable energy strategies and infrastructural investments to reduce emissions while sustaining development (9, 36). Furthermore, empirical evidence from South Asia supports the notion that access to clean energy not only mitigates emissions but also enhances human development and economic resilience (38). Thus, the regional contrasts highlighted through visual data emphasize the need for differentiated yet coordinated approaches to clean energy transitions aligned with local economic and environmental contexts.

High CO₂ emissions in rapidly developing countries such as China and India are closely linked to accelerated urbanization, industrialization, and large-scale infrastructure expansion—key dynamics influencing SDG 11 (Sustainable Cities and Communities) (41). As urban centres grow, so does energy demand, transportation usage, and construction activity, often relying on fossil fuels and lacking efficient environmental controls, which significantly increases emissions (42). The Power BI visualizations in this study clearly depict this trend, with high emission intensities accompanying the economic output of major urbanized nations in Asia. In contrast, cities in developed regions, such as those in Europe, demonstrate that integrating green infrastructure, efficient public transportation, and circular waste systems can reduce emissions without compromising growth (34). Case studies from

cities like Singapore and Copenhagen show that urban sustainability strategies—such as expanding green spaces, implementing recycling programs, and promoting low-carbon transport—are effective in decoupling economic and environmental pressures (38). These insights underscore the need for Asia-Pacific cities to adopt similar integrated planning approaches to promote resilience, reduce urban emissions, and ensure sustainable urban development aligned with SDG 11.

Small Island Developing States (SIDS) in the Asia-Pacific face unique vulnerabilities, including limited resources, dependence on imports, exposure to climate change, and challenges in deploying large-scale renewable infrastructure. Unlike developed countries with diversified economies and advanced technologies, SIDS' decarbonisation requires tailored policy assistance, international financing, and technology transfer to address their energy poverty and climate risks.

The Power BI visualizations highlight stark regional disparities in the relationship between CO₂ emissions and economic development, revealing that many developing countries, particularly in Africa and parts of Asia, exhibit relatively low GDP but disproportionately high emissions due to inefficient technologies, fossil fuel dependency, and limited environmental regulation (41). In contrast, developed nations such as Germany and the UK maintain high economic output while achieving lower emissions intensity, indicating successful adoption of cleaner technologies and stronger policy enforcement (45). These disparities underscore the importance of equity in sustainable development and the urgent need for technology transfer, capacity-building, and climate finance to support low-income countries in achieving sustainability goals without compromising economic growth (50, 51). Inclusive policy frameworks must ensure that developing nations are not left behind in global climate action, and that they receive adequate resources to adopt green infrastructure, enhance renewable energy access, and transition toward low-carbon economies (36). Addressing these inequalities is essential for advancing SDGs 7, 11, and 13, and for fostering a globally coordinated response to climate change.

The visual trends generated through Power BI underscore key examples of decoupling economic growth from CO₂ emissions, particularly in countries with high GDP and relatively low emissions, such as Germany, France, and the United Kingdom. These cases illustrate how strategic investments in renewable energy, robust emissions regulations, and technological innovation can support sustained economic growth while mitigating environmental impact (44). The success of such nations highlights the importance of policy tools including carbon pricing, emissions trading systems, and mandates for clean energy adoption in achieving sustainability goals (51). Additionally, green finance mechanisms—such as green bonds, credit facilities, and sustainable insurance products—have proven effective in mobilizing capital for low-carbon infrastructure and industrial restructuring, particularly in regions implementing innovation-driven policy frameworks (48). Climate-smart planning, which integrates resilience and mitigation strategies into economic development, further supports this balance by addressing both current environmental risks and future sustainability needs (21, 26). These insights emphasize that countries aiming to decouple emissions from growth must adopt a multidimensional policy approach that combines environmental governance, financial innovation, and inclusive planning to align with SDGs 7, 11, and 13.

The Power BI visualizations clearly illustrate examples of countries that have successfully begun to decouple economic growth from CO₂ emissions, with high-GDP nations like Germany, France, and the United Kingdom displaying relatively low emissions intensity compared to rapidly developing economies such as China and India (41, 44, 45). These trends highlight the effectiveness of comprehensive environmental policies, particularly in nations that have implemented stringent emissions regulations, invested in renewable energy infrastructure, and adopted energy-efficient technologies (51). Green finance instruments, including green bonds and sustainability-linked loans, have also facilitated the transition to low-carbon economies by directing capital toward clean technologies and sustainable industries (50). Furthermore, climate-smart planning—rooted in integrated strategies

that address both mitigation and adaptation—has proven essential for aligning economic development with long-term environmental sustainability, especially in vulnerable regions (21). These insights emphasize that decoupling is not only achievable but also critical for meeting the goals of SDGs 7, 11, and 13, requiring countries to implement multifaceted policy approaches that ensure both economic resilience and environmental protection.

Power BI and similar data analytics platforms play a transformative role in enhancing environmental governance by improving transparency, facilitating evidence-based decision-making, and strengthening stakeholder engagement. These tools enable the integration and visualization of large, complex datasets, allowing policymakers to detect trends, identify sustainability gaps, and simulate the potential impacts of environmental interventions in real time (11, 13). In the context of Environmental Impact Assessments (EIAs), data-driven platforms improve forecasting accuracy, highlight critical variables, and enhance the analytical precision needed for complex environmental decision-making without replacing human judgment (12). Moreover, by enabling the clear communication of environmental data through interactive dashboards, such tools promote transparency and build public trust while encouraging accountability among institutions (14, 15). Governments and organizations are therefore encouraged to integrate platforms like Power BI into their EIA processes and SDG monitoring frameworks to support timely and informed policy actions aligned with sustainability objectives. Such integration not only streamlines environmental assessments but also empowers inclusive, data-driven governance to achieve SDGs 7, 11, and 13 more effectively. Sub-regional disparities in economic structure and energy mix such as coal dependence in northern Asia versus hydro power in the Pacific, underscore the need to analyse regional heterogeneities. Future modelling with interaction terms or subgroup analysis may clarify how policy effects and economic transitions diverge across these sub regions

Conclusion

This study employed Power BI visualizations to explore the relationship between economic development and CO₂ emissions across countries

and regions, with a particular focus on generating SDG-oriented policy insights for the Asia-Pacific region. The findings underscore the importance of decoupling economic growth from environmental degradation, as evidenced by countries with high GDP yet low emissions intensity, demonstrating that sustainable development is attainable through strategic investment in clean energy, regulatory frameworks, and green finance. The study also highlighted the effectiveness of data visualization tools such as bar charts, maps, and scatter plots in diagnosing sustainability gaps and tracking progress toward SDGs 7 (Affordable and Clean Energy), 11 (Sustainable Cities), and 13 (Climate Action). Notably, regional disparities revealed that while Europe demonstrates relative success in emissions control, parts of Asia and Africa still face high emissions coupled with lower economic output, indicating a need for technology transfer, financial support, and inclusive climate policy. Additionally, rapid urbanization in Asia-Pacific nations like China and India emphasizes the urgency of integrating green infrastructure, sustainable transport, and energy-efficient systems in urban planning.

The study recommends the adoption of tools like Power BI in national SDG monitoring frameworks and Environmental Impact Assessments (EIAs) to enhance governance and transparency. The significance of this study lies in its ability to transform complex environmental and economic data into actionable insights that can guide evidence-based policy interventions aligned with global sustainability goals. To advance SDG 7 (Affordable & Clean Energy), it is essential to prioritize investments in grid modernization and rural electrification while implementing cost-effective renewable energy policies tailored to local needs. In line with SDG 9 (Industry, Innovation, and Infrastructure), fostering public-private partnerships for green innovation and incentivizing technology adoption for low-emission industries will enhance sustainable growth. Furthermore, to accelerate SDG 13 (Climate Action), robust emissions monitoring, strengthened carbon pricing mechanisms and participatory, evidence-based climate policy development must be introduced to ensure inclusive and effective action against climate change. However, limitations include the lack of sector-specific emissions data and the inability to

assess policy impacts in real time. This study is limited by its reliance on aggregated data; sector-specific emission contributions and policy impacts could not be assessed. Additionally, the analysis does not control for confounding effects such as carbon pricing, international trade, or regulatory stringency, which may influence outcomes. These limitations should be addressed in future longitudinal and sectoral research

Future research should incorporate longitudinal data, sectoral breakdowns, and scenario modeling to better inform differentiated policy pathways for achieving sustainable and equitable development across regions. In addition, future research may benefit from integrating variables representing carbon pricing mechanisms, renewable energy adoption rates, and technological advancement indices to further clarify causal pathways between policy, innovation, and emission outcomes

Abbreviations

None.

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Author Contributions

All authors have equally contributed.

Conflict of Interest

None.

Declaration of Artificial Intelligence (AI) Assistance

The authors declare that they did not use AI-assisted tools (ChatGPT, OpenAI etc) during the writing process.

Ethics Approval

Not applicable.

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