Financing the Green Transition in Sub-Saharan Africa: Evidence from Energy and Climate Convergence

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Abstract
This study examines how development finance relates to the green transition in Sub-Saharan Africa from 2016 to 2023. Using the Phillips and Sul log-t convergence approach, it analyses carbon emissions per capita, renewable energy consumption, and energy intensity across 49 countries, with 29 countries covered for energy intensity. The results show no full-sample convergence across the three indicators, indicating that the region is not moving uniformly toward climate and energy sustainability. Instead, countries form distinct convergence clubs, reflecting differences in institutional capacity, renewable energy uptake, infrastructure, and access to Transition Support Facility loans and grants. The findings suggest that countries such as Ethiopia and Uganda perform relatively well despite limited financing. At the same time, parts of Central and Southern Africa remain constrained by weak institutions and underfunding. The study recommends targeted development finance, stronger institutions, improved climate-finance data, and regional cooperation to support an inclusive and sustainable green transition.

Keywords: Convergence clubs, carbon emissions, renewable energy, energy intensity, TSF grants, TSF loans

Introduction
Sub-Saharan Africa remains one of the region's most vulnerable to climate change, despite contributing only a small share of global greenhouse gas emissions (IEA, 2022). Rising temperatures, recurrent droughts and floods, food insecurity, and persistent energy poverty continue to intensify socio-economic fragilities across the region (IEA, 2022; IPCC, 2022; UNDP, 2023). In this context, financing the green transition has become both a climate imperative and a development necessity. The green transition, reflected in renewable energy expansion, improved energy efficiency, and reduced carbon intensity, offers Sub-Saharan African countries an opportunity to strengthen climate resilience, expand energy access, promote sustainable industrialisation, and reduce poverty (AfDB, 2021; IRENA, 2023). However, recent evidence shows that Africa's energy investment remains insufficient to meet its sustainable development and climate goals. The International Energy Agency estimates that about USD 110 billion will be invested in Africa's energy sector in 2024. However, the scale and composition of this investment remain inadequate for achieving energy access and climate objectives (IEA, 2024). Similarly, IRENA (2024) emphasises that Africa must significantly expand renewable energy capacity if it is to align with global clean energy and climate targets. These realities suggest that the challenge is not only the need for a green transition, but also how that transition is financed and distributed across countries.

Although the green transition presents major opportunities, progress across Sub-Saharan Africa remains structurally uneven. Some countries have expanded renewable energy capacity, improved policy frameworks, and strengthened energy efficiency. In contrast, others remain constrained by fossil-fuel dependence, weak infrastructure, fragile institutions, and limited access to climate and development finance (Eberhard et al., 2017; Sovacool et al., 2019). Recent evidence on climate finance reinforces this concern. Climate Policy Initiative (2024) reports that climate finance flows to Africa increased from USD 29.5 billion in 2019/2020 to USD 43.7 billion in 2021/2022, yet these flows remain far below the continent's actual financing needs. UNDP (2024) also notes that Africa's climate finance landscape is shaped by major gaps, challenges, and opportunities, particularly in mobilising sufficient and predictable resources for climate action. These financing limitations raise a central policy concern: whether Sub-Saharan African countries are collectively moving toward a green, climate-resilient transition, or whether their national trajectories are diverging in ways that may weaken regional sustainability and coordinated climate action.

Existing studies have examined the determinants of carbon emissions, renewable energy consumption, and environmental sustainability in developing economies (Adams & Nsiah, 2019; Adams & Acheapong, 2019; Usman & Balsalobre-Lorente, 2022). However, much of this literature relies on conventional panel regression techniques that assume relatively similar transition paths across countries. Such methods often conceal important cross-country differences in climate and energy performance. The convergence hypothesis, originally developed in economic growth theory (Barro & Sala-i-Martin, 1995), has been extended to environmental and energy indicators, including carbon emissions and renewable energy outcomes (Ezcurra, 2007; Apeaning & Labaran, 2024). Nevertheless, evidence for Africa remains limited and fragmented, with many studies focusing mainly on single indicators such as CO_2 emissions. Less attention has been given to multidimensional convergence between energy and climate, focusing on carbon emissions per capita, renewable energy consumption, and energy intensity. More importantly, the role of development finance in shaping convergence or divergence in green transition outcomes remains insufficiently examined. This gap is important because Development Finance Institutions are increasingly expected to mobilise climate finance, reduce investment risks, and support sustainable energy infrastructure across Africa. Nevertheless, the African Development Bank (2024) notes that the climate finance architecture remains complex, loosely defined, and often misaligned with climate vulnerability and climate risks.

Literature Review

The literature on green transition in developing economies emphasises the importance of shifting from fossil-fuel-based energy systems to renewable and low-carbon alternatives. In Sub-Saharan Africa, this transition is closely linked to climate resilience, energy access, poverty reduction, and sustainable industrialisation. IRENA (2023) argues that renewable energy expansion can support Africa's development objectives by improving energy security and reducing dependence on carbon-intensive fuels. Similarly, AfDB (2021) highlights green growth as a major pathway for strengthening climate resilience and promoting inclusive development. However, studies such as Eberhard et al. (2017) and Sovacool et al. (2019) show that the pace of energy transition in Africa remains uneven due to infrastructure deficits, weak regulatory frameworks, limited investment, and political economy constraints.

Another strand of literature examines the relationship between renewable energy, carbon emissions, and environmental sustainability. Adams and Nsiah (2020) find that renewable energy and governance quality play important roles in reducing carbon emissions. Usman and

Balsalobre-Lorente (2021) also show that renewable energy consumption can help reduce environmental degradation in Sub-Saharan Africa. However, the effect depends on income levels, trade openness, and institutional conditions. These studies suggest that renewable energy adoption is necessary for climate mitigation. However, they also indicate that energy transition outcomes differ significantly across countries. This is particularly relevant for Sub-Saharan Africa, where some countries have made progress in deploying renewable energy. In contrast, others remain highly dependent on fossil fuels and traditional biomass.

The convergence literature provides a useful framework for understanding whether countries are moving toward similar climate and energy outcomes. Originally developed in economic growth theory, the convergence hypothesis explains whether economies tend to move toward a common long-run equilibrium (Barro & Sala-i-Martin, 1995). This idea has been extended to environmental and energy indicators. Ezcurra (2007), for example, examines convergence in carbon dioxide emissions and finds significant cross-country differences in emission patterns. Apeaning and Labaran (2024) also apply a club-convergence approach to carbon emissions in Africa and show that countries do not follow a single, uniform path. Instead, they form distinct convergence clubs, reflecting differences in economic structures, energy systems, and policy capacities.

Despite these contributions, existing studies often focus on single indicators, particularly carbon emissions, while paying less attention to multidimensional green transition indicators, such as renewable energy consumption and energy intensity. This creates a gap in understanding whether countries are converging across broader measures of climate and energy sustainability. Conventional panel regression methods also tend to assume homogeneous relationships across countries, thereby masking structural differences in transition pathways. The Phillips and Sul (2007, 2009) log-t convergence approach addresses this limitation by allowing for heterogeneous transition dynamics and the identification of convergence clubs. This makes it suitable for examining the uneven nature of green transition in Sub-Saharan Africa.

Development finance is another important area in the green transition literature. Development Finance Institutions are widely recognised as key actors in mobilising climate finance, reducing investment risks, and supporting renewable energy infrastructure in developing countries (OECD, 2021; AfDB, 2022). Climate finance can help address the large investment gap facing African countries, particularly in renewable energy, energy efficiency, and climate-resilient infrastructure. However, the literature has not sufficiently examined whether development finance contributes to convergence in green transition outcomes or whether it reinforces existing inequalities among countries. This is important because finance alone may not produce sustainable outcomes where institutional capacity, governance quality, and policy coordination are weak.

Methodology

This study employs a panel convergence framework to examine the extent to which Sub-Saharan African countries are aligning in their efforts to mitigate climate change and transition to renewable energy. The analysis focuses on three core sustainable development indicators: carbon emissions per capita (CO_2), renewable energy consumption (REC), and energy intensity (EIT). The choice of these indicators reflects key components of SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action), and their convergence serves as a proxy for harmonised climate-resilient development.

The empirical analysis draws on annual data from 2016 to 2023 for 49 Sub-Saharan African countries in the cases of CO_2 and REC, and for 29 countries in the case of EIT, and 2016 to 2022 for Transition Support Facility (TSF) Loans and Grants due to data availability constraints. The selection of 2016 as the base year coincides with the operationalisation of the United Nations Sustainable Development Goals (SDGs), while 2023 represents the most recent year with comprehensive data coverage across indicators.

Data sources include: the World Bank's World Development Indicators (WDI) for energy intensity (GDP per unit of energy use); the International Energy Agency (IEA) for CO_2 emissions and renewable energy metrics; and the United Nations Environment Programme (UNEP) databases for supplemental sustainability indicators. All variables were normalised where necessary and tested for consistency to ensure comparability across countries and over time.

Table 1: Dataset

Variable	Description/ unit of measurement	Source
Carbon Emission per Capita (CO_2)	Measured in metric tons. Measure the country's contribution to greenhouse gas emissions and progress in carbonisation.	World Bank and cross-validated with the Global Carbon Atlas.
Renewable Energy Consumption (REC)	Measured as a percentage of total final energy use. This indicator captures how countries are transitioning from fossil fuels to cleaner, renewable energy sources such as hydro, solar, wind, and biomass.	International Energy Agency (IEA) and the World Bank's World Development Indicators.
Energy Intensity (EIT)	Expressed as GDP per unit of energy use. This indicator reflects how efficiently energy is used in producing economic output.	World Bank and the United Nations Environment Programme (UNEP) databases
Transition Support Facility (TSF) Grant	Can cover green transition initiatives, especially in countries facing fragility, conflict, or economic transition, where environmental sustainability is vital for long-term development. Measure in the Unit of Account (UA), which is the AfDB's official accounting currency. It is equivalent to the IMF's Special Drawing Rights (SDR).	Africa Development Bank (AfDB)
Transition Support Facility (TSF) Loans	Concessional or semi-concessional financing is offered to countries or regions undergoing fragility, conflict, or major socio-economic transformation. Often including green and climate-related components. Measure in the Unit of Account (UA), which is the AfDB's official accounting currency. It is equivalent to the IMF's Special Drawing Rights (SDR).	Africa Development Bank (AfDB)
Private Investment in Energy (% of total)	Total private sector share in energy investment	World Bank PPI Database
Institutional Capacity Index	Governance quality, regulatory strength	WGI (World Governance Indicators), AfDB

Analytical Framework and Technique

The study applies the log–t convergence test developed by Phillips and Sul (2007). This non-linear time-varying factor model allows for heterogeneous transitional dynamics across countries. Unlike traditional β- or σ-convergence methods, the log–t test does not impose a common steady-state and is well-suited for detecting the existence of convergence clubs—groups of countries converging to distinct equilibria.

The convergence equation is specified as:

$$h_{it} = \frac{X_{it}}{\frac{1}{N}\sum_{i=1}^{N} Y_{it}} \quad (1)$$

where X_{it} is the observed variable for country i at time t. The log–t regression is estimated as:

$$log\left(\frac{H_t}{H_1}\right) - 2\log(logt) = \hat{a} + \hat{b}logt + \mu_t \quad (2)$$

where H_t is the cross-sectional variance of the relative transition coefficients. The null hypothesis of convergence is rejected if the estimated coefficient. $\hat{b}$ is significantly negative (typically at a 5% level, using a critical t-statistic of -1.65).

The test proceeds in three steps: (i) Panel convergence test for all countries; (ii) Club classification if convergence is rejected; and (iii) Club merging to refine the clusters of converging countries.

All estimations were carried out using STATA 16, with custom scripts to automate the club classification and merging algorithm based on Phillips and Sul's (2009) approach. Countries were grouped into distinct convergence clubs based on their temporal trajectories relative to the cross-country average. Visual plots of transition paths were generated to support statistical inferences and to illustrate the dynamic patterns of convergence or divergence.

This methodological framework enables the identification not only of whether convergence exists, but also of which countries are leading or lagging, and how these patterns might relate to financial and institutional capacity. The results provide critical insight into the structural heterogeneity of climate and energy performance across Sub-Saharan Africa.

Results

This section presents and interprets the findings from the log–t convergence analysis conducted and descriptive statistics. The findings from the log-t convergence analysis regarding climate and energy sustainability reveal that Sub-Saharan Africa is not moving uniformly toward these goals, despite mounting global attention and development finance commitments. Applying the Phillips and Sul (2007) log–t convergence test across three critical indicators, which include carbon emissions per capita (CO_2), renewable energy consumption (REC), and energy intensity (EIT), showed no evidence of full-sample convergence in any of the cases. Rather, countries in Sub-Saharan Africa are fragmented into multiple convergence clubs, each reflecting different levels of institutional capacity, infrastructure, and financial access (See Table 2 and Table 3).

Table 2: Summary of Convergence Results Across Indicators in Sub-Saharan Africa Countries (2016 -2023)

Indicator	Full Sample Convergence	Number of Final Clubs	Range of t- Stats	Non-Convergent Countries	Notable Revelations
Carbon Emissions (CO_2)	No (Coef. = -0.9705, t = -20.97, p < 0.05)	10 (including non-convergence group)	-27.76 to 9.71	Chad, DRC, Eswatini, Namibia, Gambia, Malawi, Seychelles, Somalia, South Africa, Zimbabwe	High divergence in emission intensity; strongest convergence in Club 7 (Liberia, Madagascar, Sierra Leone, South Sudan: t = 9.71)
Renewable Energy Consumption (REC)	No (Coef. = -1.0660, t = -28.59, p < 0.05)	9 (including non-convergent group)	-50.67 to 8.86	Guinea-Bissau, Mauritius, Sierra Leone, Togo	Broad variability in renewable uptake; Club 2 (CAR, Ethiopia, Uganda: t = 8.86) showed the highest convergence
Energy Intensity (EIT)	No (Coef. = -1.1403, t = -43.37, p < 0.05	6 (including non-convergent group)	-47.74 to 5.93	Burkina Faso, DRC, Madagascar, Mauritius	Strong convergence in energy use efficiency among Club 1 countries (Angola, Botswana, Ghana, Nigeria: t = 5.96

Source: Author's computation 2025

Note: For testing the one-sided null hypothesis, $b \geq 0$ against $b < 0$, we use the critical value: $t_{0.05} = -1.65$ in all cases. Where SE is the standard error, and Stat is the statistic.

As shown in Table 2, for carbon emissions per capita, the estimated coefficient of -0.9705 and the t-statistic of -20.97 ($p < 0.05$) firmly reject the hypothesis of convergence. Ten convergence clubs emerged, alongside a non-converging group comprising countries such as Chad, DRC, Eswatini, Namibia, Gambia, Malawi, Seychelles, Somalia, South Africa, and Zimbabwe. These results indicate deep-seated structural differences in economic development pathways and industrial dependence on fossil fuels. For example, countries like South Africa, with a historically coal-intensive energy sector, exhibit high and persistent emissions. In contrast, lower-income countries with limited industrial output converge at lower emission levels. Interestingly, convergence was strongest among countries in Club7, such as Liberia, Madagascar, Sierra Leone, and South Sudan, whose energy systems remain largely informal or biomass-dependent. These findings are consistent with Ezcurra (2007) and Apeaning and Labaran (2024), who noted limited and heterogeneous carbon convergence across developing regions, with emissions often tracking economic and energy use patterns.

Also, regarding renewable energy consumption (REC), a similar pattern of divergence across all countries in Sub-Saharan Africa was observed. With a coefficient of -1.0660 and a t-statistic of -28.59, the results reveal significant fragmentation in renewable energy uptake across the continent. Nine convergence clubs were identified, and several countries, including Guinea-Bissau, Mauritius, Sierra Leone, and Togo, failed to converge entirely (See Table 2 and Table 3). This divergence revealed the disparities in policy frameworks, energy investments, and technology deployment across the region. Countries such as Ethiopia, Uganda, and the Central African Republic showed strong convergence within a high-performing club, reflecting proactive national strategies on hydropower, feed-in tariffs, and donor-supported solar initiatives. These findings echo Sovacool et al. (2019), who emphasised that policy design and political economy factors play a central role in shaping the pace of energy transitions in Africa. Moreover, the uneven distribution of renewable investments aligns with IRENA (2023) and Eberhard et al. (2017), who noted that clean energy expansion is often confined to countries with stronger governance and donor coordination.

In the same vein, energy intensity, which measures the ratio of GDP to energy consumption, also exhibited significant divergence, with a convergence coefficient of -1.1403 and a t-statistic of -43.37. (See Table 2 and Table 3). The formation of six convergence clubs, alongside persistent divergence in countries such as Burkina Faso, Madagascar, the DRC, and Mauritius, suggests considerable variation in energy productivity across SSA. However, a subset of countries, including Nigeria, Angola, Ghana, and Botswana, demonstrated strong convergence, possibly due to ongoing reforms in industrial efficiency, energy pricing, and infrastructure investment. These results support Omri and Bel Hadj (2020), who found that financial development and institutional quality significantly affect energy efficiency outcomes. The case of Nigeria, for example, illustrates how public-private investment frameworks and regulatory reforms can drive improvements even in resource-constrained contexts.

Table 3: Summary of Convergence Final Club Merging Results Across Indicators in Sub-Saharan Africa Countries (2016 -2023)

Indicator	Club No.	Countries in Club Selected	t- Stats (Approx.)	Convergent?
Carbon Emissions (CO_2)	CO_2 Club 5 (Club 4, Club 5 and Club 6 were merged)	Angola, Benin, Burkina Faso, Cote d'Ivoire, Djibouti, Guinea, Kenya, Mali, Nigeria, Sudan, Tanzania, Togo, Zambia	-1.31	Yes
Renewable Energy Consumption (REC)	REC Club 3 (Club 3 + Club 4 were merged)	Benin, Cameroon, Congo, Eritrea, Mozambique, Niger, Nigeria, Rwanda, Tanzania, Zambia, Madagascar, Zimbabwe	-0.26	Yes
Energy Intensity (EIT)	EIT Club 3 (Club 3 + Club 4 were merged)	Chad, Congo, Eswatini, Niger, Ethiopia, Kenya, Gabon, Rwanda, Tanzania	1.10	Yes
Carbon Emissions (CO_2)	CO_2 Group 10	Chad, South Africa, Zimbabwe, etc	-27.76	No
Renewable Energy Consumption (REC)	REC Group 12	Guinea-Bissau, Togo, Sierra Leone, Mauritius	-50.67	No
Energy Intensity (EIT)	EIT Group 6	Burkina Faso, Madagascar, DRC, Mauritius	-47.74	No

Source: Authors' computation, 2025

Note: For testing the one-sided null hypothesis, $b \geq 0$ against $b < 0$, we use the critical value: $t_{0.05}$ = -1.65 in all cases. Where SE is the standard error, and Stat is the statistic. Complementing the convergence analysis, the descriptive statistics in Tables 2 and 3 reveal stark regional disparities in both financing and sustainability outcomes. Table 2 shows that Africa received an average TSF grant of UA 179.60 million, while Sub-Saharan Africa received UA 149.96 million. However, the distribution across sub-regions is uneven. West Africa had the highest average TSF loan disbursement at UA 34.77 million, followed by Southern Africa at UA 9.34 million. At the same time, East Africa received only UA 3.26 million. These disparities are notable given the performance variations across convergence clubs. For instance, countries like Ethiopia and Uganda, despite receiving relatively limited TSF loans, demonstrated strong convergence in renewable energy consumption. This suggests that institutional capacity and effective domestic policies can, to some extent, compensate for financial constraints, a point also emphasised by the OECD (2021) in its assessment of DFI's catalytic roles.

Financing the Green Transition

To complement the convergence analysis, Table 4 and Table 5 provide a descriptive overview of financing patterns and indicator performance across African regions. Table 4, which summarises Transition Support Facility (TSF) grants and loans, reveals marked disparities.

Table 4: Summary Statistics for Transition Support Facility (TSF) (2016 – 2022)

Region	TSF Grants (in UA millions)				TSF Loans (in UA millions)			
	Mean	Std. Dev.	Min.	Max	Mean	Std. Dev.	Min.	Max
Africa (Total)	179.60	40.01	134.50	257.61	67.78	36.95	28.05	114.50
Sub-Saharan Africa	149.96	47.24	94.74	246.11	58.67	37.74	9.70	111.82
West Africa	38.72	20.83	10.38	69.07	34.77	34.28	0.00	91.37
Central Africa	23.35	16.78	0.00	48.21	11.30	14.98	0.00	33.33
East Africa	69.29	54.60	32.03	190.73	3.26	5.91	0.00	14.81
Southern Africa	18.60	14.23	3.50	45.00	9.34	11.31	0.00	30.00

Source: Authors' computation, 2025

Specifically, the average TSF grant across Africa from 2016 to 2022 is UA 179.60 million, with Sub-Saharan Africa receiving UA 149.96 million on average. Within Sub-Saharan Africa, West Africa received the largest share of TSF loans among SSA regions (UA 34.77 million), while East and Southern Africa received significantly less, at UA 3.26 million and UA 9.34 million, respectively. These differences are not merely technical; they have profound implications for convergence. For instance, East Africa, despite receiving limited TSF loans, demonstrated strong convergence in renewable energy consumption (e.g., Ethiopia and Uganda). This suggests that institutional readiness and domestic policy frameworks may, in some cases, offset low levels of external finance. However, Southern Africa's low TSF access coincides with poor convergence across all three indicators, suggesting that underfinancing is a barrier to green transition in this sub-region.

Conversely, the low TSF (loans and grants) allocation to Southern and Central Africa aligns with the poor convergence results recorded in those regions, particularly for REC and EIT. This pattern reinforces the argument that underfinancing, especially when compounded by weak institutions, remains a major barrier to green transition in fragile and post-conflict states. The West African sub-region, with comparatively higher TSF inflows and REC levels, presents a more optimistic scenario, although high intra-regional variability persists.

Table 5 further validates these disparities. Southern Africa recorded the highest average CO_2 emissions per capita (1.599 metric tons) and the lowest renewable energy consumption (52.53%), justifying the sub-region's reliance on coal and other carbon-intensive fuels.

Table 5: Summary Statistics for Carbon Emissions Per-capita (CO_2), Renewable Energy Consumption (REC), and Energy Intensity (EIT) in Sub-Saharan Africa Region (2016 – 2023)

Economic Region	Variables	Obs.	Mean		SD	Min.	Max.
Sub-Saharan Africa	CO_2	392	0.860		1.389	0.030	7.983
West Africa	CO_2	128	0.364	1	0.255	0.081	1.226
East Africa	CO_2	104	0.590	2	1.258	0.304	5.225
Central Africa	CO_2	56	1.218	3	1.431	0.032	5.012
Southern Africa	CO_2	96	1.599	4	1.979	0.068	7.983
Sub-Saharan Africa	REC	392	59.825		27.571	1.2	97
Central Africa	REC	56	67.57	1	31.112	4.1	97
West Africa	REC	128	64.796	2	19.536	19.7	94.4
East Africa	REC	124	59.137	3	31.138	1.2	95.5
Southern Africa	REC	96	52.534	4	27.667	7.8	86.1
Sub-Saharan Africa	EIT	232	10.217		4.736	3.334	23.04
West Africa	EIT	72	11.726	1	4.150	5.571	19
Southern Africa	EIT	80	10.920	4	6.030	4.039	23.04
Central Africa	EIT	32	9.073	2	3.610	3.334	14.255
East Africa	EIT	48	7.547	3	1.417	5.393	10.451

Source: Authors' computation, 2025

In contrast, Central Africa had the highest REC average (67.57%), but also faced high energy intensity and weak convergence performance, suggesting that clean energy uptake alone does not guarantee efficient energy use or climate mitigation. West Africa's REC performance (mean = 64.80%) and relatively high EIT (mean = 11.73) reflect a mixed outcome, demonstrating good progress on renewables but highlighting room for improvement in energy efficiency and emission control.

Notably, while TSF grants and loans are central to climate finance in Africa, the available data were insufficient to apply the log–t convergence test to these indicators. Disaggregated TSF financing data across the full 2016–2022 study period and all 49 countries were not consistently available, thereby limiting statistical applicability. This data gap points to a broader systemic issue: the lack of transparent, harmonised, and publicly available data on climate finance disbursements from development finance institutions (DFIs). As emphasised by AfDB (2022) and UNDP (2023), addressing climate change in Africa will require not only increased financing but also improved data ecosystems to monitor impact, evaluate convergence, and drive strategic investment.

Overall, the results affirm that Sub-Saharan Africa's path to a green transition is marked by structural divergence, policy fragmentation, and unequal access to climate finance. The emergence of convergence clubs provides an opportunity to tailor policy and financing strategies to the specific needs of similar-performing countries rather than assuming uniform trajectories. In this regard, countries within strong convergence clubs such as Nigeria, Ethiopia, and Uganda can serve as regional anchors for knowledge sharing, investment coordination, and collective progress. Simultaneously, TSF allocations must become more targeted and equity-based, prioritising non-converging and underfunded regions where green transition pathways are most at risk. Ultimately, the pursuit of sustainability in Africa demands a combined strategy of financial justice, institutional reform, and regional collaboration, rooted in evidence and responsive to the continent's multidimensional challenges.

Conclusion

This study examined the extent to which Sub-Saharan African countries are converging in their efforts toward climate change mitigation and energy transition, focusing on three key indicators: carbon emissions per capita, renewable energy consumption, and energy intensity. Using the Phillips and Sul (2007) log–t convergence framework, the analysis reveals significant divergence across all three indicators, with countries clustering into distinct convergence clubs. These findings highlight the structural inequalities, policy incoherence, and financing disparities that shape sustainability outcomes in the region. The evidence suggests that Sub-Saharan Africa is not on a uniform trajectory toward climate and energy goals. While some countries exhibit encouraging signs of convergence, especially those with stronger institutions and policy frameworks, many others remain on the margins, constrained by underfinancing, fragile governance, and infrastructure deficits. The inability to apply convergence tests to TSF grants and loans, due to data limitations, further underscores the urgent need for improved transparency and monitoring in development finance.

The persistent divergence in sustainability indicators across regions, as seen in both the convergence analysis and descriptive statistics, reflects not only technical or economic challenges but also systemic governance and financing bottlenecks. It reinforces the need to move away from one-size-fits-all models toward differentiated, country-specific club-based approaches. At the same time, the role of development finance institutions, particularly the African Development Bank, remains pivotal in closing the green investment gap and ensuring that all countries, regardless of their current trajectory, have the opportunity to transition toward sustainability.

Recommendations

The study therefore recommends the following:

i. TSF grants and loans should be restructured to prioritise countries and sub-regions that exhibit persistent divergence, particularly in Central and Southern Africa. These areas often suffer from underinvestment and weak institutional capacity, making them ideal candidates for concessional financing, risk guarantees, and technical assistance to catalyse green transitions.
ii. Investments in renewable energy and climate mitigation will only be effective if accompanied by institutional reforms. Hence, countries should be supported in developing stable, transparent, and enforceable regulatory environments that incentivise private investment, promote policy continuity, and ensure efficient resource allocation.
iii. The lack of granular, consistent TSF financing data hindered deeper econometric analysis. It is imperative that DFIs, especially the AfDB, collaborate with national governments and global platforms to develop publicly accessible systems for tracking climate finance. These should report disbursements by country, year, sector, and outcome indicators to enable better policy targeting and accountability.
iv. Development finance should act as a catalyst for private capital. Hence, governments and DFIs should create blended finance instruments, offer de-risking mechanisms, and support bankable projects that attract private sector participation in renewable energy, energy efficiency, and green infrastructure.

v. Regional organisations such as ECOWAS, EAC, and SADC should be empowered to facilitate cross-border energy projects, harmonise regulatory standards, and promote joint investments in climate-resilient infrastructure. Countries in strong convergence clubs should lead in establishing regional platforms for peer learning and resource pooling.

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