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The AU Green Industrial Pivot: A Model Framework for Decision-Makers

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Preface

Africa is at a decisive moment in its energy and industrial history. The continent has some of the richest solar, wind and mineral resources on Earth, yet roughly 600 million of its people still live without reliable electricity. The plans meant to close that gap are, on paper, among the most ambitious anywhere. The problem is not vision. It is that good plans keep running into a system, made of institutions, money flows, politics and habits, that resists them.

This working paper is about that system. It explains, in practical terms, how green industrialisation in Africa actually works: who holds power and who does not, where money flows and where it gets stuck, why sound projects stall for years and where real change is already happening, often in places that official statistics do not see. It then turns that understanding into something the AU can use: a strategic framework built on clear guiding pillars and imperatives, a five-year sprint plan with named lead institutions and measurable targets, and an accountability architecture to keep the whole effort honest.

The paper was developed by the SAIIA Futures Programme to support the AU Development Agency (AUDA-NEPAD), the African Energy Commission (AFREC) and AU member states. It grew out of a series of Policy Innovation Labs that brought policymakers, researchers, business leaders, civil society and community practitioners into the same room to question assumptions and build strategy together. Rather than studying the energy sector piece by piece, the Labs mapped it as a whole: how its parts push and pull on one another, which pressures are building beneath the surface and which small experiments at the margins carry the seeds of something much larger. Readers interested in the formal methods behind this work, including systems mapping, the Multi-Level Perspective, Causal Layered Analysis and Futures Literacy Labs, will find them explained inside the Annexes; no prior knowledge of them is needed to follow the argument. The findings were tested through consultations across the continent and through engagement with the G20 Energy Transitions Working Group during South Africa's G20 presidency.

Two convictions run through every page. The first is that Africa's energy future should be authored in Africa: financed increasingly by African capital, owned by African communities and governed by rules that African institutions set for themselves. The second is that inclusion is not a courtesy but a condition of success. The women, young people, informal entrepreneurs and community cooperatives currently excluded from decision-making are among the most credible builders of the transition.

This paper should be read by anyone who makes or influences decisions about energy, industry, finance or development in Africa, and by anyone who has wondered why two decades of good policy have delivered so little power. It explains why linear plans keep failing, where the real levers of change lie and what can practically be done in the next five years. The choice it describes is stark but genuine. Africa can keep exporting its sun, wind and minerals as raw commodities, or it can capture their value at home. The decisions that will settle which path prevails are being made now.

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Key findings at a glance

The problem is implementation, not policy.

Africa's continental energy architecture is robust, yet around 600 million people remain without electricity, 28 countries face debt distress and national priorities diverge sharply from continental frameworks.

The system is not broken; it is performing as designed.

Carbon lock-in, raw-material export and external dependence are features of the current regime, not faults. Adding technology without changing the underlying rules will not shift it.

Transformation is nonlinear and networked.

Change spreads through ripple effects, in which local experiments in Egypt, South Africa, Kenya and Rwanda reshape regional and continental possibilities, rather than through top-down rollout.

The incumbent regime is under mounting strain.

A population with half its people under the age of 25, sovereign debt distress, climate-driven infrastructure failure and the collapse of solar costs below \$0.04 per kWh are eroding the foundations of the fossil-industrial order.

The alternatives already exist as niches.

Decentralised 'Swahili Solar Swarms', community-financed 'Ubuntu Finance Clusters', informal 'Jua Kali' manufacturing and 15 identified AU-level niches are functioning prototypes that could consolidate and flip the regime once they interoperate.

Africa faces a mineral paradox.

The continent holds roughly 70% of global cobalt reserves and has world-class solar and wind resources, yet hosts almost no battery manufacturing and sees its minerals valued and traded on foreign exchanges.

African capital is the central unlock.

African pension funds hold over \$300 billion. Redirecting just 5% into domestic green bonds would generate around \$15 billion in endogenous capital, reducing dependence on external finance and its conditions.

Inclusion is a precondition, not an add-on.

Women, youth and grassroots cooperatives remain excluded from decision-making despite proven contributions, and the transition cannot achieve legitimacy or resilience without them.

The window is open now.

A plausible 'debt-default' juncture within the next five years could break utility monopolies and move today's experimental niches into mainstream infrastructure.

A clear roadmap exists.

Four policy recommendations and a 2025–2030 Sprint Plan translate the analysis into action, targeting 50GW of new renewable capacity and electricity access for 300 million people by 2030.

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Executive summary

Africa has more than 40% of the world's solar resources, world-class wind resources and the minerals on which the global energy transition depends. Yet roughly 600 million Africans live without electricity, and the distance between today's installed capacity of about 266GW and the AU's Agenda 2063 target of 1 218GW by 2040 remains vast. The plans are strong; delivery is fragmented. Twenty-eight countries are in or near debt distress; nearly 19 spend more on servicing debt than on health or education; national priorities diverge from continental frameworks; and the people closest to the problem, particularly women and youth, are furthest from the decisions.

The paper's central finding is uncomfortable but clarifying: the system is not broken. It is performing exactly as designed. It was built to export raw minerals, import finished goods and keep energy under centralised control, and it defends that design. Three powerful engines are genuinely running in Africa's favour: solar costs have collapsed to around four US cents per kilowatt-hour, green finance is flowing and community confidence in local energy solutions is spreading from village to village. But each engine is wired to a brake that switches on at a knowable point. When sovereign debt passes roughly 60% of GDP, new capital dries up. When renewables approach about a quarter of the electricity mix, utilities push back to protect the grid and their monopoly. When youth unemployment exceeds roughly 30%, green promises that displace informal livelihoods create political backlash. Strategy therefore means managing these thresholds, not simply fuelling the engines. It also explains why linear plans keep failing: the system's behaviour changes as the limits approach, and a plan that assumes tomorrow will work like today is overtaken by its own context.

The alternatives are not hypothetical. Diaspora-financed solar networks along the Kenya–Ethiopia border already electrify communities the national grid has never reached. South African savings groups and municipal pension funds circulate capital whose returns stay in communities. Kenya's informal metalworkers turn surplus solar components into real manufacturing that official statistics record as unemployment. The paper examines these three in depth, alongside 15 practical instruments that can be housed in existing AU institutions, ranging from an open energy data commons and a registry that makes small energy systems visible and countable to licence templates that let traditional communities own their own micro-utilities. None of these is a pilot project. Each is a working piece of the next system. Once they can connect with one another, they can grow from the margins into the mainstream.

Two structural constraints shape everything else. The first is the mineral paradox: Africa holds roughly 70% of the world's cobalt reserves and supplies the inputs of the global transition, yet hosts almost no battery manufacturing and watches its minerals valued and traded on foreign exchanges. The second is finance. External capital arrives with conditions that reproduce dependence, while Africa's own money is under-used: the continent's pension funds alone hold over \$300 billion, and shifting just 5% into domestic green bonds would create some \$15 billion of African capital answering to African priorities.

In response, the paper sets out a Model Strategic Framework running to 2063 in three phases (2025–2030, 2030–2040 and 2040–2063), built on seven strategic imperatives. In plain terms, these are: ground every plan in environmental reality; plan for the materials and budgets that actually exist; own the technology rather than only buying it; put energy in the hands of the people who use it; shift the economic model from extraction to value creation; govern with foresight rather than hindsight; and carry culture and people along with the infrastructure. The connecting thread is anticipatory governance: the discipline of watching for shocks before they arrive, stating assumptions openly and adjusting course as the evidence changes.

Four policy recommendations give the framework operational form:

1. **AU-AFREC Renewable Energy Industrialisation Fund (REIF):** A blended-finance vehicle, capitalised initially at \$500 million and scaling towards \$2 billion, to pool resources, reduce the risk of cross-border infrastructure and get joint projects built.
2. **African Minerals Sovereignty and Capital Markets Initiative:** A strategy to value and trade Africa's minerals on African terms, anchored by AMREC-PARC standards and a Continental Digital Minerals Exchange, so that the continent sets rules rather than takes prices.
3. **AFREC Energy Foresight Hub:** The data, climate-risk modelling and scenario capacity that lets the continent see shocks coming and plan ahead of them, institutionalising anticipatory governance.
4. **Community Energy Ownership Initiative:** A mandate for 20% local equity in large-scale projects, making communities co-owners and co-producers rather than bystanders, with gender-inclusive capacity building built in.

These recommendations are sequenced through a 2025–2030 Green Industrialisation Sprint Plan with named lead institutions and measurable milestones, designed for adoption by the AU Assembly and AFREC's Governing Board. Its 2030 targets are concrete: 50GW of new renewable capacity financed or under construction, electricity access for 300 million people in line with Mission 300 and Agenda 2063 and an early finance-mobilisation goal of \$5 billion in pledges, supported by a dedicated accountability architecture.

The paper is candid about the hard constraints ambition should confront: continued dependence on external manufacturing and intellectual property, the finite working lives of renewable equipment,

planning that ignores energy and material realities and the real risk that a green transition simply repeats old extractive patterns in new language. It also names the early signal that will tell decision makers which way the transition is tipping: the African Green Bond Standard. If that standard embeds local content, community benefit and shared ownership, it will write the new system into the financial rulebook. If it merely copies external templates, it will entrench external control.

The conclusion is a choice of destinies. Africa can export its sun, wind and minerals as raw commodities, or it can capture their value through green manufacturing, skilled employment and energy sovereignty. The decisive question is not whether the transition will happen, but who will write its rules. The sun does not rise for a few; it rises for all, and Africa's energy transition can do the same.

Introduction

Africa's green industrialisation is governed by one of the most complete policy architectures anywhere in the world. The African Common Position on Energy Access and Just Energy Transition, endorsed by heads of state and government in 2022, sits alongside the African Renewable Energy Initiative, the Programme for Infrastructure Development in Africa and the African Single Electricity Market, all under the horizon of Agenda 2063. Yet the outcomes gap between this architecture and life on the ground remains vast, and the figures that describe it, set out in full in the next section, have barely moved in a decade. This persistence is the starting point of the paper. When ambitious frameworks and abundant resources repeatedly fail to produce transformation, the useful question is no longer what should be done – that has been answered many times – but why the system keeps absorbing good answers without changing.

The question is asked at a particular moment, and the moment matters. Sovereign debt distress has spread across the continent at the same time that solar costs have collapsed to historical lows; a demographic generation has come of age that refuses to accept energy poverty; and the world's major economies have begun competing for the minerals that run through African ground. These pressures are pulling the existing energy order apart faster than any plan is building its successor. South Africa's G20 presidency, the Mission 300 electrification drive and the AU's deepening institutional capability through the AU Development Agency – Partnership for Africa's Development (AUDA-NEPAD) and the African Energy Commission (AFREC) together create a rare institutional window in which continental coordination can shape what emerges from that strain, rather than merely react to it.

Most energy analyses available to African decision makers are linear and sectoral. They treat finance, technology, policy and society as separate files, assume that causes and effects stay fixed over time and measure progress against calendar milestones. Two decades of that approach have produced excellent documents and stubborn outcomes. The justification for this paper is the growing evidence, visible in every stalled project and every reversed policy, that the energy transition behaves as a connected system. Money, politics, technology and trust push and pull on one another; small changes sometimes cascade, while large investments sometimes vanish without a trace; and the rules of the game shift as thresholds are crossed. Policy made for a linear world will keep being defeated by a systemic one.

The paper therefore does several things that, to the authors' knowledge, have not previously been combined for the AU's green industrialisation agenda. It maps the whole ecosystem, actors, materials and rules across five dimensions, as one connected structure rather than a set of sectors. It names the specific feedback loops that drive and constrain change, the growth engines, the brakes, the traps in which money and effort circulate without result and the thresholds at which the system's behaviour flips, so that decision makers can locate their own countries and portfolios within the dynamics. It brings the continent's invisible infrastructure into analytical view, treating diaspora capital, community savings

groups and informal manufacturing as systems that can be understood and supported rather than as anecdotes at the margins. It translates the diagnosis into a portfolio of 15 practical instruments that existing AU institutions could host, each aimed at a specific constraint in the system. And it embeds the whole in an operational approach to anticipatory governance, with a strategic framework, a five-year sprint plan and an accountability architecture, so foresight becomes a working discipline rather than an aspiration.

Honesty about limits is part of the method, and five limitations deserve to be stated at the outset. First, the quantitative markers used in the systems analysis, including the thresholds at which the system's brakes engage, are stylised parameters derived from a participatory mapping process. They are order-of-magnitude markers of where behaviour changes, not econometric estimates, and they will need calibration to each member state's circumstances. Second, the underlying data is current as of mid-2026; in a fast-moving landscape, specific figures will age faster than the structural argument they illustrate. Third, continental breadth has been chosen over national depth: country examples illuminate the dynamics but do not substitute for country-level analysis. Fourth, some of the most important flows in the system – diaspora remittances, community capital and informal production – are by their nature poorly measured; their invisibility to official statistics is itself one of the paper's findings, but it also limits the precision of any claims about them. Fifth, foresight is not prediction. The scenarios and junctures described here are structured judgements about plausibility, intended to widen preparation, not to forecast events. The framework's ultimate success depends on political adoption and resourcing that no analysis can guarantee.

The paper unfolds in three movements. The first builds understanding. 'A System in Transition' sets out the context, challenges and systemic constraints in which African green industrialisation unfolds.

'Understanding the Emerging African Green Industrialisation Ecosystem' maps the actors who drive or block change, the materials that enable it and the rules that govern it across five interlocking dimensions. The second movement is diagnosis. 'The Current African Energy Regime: A System Under Strain' analyses the incumbent order, the landscape pressures cracking its foundations and the causal loops and traps that hold it in place. 'From Seeds to Niches' identifies where working alternatives are already growing, how they could consolidate through AU-level instruments and the dynamics, including critical junctures, through which the system could tip. The third movement turns to action. 'A Transformative Vision' and 'Anticipating the Future' link analysis and intent and 'Towards a Model Strategic Framework' sets out guiding principles, strategic imperatives to 2063, the 2025–2030 Sprint Plan, the governance and accountability arrangements and four policy recommendations. These are followed by an account of the co-creation and validation process and a methods annex for readers who want the analytical underpinnings.

The analysis opens a research agenda larger than any single paper. Priorities include calibrating the system's thresholds and delays at member-state level; building the live monitoring dashboard that would turn the paper's threshold analysis into a continental early-warning capability, a task for which the proposed AFREC Energy Foresight Hub is the natural vehicle; tracking the consolidation of the identified niches over time; improving the measurement of diaspora, community and informal energy economies, with gender-disaggregated data throughout; and modelling the debt-default and utility-insolvency scenarios whose plausibility the paper establishes but does not quantify. Each of the four policy recommendations would also benefit from a dedicated evaluation framework designed before, not after, implementation begins.

Finally, this paper is an invitation, not a verdict. It offers a map of a living system, and maps improve when more people draw on them.

- Policymakers are invited to test the framework against their own portfolios and to tell the authors where it breaks down. Member states are invited to calibrate the thresholds to their own conditions.
- Financiers are invited to pilot the instruments, from parametric insurance to the recognition of community capital, that the analysis suggests can move money without deepening debt.
- Researchers are invited to challenge the loop structure and sharpen its parameters.
- The practitioners who are already building the next system in cooperatives, workshops and diaspora networks are invited to bring forward cases that official statistics still miss.
- The SALLA Futures Programme and its Policy Innovation Labs remain open channels for that engagement.

The system described in these pages is already transitioning; the purpose of the paper is to help its many authors act on it deliberately and in time.

A system in transition: African green industrialisation

Africa's green industrialisation unfolds within complex, multi-level ecosystems shaped by diverse actors and frameworks. The [African Common Position on Energy Access and Just Energy Transition](#)¹ anchors a

¹ AU, "[Africa Speaks with Unified Voice as AU Executive Council Adopts African Common Position on Energy Access and Just Energy Transition](#)", July 22, 2022.

shared vision, while institutions like [AFREC](#) and [AUDA-NEPAD](#) coordinate policy and infrastructure through the [African Renewable Energy Initiative](#) and the [Programme for Infrastructure Development in Africa](#), all resulting in the [African Single Electricity Market \(AfSEM\)](#). Yet execution falters. Incentives are misaligned and the continent remains fragmented. With 55 countries operating under unique conditions, priorities diverge sharply; for example, fossil fuel-rich member states, such as Nigeria, pursue extractive gains, while Kenya and Morocco invest heavily in renewables.

Financial constraints compound the problem. As of 2024, 28 countries face debt distress; nearly 19 spend more on debt servicing than on health or education.² These constraints dampen investment in capital-intensive infrastructure, weakening regional initiatives and entrenching inequality. Tensions between national sovereignty and regional integration deepen this fragmentation. AfSEM envisions a continent-wide electricity market, but many member states prioritise energy security over liberalisation. Inconsistent tariffs, licensing regimes and grid codes obstruct integration and erode competitiveness.

Capacity bottlenecks persist. Many countries lack the skilled personnel, institutional strength and governance continuity that multi-year infrastructure projects demand. Political instability compounds these weaknesses, derailing timelines and deterring investors. The stakeholder landscape increases complexity: governments, private companies, donors and communities influence renewable energy initiatives with conflicting interests. The Grand Ethiopian Renaissance Dam (GERD) exemplifies this tension. While it is central to Ethiopia's development, it triggers regional disputes over water security, illustrating how energy projects without inclusive dialogue become geopolitical flashpoints.³

The disparities are stark. In 2020, 600 million Africans lacked access to electricity, compared with near-universal access in OECD countries. Sub-Saharan Africans consume just 518kWh per person per year – what an average OECD resident uses in 25 days.⁴ This gap illustrates the distance between the current installed capacity of 266GW and [the AU's Agenda 2063](#) target of 1 218GW by 2040.⁵ Energy poverty traps communities in cycles of underdevelopment, undermining both green industrialisation and climate resilience.

Climate vulnerabilities compound these challenges. Hydropower, accounting for 60% of Africa's electricity capacity, faces mounting risks from erratic rainfall and shifting river flows, introducing

² UN Economic Commission for Africa, [Economic Report on Africa 2023](#) (UNECA, 2023).

³ “[In Hindsight: The GERD and Water Security](#)”, *Security Council Report*, September 30, 2021.

⁴ Independent Energy Agency, “Key Findings”, in *Africa Energy Outlook 2022*, accessed June 13, 2025, <https://www.iea.org/reports/africa-energy-outlook-2022/key-findings>

⁵ AFREC, “African Energy Transition Programme”, accessed June 13, 2025, <https://au-afrec.org/energy-transition-programme>

uncertainty that deters investment.⁶ Despite holding between 40% and 60% of global solar resources, Africa contributes just 1.48% of global solar electricity capacity.⁷

Yet transformation occurs through nonlinear ripple effects. Egypt's push to source 53% of electricity from renewables by 2030 exemplifies this dynamic.⁸ Its manufacturing-led strategy influences regional initiatives such as the Sahel solar corridors. South Africa illustrates asymmetric private sector influence: with its developed financial systems, it attracts significant investment. Three green hydrogen projects worth \$7.1 billion were announced in 2024.⁹ Through cross-border exports to Malawi and Zimbabwe, South Africa stabilises the regional energy supply.¹⁰ However, unfavourable factors such as load-shedding redirect investors to Namibia and Mozambique,¹¹ highlighting how one nation's weaknesses catalyse regional opportunity.

At the grassroots level, decentralised energy adoption in Rwanda and Kenya is reshaping institutional attitudes towards community-driven solutions.¹² Marginalised actors, particularly women-led cooperatives, remain excluded from decision-making despite proven contributions.¹³ Navigating this complexity demands bold, adaptive leadership and inclusive governance. Business-as-usual will not deliver Agenda 2063's transformative outcomes. Systemic innovation is needed across financing models, regulatory reform, capacity building and policy design.

Challenges in re-imagining and transforming Africa's energy futures

This section explores Africa's agency to move beyond technocratic and linear transition models, opening space for reflexivity, systemic critique and bold re-imaginings of its energy futures.

⁶ Theresa Smith, "Hydropower in Africa to Support Modernisation of Grids", *ESI-Africa.com*, May 16, 2024.

⁷ COP29, UN Climate Summit News, "Renewable Energy in Africa Set for Take Off", accessed June 13, 2025, <https://unclimatesummit.org/renewable-energy-in-africa-set-for-take-off/>

⁸ Climate Action Tracker, "Egypt: Policies & Action", accessed June 13, 2025, <https://climateactiontracker.org/countries/egypt/policies-action/>

⁹ Global Trade Portal, "South Africa: Investing", accessed June 23, 2025, <https://trade.mu/en/portal/explore-new-markets/country-profiles/south-africa/investing>

¹⁰ Allan Davison, "Unlocking SA's Potential as a Regional Energy Exporter", *IT-online*, October 22, 2024.

¹¹ Malcolm Libera, "The Big Problem for South Africa Pushing Investors to Neighbouring Countries Instead", *BusinessTech*, June 9, 2025.

¹² Joshua Mugisha et al., "Assessing the Opportunities and Challenges Facing the Development of Off-Grid Solar Systems in Eastern Africa: The Cases of Kenya, Ethiopia, and Rwanda", *Energy Policy* 150 (March 2021): 112131.

¹³ Rosalie Lédée, "Women and Energy", *Energy Cities*, July 29, 2019.

Technological innovation and infrastructure development: While advances in green hydrogen, solar PV and grid upgrades are highlighted, questions remain that call into question technological determinism. Are innovations genuinely aligned with local priorities or driven by external market demands, particularly export-focused narratives? Risks of technological dependency and neglected local research and development (R&D) ecosystems raise concerns about whether Africa is positioned as a consumer or a co-creator. African agency demands contextual adaptation and systemic embedding of technology within local capacities and needs.

Policy, governance and regulatory frameworks: Emphasis on policy clarity, targets and governance structures is foundational. However, critical approaches interrogate gaps between policy formulation and execution. Given persistent corruption and weak institutional capacity, how will governance be operationalised in practice? The challenge emerges from assuming regulatory frameworks alone deliver transformation. More appropriate responses reimagine alternative, contextually relevant governance models or participatory mechanisms, shifting power dynamics and ensuring accountability beyond formal institutions.

Investment and finance mobilisation: Financial flows via concessional loans, blended finance and green bonds are central to the renewable transition. Yet critics question Africa's genuine sovereignty, debt dependency and the structural conditions attached to capital. Examples like Kenya's debt stress and Nigeria's subsidy regimes illuminate how financialisation can reproduce old dependencies under green veneers. Is there space to reimagine financing models outside global capitalist logics, such as mutual credit systems, diaspora bonds or commons-based approaches, centring African agency?

Market development and integration: The need for liberalised, competitive markets and cross-border energy trade faces increasing challenges, raising questions about whether market-led integration genuinely promotes equitable access or risks marginalising local, decentralised solutions. For 600 million Africans without electricity, does liberalisation translate into affordability or further exclusion? Energy market futures should be interrogated for efficiency, justice, resilience and ownership models serving the many, not the few.

Socio-cultural integration and community engagement: Community resistance and scepticism are evident, with deeper analysis revealing underlying concerns rooted in historical extractive legacies, marginalisation and perceptions of neocolonial impositions. An alternative African perspective reframes community engagement as a call for transformative participation, reparative justice and power redistribution. Energy transitions should be co-created with communities, honouring Indigenous knowledge and place-based practices.

Systemic constraints and limitations

Global stock markets and African mineral trade dynamics: Despite growing demands for decolonising financial systems and reclaiming economic sovereignty, African resources, particularly critical minerals, are primarily capitalised, valued and traded in global financial centres far removed from origin countries. Africa's vast resource base, including cobalt, lithium, nickel and rare earths, is central to global decarbonisation agendas. However, African minerals are predominantly listed and traded on foreign exchanges (LSE, NYSE, TSX, ASX), reflecting a structural dependency shaped by capital scarcity, underdeveloped regulatory infrastructure, investor preferences for 'safe' jurisdictions and legacy colonial financial linkages.

The introduction of [AMREC](#) and [PARC](#) marks a foundational intervention offering strategic leverage points: standardisation for sovereignty, investor confidence through ESG integration, continent-wide systemic coherence and long-term shifts toward endogenous financing. AMREC-PARC provides the foundation for African member states to build sovereign financial ecosystems, reclaiming agency over valuation and integrating capital markets with local industrialisation strategies.

Emerging discontinuities: Several discontinuities reshape global mineral finance and governance landscapes with significant implications for Africa's strategic positioning. Geopolitical realignments driven by US–China tensions, US tariffs, EU green tariffs and critical mineral supply chain reconfigurations destabilise established capital flows, potentially catalysing unexpected alliances and opening space for African-led platforms. Monetary fragmentation introduces constraints and opportunities, while traditional capital market access may tighten; fragmentation could create niches for regionally anchored financial ecosystems aligned with African development priorities.

Technological leapfrogging, particularly via blockchain-based commodity trading platforms, offers Africa an unprecedented ability to decentralise mineral trading, introduce tamper-proof provenance tracking and bypass legacy financial infrastructures that have historically excluded or undervalued African resource markets. Global ESG recalibration creates growing space for alternative approaches; Africa's AMREC-PARC system could evolve into counter-hegemonic frameworks embedding plural sustainability logics grounded in African socio-ecological realities.

Energy and materials blindness: Energy blindness¹⁴ refers to the pervasive lack of awareness among policymakers, institutions and publics of energy's foundational role in shaping modern economies, technologies and daily life. This cognitive blind spot results in energy mispricing and undervaluation, misguided policy decisions and overconfidence in technological fixes disconnected from energetic

¹⁴ Nate Hagens and H Kunz, "[Applying Time to Energy Analysis](#)", The Oil Drum, December 13, 2010.

realities. Minerals blindness¹⁵ is the widespread failure to recognise the essential roles minerals play in powering modern economies, enabling technological systems and driving sustainability transitions. This leads to unrealistic expectations about the scalability of renewable energy despite heavy reliance on finite, geopolitically sensitive minerals.

Renewables as 'rebuildables' with finite lifespans: Renewable energy technologies typically require replacement or major refurbishment every 20–30 years, implying ongoing material and energy inputs rarely factored into transition planning. Manufacturing remains heavily dependent on fossil fuel-powered industrial processes and mining operations. Circular economy principles, such as reuse, remanufacturing and recycling, are poorly integrated into current strategies. Recycling renewable energy components is technically challenging and economically unviable at scale due to complex material composites, low recovery rates and a lack of infrastructure.

External manufacturing and intellectual property (IP) constraints: Most renewable energy technology manufacturing occurs outside Africa, primarily in China, Europe and North America, perpetuating dependency on external supply chains and exposing countries to geopolitical and trade vulnerabilities. IP ownership by multinational corporations restricts African countries' ability to develop manufacturing capacity and innovate locally, limiting technology sovereignty and economic benefits.

Without addressing these deep structural and systemic issues, renewable energy industrialisation risks replicating the patterns of resource extraction, environmental degradation and unequal power relations that it aims to overcome.

Understanding the emerging African green industrialisation ecosystem

Framing the systemic architecture

The African Green Industrialisation Ecosystem (AGIE) is a complex adaptive system. Equitable, climate-resilient transformation depends on the structural integrity of its inter-regional subsystems. This systems

¹⁵ Simon P Michaux, [The Mining of Minerals and the Limits to Growth](#), Report 16/2021 (GTK Geological Survey of Finland, 2021).

mapping¹⁶ section analyses the dynamic interplay of three foundational components: the key actors who drive or constrain development; the materials, both tangible and intangible, that enable infrastructure and the flow of resources; and the rules, including regulative, cognitive and normative, that govern all interactions.

The analysis below identifies each of the five subsystems, their core functions and the multidirectional linkages that generate the emergent properties that both enable and constrain Africa's energy transition. These are the energy-industrialisation nexus, which is the productive core; the policy and governance architecture, which acts as the coordination layer; the finance and investment ecosystem, which functions as the circulatory system; society and culture, which provides the legitimisation subsystem; and markets and value chains, which operate as the exchange interface.

By examining these core elements and their interdependencies, the following discussion provides a roadmap for understanding the critical leverage points within Africa's renewable energy industrialisation landscape. These systems mappings reveal that the ecosystem's capacity to deliver equitable, climate-resilient industrial transformation by 2035 depends less on individual states' performance and more on the structural integrity of interconnections between these inter-regional subsystems.

Africa's energy and industrial system is not broken. It is performing exactly as designed within a logic of centralised control, resource extraction and external dependence. The typical pattern is that raw minerals are exported, finished products are imported and utilities buckle under debt and political interference. This creates a 'lock-in' effect in which even beneficial alternatives struggle to take root.

The renewable energy opportunity is vast. Africa possesses 40% of the world's solar irradiation potential,¹⁷ exceptional wind corridors¹⁸ and 70% of the global cobalt reserves essential for batteries.¹⁹ The system remains tethered to diesel generators, kerosene lighting and carbon-intensive industrialisation. Understanding why requires mapping the whole ecosystem.

¹⁶ Systems mapping is a structured methodology for visualising the complex interactions between actors, resources, technologies, institutions and feedback loops within a broader system. In the context of African renewable energy industrialisation, its primary use is to illuminate critical interdependencies, such as those between policy, finance, infrastructure and skills, that shape progress. Its key benefits include revealing strategic leverage points for intervention, fostering collaborative intelligence by exposing shared insights and hidden assumptions and providing a dynamic, evolving document that aids in steering complex socio-technical transitions with greater strategic clarity.

¹⁷ ["Africa Moves to Finally Harvest Its Solar Energy Potential"](#), Polity, October 9, 2024.

¹⁸ David King Boison, Iddrisu Awudu and Cynthia Morkoah Agyemang, ["Harnessing the Wind: A Strategic Roadmap for Wind Energy Development in Africa – A Ghanaian Case Study with Global Insights"](#), MyJoyOnline, April 15, 2025 .

¹⁹ Emmanuel Chilamphuma, ["Africa's Critical Minerals: The Key to Winning the Global Battery Race"](#), FurtherAfrica, August 1, 2025.

The AGIE represents a socio-technical regime shift from carbon lock-in to renewable-led industrialisation. This mapping reveals a contested transition zone in which incumbent fossil fuel systems and emerging renewable pathways co-produce instability and opportunity. The analysis is anchored in Africa's specific context – 600 million unelectrified citizens,²⁰ \$30–50 billion annual energy financing gaps,²¹ critical mineral wealth and climate vulnerability.

The systems mapping of Africa's role in green industrialisation is presented through five thematic dimensions encompassing science, technology and infrastructure; policy and governance; investment and finance; society and culture; and market dynamics. The key insights emerging from this systems mapping are outlined in the following section.

Five thematic dimensions of the AU's renewable energy ecosystem

Dimension 1: Science, technology and infrastructure

This dimension covers both the hardware of energy systems and the knowledge that makes them function. Key actors include African universities and research centres such as the Kwame Nkrumah University of Science and Technology and the African Institute for Mathematical Sciences, as well as international and regional partners such as the African Development Bank (AfDB).

Physical materials range from solar panels and wind turbines to battery storage systems and mini-grid controllers. Less visible but equally important are the standards that govern interoperability, the geographical information systems that map renewable resources and the mobile money application programming interfaces (APIs) that enable payment systems.

Embedded rules include technical standards written for Western grids, 20- to 25-year asset depreciation cycles that favour large projects and IP restrictions that limit technology transfer. These rules entrench dependence on multinational suppliers and discourage local adaptation.

Core paradigm: Slugging through distributed modular systems rather than replicating Western centralised grids.

²⁰ Fred Kennedy, "[Africa's Energy Deficit: 600 Million People Still Lack Electricity](#)", Empower Africa, August 15, 2025.

²¹ Fondation Nexans, "[World Africa Day: State of Electrification in Sub-Saharan Africa](#)", May 25, 2025.

Table 1 presents a high-level summary of the actors, materials and embedded rules within the science, technology and infrastructure dimension of the systems architecture framework.

Table 1: Dimension 1: Science, technology and infrastructure

Actors	Materials	Embedded rules
African Centres of Excellence (KNUST, UCT, AIMS), African partnerships, AfDB's Desert to Power engineers, informal solar technicians, digital public infrastructure providers	Solar PV modules, lithium iron phosphate (LiFePO ₄) batteries, wind turbines, mini-grid controllers, GIS resource atlases, mobile money APIs, satellite-based PAYG meters, transmission corridors	IEC 61850 interoperability standards, grid codes designed for baseload, 20–25 year asset depreciation cycles, 'last-mile' electrification zoning, technology transfer, IP restrictions

Source: Compiled by authors

Dimension 2: Policy and governance

Anti-corruption watchdogs and the International Renewable Energy Agency (IRENA) are among the key institutions that shape the governance landscape.

The written materials of governance are familiar: Nationally Determined Contributions (NDCs) under the [Paris Agreement](#), renewable energy feed-in tariffs, power purchase agreements (PPAs) and national energy master plans. However, these documents exist alongside customary land title deeds and oral agreements recognised by local communities. The rules that bind this dimension are complex. Formal regulations include requirements for government guarantees that often stall projects, local content quotas intended to build domestic industry and licensing systems that can be opaque and politicised. Informal norms involve patronage networks that influence project siting and colonial-era land laws that allow governments to seize customary lands for 'public interest' developments, often overriding community consent.

Core paradigm: Competing sovereignties between national energy targets, regional power pools and customary land authorities.

Table 2 presents a high-level summary of the actors, materials and embedded rules within the policy and governance dimension of the systems architecture framework.

Table 2: Dimension 2: Policy and governance

Actors	Materials	Embedded rules
Regional power pools (eg, SAPP, WAPP) and technology firms, African Continental Power Systems Masterplan (CMP). ECOWAS/EAERERA regulators, AU African Energy Commission, Rural Electrification Authority (REA) agencies, traditional chiefs (customary land custodians), anti-corruption watchdogs and IRENA-Africa platform	NDCs, renewable energy feed-in tariffs, PPAs, customary land title deeds, integrated resource plans and implementation frameworks such as SE4ALL energy compact action agendas	Sovereign guarantee requirements, 30% local content procurement quotas, 'use-it-or-lose-it' licensing, gender quotas in energy committees, patronage-driven project siting, colonial-era territorial boundaries

Source: Compiled by authors

Dimension 3: Investment and finance

This dimension reveals how capital circulates and who controls it. Dominant actors include development finance institutions (DFIs) such as the AfDB and International Finance Corporation (IFC), African pension funds (particularly Nigeria's substantial system), climate funds such as the [Green Climate Fund](#), impact investors like [Acumen](#) and [SunFunder](#) and, increasingly, Chinese export-import banks.²² Fintech lenders providing pay-as-you-go solar financing represent a disruptive new force.

Financial materials are mostly intangible. They include letters of credit, political risk insurance, currency hedging instruments and complex blended finance structures that combine concessional and commercial capital. Carbon credit streams and securitised receivables from pay-as-you-go systems are becoming important new asset classes.²³

The rules governing finance reflect deep power imbalances. Investors typically demand returns of 7–12%, impose debt–equity ratios of 70:30 and require projects to meet 'bankability' standards defined by OECD credit ratings. Foreign-exchange repatriation limits constrain reinvestment; concessionality is often tied to cumbersome climate reporting requirements.

²² Africa Finance Corporation, "Africa Finance Corporation and the Export-Import Bank of China (CEXIM) Strengthen Partnership to Drive Trade and Infrastructure Growth Across Africa", February 14, 2025.

²³ Solar Financed, "[Innovative Solar Finance Models in Sub-Saharan Africa](#)", November 1, 2024.

Core paradigm: Blended finance serves not only as a capital-raising mechanism but also as a means for Africans to reclaim decision-making power.

Table 3 presents a high-level summary of the actors, materials and embedded rules within the investment and finance dimension of the systems architecture framework.

Table 3: Dimension 3: Investment and finance

Actors	Materials	Embedded rules
DFIs (eg, AfDB, IFC, Proparco), African pension funds (eg, Nigerian PFAs), climate funds (GCF, ACEF), impact investors (eg, Acumen, Persistent), sovereign wealth funds (eg, Angola, Botswana), fintech lenders (eg, M-KOPA, SunFunder), Chinese EXIM Bank	Letters of credit, currency hedging instruments, results-based climate finance approaches, carbon credit streams, political risk insurance, mezzanine debt tranches, PAYG receivables securitisation	7–12% IRR hurdles, 70:30 debt-equity ratios, OECD arrangement on export credits, forex repatriation limits, 'bankability' defined by credit ratings, concessionality tied to climate reporting

Source: Compiled by authors

Dimension 4: Society and culture

No system map is complete without the people it is meant to serve. Key societal actors include women's energy cooperatives such as [Solar Sister](#), youth climate movements expanding international initiatives like [Fridays for Future](#), faith-based environmental networks, artisanal mining communities, media houses that shape public opinion and diaspora professionals who broker knowledge and connections. These groups often operate outside formal structures, yet wield immense influence through social licence and moral authority.

Materials in this dimension are largely intangible, but operationalised through trust between communities and project developers, Indigenous knowledge of local conditions, social licence to operate and benefit-sharing agreements. Mobile messaging platforms have become vital conduits for information sharing and collective action.

Rules here reflect deep cultural values. Many communities view energy as a public good, not a commodity – a legacy of post-colonial socialism. Gendered divisions of labour mean women bear the burden of wood fuel collection, shaping their stake in energy transitions. Concepts like Ubuntu emphasise collective ownership over individual gain, while generational land stewardship ethics prioritise long-term

community survival over short-term profit. Conversely, 'big man' patronage politics can undermine transparent benefit distribution.

Core paradigm: Energy must be a fair public good, not a private cash machine for the few.

Table 4 presents a high-level summary of the actors, materials and embedded rules within the society and culture dimension of the systems architecture framework.

Table 4: Dimension 4: Society and culture

Actors	Materials	Embedded rules
Women's energy cooperatives (eg, Solar Sister), youth climate activists (Africa Fridays for Future), faith-based environmental networks, artisanal miners, media houses (Nation Media Group), diaspora knowledge brokers	Energy-as-a-service subscriptions, Indigenous knowledge, community benefit agreements, social licence to operate, trust in chieftaincy institutions, WhatsApp knowledge-sharing groups	Energy as 'public good' (post-colonial socialism legacy), gendered wood fuel collection labour, generational land stewardship ethics, Ubuntu collective ownership norms, 'big man' patronage expectations, environmentalism as 'Western luxury'

Source: Compiled by authors

Dimension 5: Markets

The market dimension includes the commercial actors who produce, trade and consume energy and related products. Incumbent utilities like [Eskom](#) and [KenGen](#) remain powerful, although increasingly challenged by independent power producers such as [ACWA Power](#) and [Scatec](#). Engineering, procurement and construction (EPC) contractors heavily shape project delivery. Mineral processors, green hydrogen consortia in Namibia and South Africa and regional power traders in the West African Power Pool all shape market dynamics.

Market materials include the electricity itself (kilowatt-hours), renewable energy certificates, critical minerals such as cobalt and lithium, skilled engineers and supply chain traceability systems. Industrial parks and export processing zones concentrate economic activity, impacting migration patterns.

Market rules include cost-reflective tariff principles that often make electricity unaffordable for the poor, 'willing buyer-willing seller' contracts that favour large corporate consumers, and beneficiation requirements that mandate local value addition. The [African Continental Free Trade Area's](#) (AfCFTA) rules of origin are creating new opportunities for intra-African green trade, while fears of a resource boom that hurts other industries²⁴ make resource-rich countries cautious about over-reliance on mineral exports.

Core paradigm: Limit the export of raw materials while expanding beneficiation industries to support local value chains.

Table 5 presents a high-level summary of the actors, materials and embedded rules within the markets dimension of the systems architecture framework.

Table 5: Dimension 5: Markets

Actors	Materials	Embedded rules
IPPs (ACWA Power, Scatec), national utilities (Eskom, ZESCO, KenGen), EPC contractors (installation monopolies), mineral processors (Mozambique graphite), green hydrogen consortia (Namibia, SADC Green	Electricity (kWh), renewable energy certificates, critical minerals (cobalt, lithium, rare earths), skilled workforce (engineers), supply chain traceability (blockchain),	Cost-reflective tariff principles, 'willing buyer-willing seller' contracts, local value-addition mandates (beneficiation), circular economy e-waste liabilities, AfCFTA Rules of Origin,

²⁴ Also known as 'Dutch disease'.

Actors	Materials	Embedded rules
H2 corridor), regional power traders (WAPP pool)	industrial parks, export processing zones	'Dutch disease' avoidance in resource economies

Source: Compiled by authors

Systemic effects of interrelationships: Who makes things happen

Actors across these dimensions fall into three broad categories: dominant, disruptive and bridging. Each category has distinct roles in preserving or transforming the AGIE.

Dominant actors defend the current fossil fuel regime. These include political elites who benefit from petroleum subsidies (Nigeria spent \$7.5 billion on subsidies in 2023 alone),²⁵ managers of state-owned utilities who fear losing control and multinational oil companies with sunk investments in legacy infrastructure. Central bank governors often resist renewable energy imports to protect foreign currency reserves, inadvertently propping up diesel dependency.

Disruptive actors are building green industrialisation alternatives. Off-grid energy enterprises like [Bboxx](#) and [d.light](#) are creating entirely new distribution models through pay-as-you-go (PAYG) systems. The [AfDB's Desert to Power](#) initiative, targeting 250 million beneficiaries with \$20 billion in investments, is reshaping regional infrastructure planning. Perhaps most consequentially, the 200 000 artisanal miners in the Democratic Republic of Congo (DRC) who supply 72% of global cobalt²⁶ are beginning to organise and demand a place in formal supply chains, threatening the prevailing extractive model.

Bridging actors oscillate between the old and new regimes. [IRENA's](#) Africa platform works to harmonise European technical standards with African realities. Regional power pools such as the West African Power Pool (WAPP) and East African Power Pool (EAPP) establish unified market frameworks across member states to promote cross-border electricity trade and infrastructure development, effectively addressing national-level constraints such as limited generation or transmission capacity.²⁷ Traditional

²⁵ Camillus Eboh, "[Nigeria to Spend \\$7.5 Bln on Petrol Subsidy to Mid-2023](#)", *Reuters*, January 4, 2023.

²⁶ Shree Mishra, "[DRC Produces Inaugural 1,000t of Traceable Artisanal Cobalt](#)", *Mining Technology*, November 14, 2025.

²⁷ Global Energy Monitor, "[Power Sector Transition in the West African Power Pool](#)", November 3, 2025.

leaders play a crucial mediation role, translating between customary land rights and industrial project requirements.

Table 6: Systemic actors and influence in the African renewable energy ecosystem

Actor category	Key actors	Role and impact in the system
Dominant (incumbent-protecting)	Political elites	Petroleum subsidy beneficiaries (Nigeria spent \$10 billion in 2023); state-owned utility managers preserving centralised control
	Multinational oil majors	Shell, TotalEnergies, with legacy infrastructure and supply chain lock-in
	Central bank governors	Defending foreign exchange reserves against renewable energy equipment import pressure
Disruptive (emergence-enabling)	Off-grid energy enterprises	Bboxx, d.light are creating entirely new distribution logics via pay-as-you-go models
	AfDB	Desert to Power initiative (\$20 billion, 250 million beneficiaries) reshaping regional infrastructure planning
	Artisanal miners	200 000+ in DRC cobalt supply chain, operating outside formal extraction regimes
Bridging (translation)	IRENA-Africa Platform	Harmonising standards between the EU taxonomy and African realities
	Regional power pools	EAPP, WAPP and SAPP are creating multi-sovereign market rules

Actor category	Key actors	Role and impact in the system
	Traditional leaders	Mediating between customary land rights and industrial-scale solar farms

Source: Compiled by authors

The materials: The building blocks

Materials in this system range from physical infrastructure to flows of knowledge and trust. They may be fixed or flowing, visible or invisible.

Fixed infrastructure (visible) includes [Morocco's 11.5GW Noor Ouarzazate solar complex](#), [Ethiopia's GERD](#) and [Kenya's Lake Turkana wind farm](#) and its transmission lines. Invisible fixed assets include the software protocols that maintain grid stability, the data centres that host utility control systems and the legal registries that record land leases and ownership.

Flowing resources shift across the system. Visible flows include Africa importing over 15GW of solar panels from China in the 12 months ending June 2025, a 60% increase year-on-year²⁸ and accounting for the vast majority of the continent's solar supply due to limited domestic production. China produces over 80% of global panels and remains the primary exporter to Africa, where local capacity, like Morocco's 1GW, is negligible.²⁹ Zimbabwe's lithium exports, driven largely by Sinomine's production of spodumene concentrate at Bikita, have expanded rapidly, rising by 30% in the first half of 2025 to 586 197 tonnes.³⁰ As a landlocked producer, Zimbabwe depends on regional logistics networks, with exports typically routed through South Africa's Port of Durban for southern markets or via eastern corridors that link to Kenya's Port of Mombasa through Mozambique or Tanzania. These routes align with long-established mineral export pathways across the region. The surge in output comes alongside Bikita Minerals' planned \$500 million lithium sulphate plant, which underscores Zimbabwe's growing role as Africa's leading lithium producer despite global price volatility.

²⁸ J.P. Casey, "Ember: African Imports of Chinese Solar Panels up to over 15GW", *PV Tech*, August 26, 2025.

²⁹ Casey, "Ember: African Imports".

³⁰ Chris Takudzwa Muronzi, "[Zimbabwe's Spodumene Exports Surge 30% despite Weak Lithium Prices](#)", *Reuters*, July 21, 2025.

Invisible flows are subtler but equally vital: the trust communities must extend to project developers; the knowledge diaspora engineers send home through professional networks; the carbon credit validation data processed by international registries; and the grid frequency stability that determines whether different systems can interconnect.

Critical bottlenecks constrain the system. African engineers emigrate to Europe, North America, the Middle East and other African economies, exacerbating severe shortages, with approximately one engineer per 8 000 to 825 000 people in sub-Saharan countries.³¹

The 'mineral paradox' sees the DRC supply 70% of global cobalt but host limited battery manufacturing facilities, further imprinting export infrastructure onto the economy that prevents value addition. Currency volatility is depicted in Ghana's cedi, which depreciated by ~59% against the US dollar from December 2022 (~11.2 GHS/\$)³² to December 2024 (~17.8 GHS/\$), and Nigeria's naira, which fell ~70% over the same period (from ~450 NGN/\$³³ to ~1,600 NGN/\$), rendering renewable energy projects unfinanceable in domestic terms due to dollar-denominated imports and financing.³⁴

Table 7: Materials: Fixed vs flowing architecture

Material category	Type	Description and examples
Fixed infrastructure	Visible	11.5GW Noor Ouarzazate solar complex (Morocco); Ethiopia's GERD; Inga III hydro corridor; Kenyan Lake Turkana Wind Farm transmission lines
	Invisible	Grid stability protocols; data centres hosting utility SCADA systems; legal title registries for land leases
Flowing resources	Visible	Chinese-made solar panels (95% market share); lithium from Zimbabwe's Bikita mine; wind turbine blades via Mombasa port

³¹ Ronak Gobaldas, [“Africa’s Demographic Conundrum: Turning Talent Leaks into Talent Flows”](#), ISS Africa, May 6, 2025.

³² Currency code for the Ghanaian cedi.

³³ Currency code for the Nigerian naira.

³⁴ [“How Policy Missteps Threaten Nigeria’s Renewable Energy Goals”](#), Africa Digest News, August 26, 2025.

Material category	Type	Description and examples
	Invisible	Trust capital between communities and IPPs; remittance knowledge flows from diaspora engineers; carbon credit validation data from Verra registries; grid frequency stability (50Hz vs. 60Hz legacy)
Critical material flow bottlenecks	Skills drain	27 000 African engineers emigrate annually, creating 'knowledge ghost grids'
	Mineral paradox	DRC supplies 70% of global cobalt but hosts zero battery gigafactories – rules of comparative advantage imprinted on export infrastructure
	Currency volatility	Local currency PPAs devalued by 40% in 24 months (Ghana cedi, Nigerian naira), making long-term renewable energy contracts unbankable

Source: Compiled by authors

The rules that guide action

Rules are more than regulations; they encompass values, assumptions and habits that shape what people regard as possible or desirable. Three rule types are focused on here:

Regulative rules are formal laws and regulations. Incumbent-protecting rules include Nigeria imposing a 20% import duty on lithium-ion solar batteries (plus 7.5% VAT), in contrast to 0% duty on solar panels and exemptions aimed at promoting renewables,³⁵ although diesel generators benefit from lower effective barriers amid fossil fuel subsidies. Utility monopsony clauses persist in 16 African countries (eg, Nigeria, Kenya), where national utilities hold exclusive rights to procure power, blocking direct corporate renewable PPAs and favouring incumbents.³⁶ Colonial-era expropriation laws allow governments to seize

³⁵ Frank Eleaney, "[20% Lithium Battery Duty Slows Solar Energy Growth](#)", *BusinessDay NG*, January 26, 2023.

³⁶ "[Customs Moves to Ease Import of Renewable Energy Technologies](#)", *Vanguard News*, May 19, 2025.

customary land for 'public interest' projects, often overriding community consent. Emergence-enabling rules include [Kenya's 2019 Energy Act](#), which unbundled generation and allowed community ownership, and [South Africa's Renewable Energy Independent Power Producer Programme](#), which introduced transparent bidding with local content requirements. The AfCFTA Investment Protocol, adopted in February 2023, promotes intra-African investment through facilitation measures like national focal points, streamlined procedures and incentives for sustainable (including green) investments.³⁷

Cognitive rules are socially acquired beliefs and worldviews. The 'baseload mindset' among utility engineers treats renewables as unreliable, mandating expensive diesel backup systems. The 'carbon colonialism' narrative frames climate action as a Western imposition threatening Africa's right to develop. The World Bank supports grid expansion via regional interconnections (eg, CLSG line serving 2.8 million people, the Gambia River Basin Development Organisation for 15 million beneficiaries) under Mission 300, aiming for 300 million connections by 2030, often prioritising centralised transmission historically.³⁸ However, new cognitive rules are emerging. The 'just transition' framework championed by the African Group of Negotiators positions renewable energy as decolonised development. Youth techno-optimism views leapfrogging as African exceptionalism: just as mobile money bypassed bank branches, distributed energy can bypass dysfunctional grids. Ghana is a case in point, with rural electrification via solar mini-grids ('solar villages', in policy discourse) tied to national programmes such as Energy Commission initiatives,³⁹ which promote community-shared solar as cultural continuity, as embedded in the Ubuntu philosophy.

Normative rules are deep-seated customs and assumptions followed almost subconsciously. Public procurement in Africa faces risks such as corruption, non-compliance and poor planning, leading officials to favour established suppliers over local innovators to minimise accountability risks.⁴⁰ Resource nationalism via raw mineral export bans in countries like Zimbabwe (lithium, 2023), Namibia (lithium/cobalt/manganese, 2023), Ghana (lithium, 2023), Malawi (all unprocessed minerals, 2025) and Guinea (bauxite/gold, licences revoked in 2023) creates stalemates, as inadequate refining capacity halts exports without value addition, spurring smuggling and lost revenue.⁴¹

³⁷ Electronic Database of Investment Treaties, "AFCFTA Protocol on Investment (2023)", accessed December 5, 2025, <https://edit.wti.org/document/show/8993cb69-cbc5-4f07-a372-5ef5c74e7b78>

³⁸ World Bank, "[Powering Africa: The Transformational Impact of Regional Energy Projects in West Africa](#)", February 6, 2025.

³⁹ Oxfam International, "[Oxfam's Solar Energy Project Lights up a Rural Village in Ghana](#)", May 25, 2022.

⁴⁰ Matt Ross, "[Hope Is Not a Strategy: How to Change How Civil Servants Think about Risk](#)", Global Government Forum, March 20, 2024.

⁴¹ T Reilly Geopolitical, "African Raw Material Export Bans: Protectionism or Self-Determination?", accessed December 5, 2025, <https://www.treillygeopolitical.fr/blog/african-raw-material-export-bans-protectionism-or-self-determination>

But new norms are taking root. Africans are waking up to alternative ways of changing these locked-in and stuck systems. Informal solar technicians learn new skills via social media and informal networks, circumventing formal accreditation systems and spurring innovation in their communities. Traditional chieftaincy consultation has become a non-negotiable project requirement; without libation ceremonies and community land consent, projects are likely to fail in countries such as Ghana and Zambia. Diaspora returnees are creating a moral economy in which engineers accept lower financial returns in exchange for greater social impact.

Table 8: Rules: The deep structure of inaction

Rule level	Orientation	Examples and descriptions
Regulative (formal)	Incumbent-protecting	Diesel generator import duty waivers (Nigeria: 0% vs. 10% for solar batteries); utility monopsony clauses preventing corporate PPA direct procurement in 16/54 African states; colonial-era expropriation laws enabling state seizure of customary lands for 'public interest' projects
	Emergence-Enabling	Kenya's 2016 Energy Act: unbundled generation licences and community ownership provisions; South Africa's Renewable Energy Independent Power Producer Programme (REIPPPP): transparent bidding with local content scoring; AfCFTA Protocol on Investment: intra-African green FDI pre-authorisation streams
Cognitive (values & beliefs)	Incumbent-protecting	'Baseload mindset' among utility engineers: renewables as 'unreliable', requiring diesel backup; carbon colonialism narrative: climate action as Western imposition threatening African development rights; electrification = grid extension: World Bank's historical \$30 billion investment imprinting centralised delivery norms
	Emergence-Enabling	'Just transition' framing championed by African Group of Negotiators: renewable energy as decolonised development; youth techno-optimism: leapfrogging as African exceptionalism (mobile money → distributed energy); Ubuntu energy ethics: community-shared solar as cultural continuity (eg, Ghana's 'solar villages')
Normative (deep habits)	Incumbent-protecting	Political patronage cycles: pre-electoral diesel subsidy restoration as vote buying (Senegal, 2022); risk-averse civil service culture: 'no one ever got fired for buying Siemens' – preference for OECD-known

Rule level	Orientation	Examples and descriptions
		suppliers over African manufacturers; resource nationalism vs. beneficiation gap: banning raw mineral exports while lacking domestic processing capacity, creating extractive stalemate
	Emergence-enabling	Informal sector adaptability: solar technicians training via YouTube, circumventing formal accreditation; chieftaincy consultation as non-negotiable: projects failing without libation ceremonies and stool land consent (Ghana, Zambia); diaspora returnee entrepreneurship: 'brain gain' engineers accepting lower returns for social impact (moral economy)

Source: Compiled by authors

How rules are imprinted on materials

Materials are not neutral; they carry the rules of the actors.

Solar PAYG meters encode individual creditworthiness scores and Western-style billing cycles, enforcing financialisation upon rural users. Yet communities appropriate these devices for collective charging, subverting the individual ownership model and reprogramming the technology for communal benefit.

Artisanal mining pits in the cobalt sector embed informal economy survival strategies, non-state labour regulation and, problematically, child labour norms. When multinational buyers impose OECD due diligence rules on these spaces, miners resist through mobility and opacity, showing how materials and actors can evade rules.

Regional power pool interconnectors, such as those planned to integrate Ethiopia's GERD with Kenya and Sudan, embed post-colonial sovereignty pooling and infrastructure-as-diplomacy rules. Egypt's opposition to the dam has materialised in delays to grid connection, showing how geopolitical disputes can become technical bottlenecks.

[Green hydrogen export pipelines in Namibia](#) encode European Carbon Border Adjustment Mechanism (CBAM) compliance rules and German offtake specifications, creating a form of neo-extractivism reminiscent of the DESERTEC proposals of the 2000s. Yet, the Namibian Sovereign Wealth Fund focuses on stabilisation (drawing when revenue <3-year GDP average) and intergenerational savings (20% GDP target), with strict caps on local assets to avoid crowding out private capital, creating friction between

pipeline design following German Technical Inspection Association (TÜV) standards and local ownership aspirations.⁴²

Table 9: Material-rule imprinting: How artefacts encode power

Artefact	Imprinted rules	Actor enactment and system impact
Solar PAYG meters	Individual creditworthiness; Western time discipline (billing cycles); bypass of state utility (governance)	Fintech lenders enforce financialisation; rural users appropriate meters for collective charging, subverting individual ownership
Artisanal mining pits (cobalt)	Informal economy survival; non-state labour regulation; child labour norms (cognitive)	Multinational buyers impose OECD due diligence rules (OECD Guidance), creating 'formalisation' pressure that miners resist via mobility and opacity
Regional power pool interconnectors	Post-colonial sovereignty pooling (normative); cost-reflective trade (regulative); infrastructure as diplomatic leverage (cognitive)	Ethiopia's GERD transmission lines to Kenya/Sudan embed Nile Basin geopolitical rules; Egypt's opposition materialises as grid connection delays
Green hydrogen export pipelines (Namibia)	European CBAM compliance; German offtake demands; neo-extractivism (DESERTEC 2.0)	Namibian sovereign wealth fund rules require 30% domestic equity, but pipeline material design follows German TÜV standards, creating implementation friction

Source: Compiled by authors

The current African energy regime: A system under strain

⁴² International Monetary Fund, "[Namibia: 2025 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for Namibia](#)", IMF Country Reports 25, no. 132 (2025).

The incumbent regime is an alignment of dominant actors, materials and rules that keeps the fossil fuel system stable despite its failures. In systems terms, a regime is not a structure that passively resists change. It is a set of interlocking feedback loops that actively correct deviations: every time a challenger gains ground, some part of the system pushes back. A subsidy is defended, a licence is delayed, a tariff is adjusted, a narrative is repeated. This matters for decision makers because it explains why two decades of sound continental policy have not produced transformation, and why adding more technology or more finance, without changing the rules that connect them, will not either. The regime is characterised by:

- centralised control defended by state-owned utilities and political elites;
- carbon-intensive infrastructure, supply chains and baseload-focused grids; and
- extractive rules that prioritise mineral exports over local processing and that treat energy as a patronage good.

Three self-reinforcing mechanisms give this regime its stability, and each behaves as a loop rather than a fact. The first is financial entanglement. China Development Bank's oil-backed lending to Angola, including a \$10 billion facility in 2015 to recapitalise Sonangol and prepay outstanding debts, is structured through prepayment facilities and escrow accounts, with a debt service reserve account replenished to \$1.5 billion.⁴³ Because repayment is drawn directly from oil revenues, any slowdown in extraction threatens debt service, which in turn generates pressure to restore extraction; the debt reprofiling of 2020 and 2024 extended the horizon of this loop without breaking it.

The second mechanism is sunk cost. Globally, fossil fuel investment still totalled roughly \$1 trillion in 2024, even as clean energy investments reached about twice that amount;⁴⁴ on the continent, an estimated \$120 billion flowed into fossil generation between 2010 and 2020. Every unit of that capital strengthens a constituency whose rational interest is to prevent its own stranding.

The third mechanism is skills path dependency: a generation of utility engineers trained for thermal plant operation constitutes human capital that votes, lobbies and plans in favour of the system it knows. None of these loops requires bad faith to function. That is precisely what makes them durable.

Yet the regime is cracking under its own contradictions, and the cracks are visible on balance sheets before they are visible in policy. Eskom, South Africa's state utility, entered its 2023 government debt-relief

⁴³ AidData Global Chinese Development Finance Dataset, "CDB Provides \$10 Billion to Government of Angola to Recapitalize Sonangol and Prepay Outstanding Debts", accessed December 5, 2025, <https://china.aiddata.org/projects/53063/>

⁴⁴ International Energy Agency, [World Energy Investment 2024](#), Report (IEA, 2024).

programme with gross debt of around ZAR⁴⁵ 400 billion (\$26 billion),⁴⁶ with the programme designed to reduce this to ZAR 250 billion (\$15.5 billion); net debt still stood near ZAR 370 billion (\$23 billion) in late 2025, and arrears owed to Eskom by municipalities passed ZAR 105 billion (\$6.53 billion) by September 2025.⁴⁷ On these numbers, new thermal investment is unfeasible without fiscal intervention, which is itself constrained.

In Egypt, the IMF calculated a diesel supply cost of \$0.88 a litre in 2022 against a consumer price of \$0.3 a litre, an explicit diesel subsidy of \$11.7 billion, or 3.5% of GDP, in that year alone.⁴⁸ Successive price increases of roughly 15% in April 2025 and up to 13% in October 2025 moved the country towards the cost-recovery commitment made to the IMF for December 2025, with diesel remaining partially subsidised and cross-financed by other fuels.⁴⁹

The systems reading of these episodes is more important than the individual numbers: the subsidy regime that once stabilised the fossil order as a social contract is being dismantled by external conditionality, which removes the very buffer that absorbed public discontent. Most critically, a population with half its people under the age of 25 is withdrawing consent from a system that delivers energy poverty to roughly 600 million people.⁵⁰

Table 10 summarises the regime as a contested stability: not one system but three overlapping configurations, each held together by its own loops.

Table 10: The AGIE regime: Contested stability

Regime type	System elements	Description and manifestation
Incumbent fossil-industrial complex	Alignment	Actors: state-owned utilities, oil marketers and political patronage networks. Materials: diesel generators, kerosene stoves and baseload-

⁴⁵ Currency code for the South African rand.

⁴⁶ Parliament of South Africa, "[Media Statement: Committee Received Briefings on Interventions to Address the Escalating Municipal Electricity Debt](#)", April 2025.

⁴⁷ Mayibongwe Maqhina, "[Minister Ramokgopa Outlines Eskom's Strategies to Recover R100 Billion Municipal Debt](#)", DFA, January 3, 2026.

⁴⁸ Enerdata, "[Egypt Raises the Prices of Fuel Products by 10-15%](#)", July 26, 2024.

⁴⁹ Salma El Wardany, "[Egypt Hikes Gasoline, Diesel Prices as Part of IMF-Led Bailout](#)", Bloomberg, October 17, 2025; "[Egypt Implements Second Fuel Price Hike in 2025 to Curb Subsidies, Budget Deficit](#)", Africanews, October 17, 2025.

⁵⁰ IEA, "Key Findings: Africa Energy Outlook 2022", accessed June 13, 2025, <https://www.iea.org/reports/africa-energy-outlook-2022/key-findings>

		oriented grid infrastructure. Rules: centralised planning, energy subsidies as social contract and corruption as a transaction cost.
	Lock-in mechanisms (balancing loops)	Sunk costs: an estimated \$120 billion invested in fossil generation (2010–2020) feeds asset-stranding fears. Skills path dependency: tens of thousands of utility engineers trained for thermal plant operation. Financial entanglement: oil-backed loans (Angola, Chad) tie debt service to continued extraction.
Emerging decentralised green regime	Alignment	Actors: off-grid enterprises, regional power pools, DFIs, artisanal miners turned processors, and diaspora investors. Materials: distributed solar, battery storage, mobile money rails and traceable mineral supply chains. Rules: blended-finance de-risking, community ownership, the leapfrog narrative and AfCFTA market integration.
	Stabilising mechanisms (reinforcing loops)	Learning by doing: successive REIPPPP bidding rounds cut solar tariffs to 43c/kWh by Bid Window 5. Policy feed-in: 48 of 55 countries now have renewable energy targets. Financial innovation: Kenya's 2019 Acorn green bond, rated B1 by Moody's, created a replicable template.
Transition zone grey space	Hybrid compromises	The system is not binary. Hybrid diesel–solar mini-grids are a compromise, preserving utility control while meeting donor green targets. Chinese-financed coal at Hwange (Units 7 and 8, commissioned 2023) locks in 600MW of baseload through escrow-secured project finance even as landscape pressures mount.

Source: Compiled by authors

A contested arena

The regime is not monolithic. The incumbent fossil–industrial complex represents the dominant alignment: state-owned utilities such as Eskom, TANESCO and NEPA, oil marketers, patronage networks and thermal engineers; materialised in diesel generators, kerosene stoves, baseload-oriented grids and fossil-backed debt instruments; and governed by rules of centralised planning, subsidy as social contract and mineral export over local processing.

The emerging decentralised green regime is the challenger: off-grid enterprises such as [M-KOPA](#) and [d.light](#), regional power pools, DFIs, artisanal miners turned processors and diaspora investors; materialised in distributed solar, storage, mobile money rails and traceable mineral chains; and governed by

blended-finance de-risking, community ownership quotas, the leapfrogging narrative and AfCFTA integration.

Between the two lies a transition zone, a grey space where hybrid compromises materialise and where each regime's rules partially apply. Hybrid diesel-solar mini-grids embody one compromise, achieving substantial renewable penetration with diesel backup while preserving utility control and satisfying donor green targets. The Hwange Units 7 and 8 expansion in Zimbabwe embodies another: a 600MW Chinese-financed coal project delivered through a special purpose vehicle, secured by escrow accounts and a 20-year power purchase agreement, and commissioned in 2023, locking in baseload coal for decades even as the landscape turns against it.⁵¹ The grey space is not a failure of clarity. It is where the two regimes' feedback loops interpenetrate, and therefore where hybridisation, capture and conversion all become possible.

The strategic conclusion is that the regime's apparent equilibrium is not rest but tension: forces pushing for change and forces defending the status quo hold each other in place. Systems held in tension do not decay gradually; they flip when a shock or an accumulation of alternatives shifts which loops dominate. A linear reading of today's trend lines, therefore, misreads the system's nature. The question for the AU is not what the trend says, but which loops are gaining strength, which are weakening and where the thresholds lie.

Power dynamics in the green industrialisation ecosystem: Implications for the AU

The Multi-Level Perspective frames the African green industrialisation ecosystem as a turbulent co-evolution between three analytical levels:

- slow-moving landscape pressures;
- incumbent and emergent regimes; and
- niche innovations probing for cracks.⁵²

⁵¹ AidData Global Chinese Development Finance Dataset, "China Eximbank Provides \$997.7 Million Preferential Buyer's Credit for 600 MW Hwange Makomo Power Station Expansion Project," accessed July 7, 2026, <https://china.aiddata.org/projects/63475/>

⁵² Frank Geels, "[The Multi-Level Perspective on Sustainability Transitions: Background, Overview, and Current Research Topics](#)", Cambridge Open Engage, December 3, 2024.

The landscape: Pressures creating cracks in the regime

Landscape factors are exogenous forces that erode the incumbent regime's foundations and open space for niche breakthroughs. They operate on 10- to 30-year cycles, far slower than regime cycles but, when they align, shockwaves emerge.

Structural pressures (slow-moving trends)

Demographic deluge

Africa's youth bulge (50% under 25) is a ticking time bomb for the incumbent regime. The fossil system delivers energy poverty (600 million without access) and fails to create enough formal-economy jobs to support acceptable levels of labour absorption. Youth unemployment exceeding 30% triggers the cultural buffer loop, but also generates frustration, resulting in social movements rejecting energy poverty as a neo-colonial legacy. This is not socio-economic pressure. It is a values revolution in the making.

Debt-driven depletion

The debt brake is a structural feature of Africa's post-colonial financial architecture. At 60% debt-to-GDP, governments enter a subsistence mode in which green investment becomes a balance sheet liability. IMF conditionality now explicitly demands the removal of fuel subsidies in Egypt and Nigeria, thereby destabilising the social contract that underpinned fossil fuel patronage. The landscape is financially deplatforming the old regime.

Climate-triggered fragility

Droughts in Zambia cripple hydropower (36% generation loss in 2022/23). Floods in Nigeria destroy diesel supply chains. These events are often dismissed as isolated shocks, but should be considered as cascading landscape events that expose the regime's vulnerability. The Ukraine war's fossil price spike was a landscape accelerant, making solar cost-competitive overnight and eroding the baseload mythology.

Geopolitical and technological discontinuities

US-China tech competition

The US Inflation Reduction Act and the EU Green Deal are landscape-level signals that revalue African minerals (lithium, cobalt, graphite) from extractive commodities to strategic industrial inputs. This accelerates the emergent regime timeline, creating export markets for renewable energy sources such as green hydrogen and batteries that bypass the fossil regime entirely. The unintended consequence of

new dependency remains if beneficiation remains offshore, leaving the African continent at the bottom of global value chains.

Cost curve collapse

Solar energy levelised cost of energy (LCOE) falling below \$0.03/kWh is a landscape inevitability beyond the control of any regime actor. It makes the incumbent's sunk-cost argument (the \$120 billion fossil investment) economically irrational but politically potent. The regime defends itself through asset-stranding narratives that protect utility balance sheets while blocking Chinese-driven solar, PV expansion and modular inverter innovation, disempowering legacy utility incumbents while enabling renewable energy acceleration.

Value shifts and narrative resonance

The rise of 'African solutions for African problems' is a landscape-level narrative that displaces Western aid frameworks. This emergent narrative and agency act as a gravitational field, pulling niches upstream by unlocking South–South finance and deactivating business-as-usual conditionality. It is a cultural-landscape pressure that legitimises decentralised, community-owned models over centralised state control.

Shocks most likely to weaken the regime

1. **Sovereign debt default cascade:** If Ghana- or Zambia-style restructuring spreads to Nigeria or Kenya, the IMF will impose harsher subsidy cuts, triggering social unrest and collapsing the patronage regime overnight. Probability: High within 5 years.
2. **Utility insolvency domino:** Eskom's \$25 billion default could cascade to TANESCO, ZESCO and NEPA, breaking the grid stability loop by making utilities irrelevant. This would open space for community confidence to scale sideways into regime replacement. Probability: Medium-high, already underway in South Africa.
3. **Climate-induced infrastructure failure:** A major dam collapse or grid-destroying cyclone could function as a 'creative destruction' shock, forcing emergency decentralisation. This would bypass prevailing policy delays and thrust niches into regime status. Probability: Medium-high in Southern and East Africa.

These shocks are transition midwives. They expose regimes' internal contradictions and create adaptive deficits that niches are already engineered to fill.

The regime: Causal loop analysis of African energy systems

The systems mapping conducted for this paper translates that framing into an explicit non-linear causal loop analysis and structure.⁵³ Three reinforcing loops act as the system's engines (See Annex 3 for a detailed account).

- The leapfrog accelerator (R1) runs from falling solar costs to expanding access, higher productivity and grid modernisation, and back to still-cheaper deployment. It is powered by imported equipment, with African solar panel imports exceeding 15GW in the 12 months to June 2025, a 60% year-on-year surge led by South Africa, Nigeria and Algeria.⁵⁴
- The green finance spiral (R2) runs from bond issuance to political signalling, lower perceived risk, improved ratings and greater capital inflow.
- The community confidence loop (R3) runs from local microgrid success to trust, adoption, re-skilling and further success, spreading through word of mouth rather than through markets.

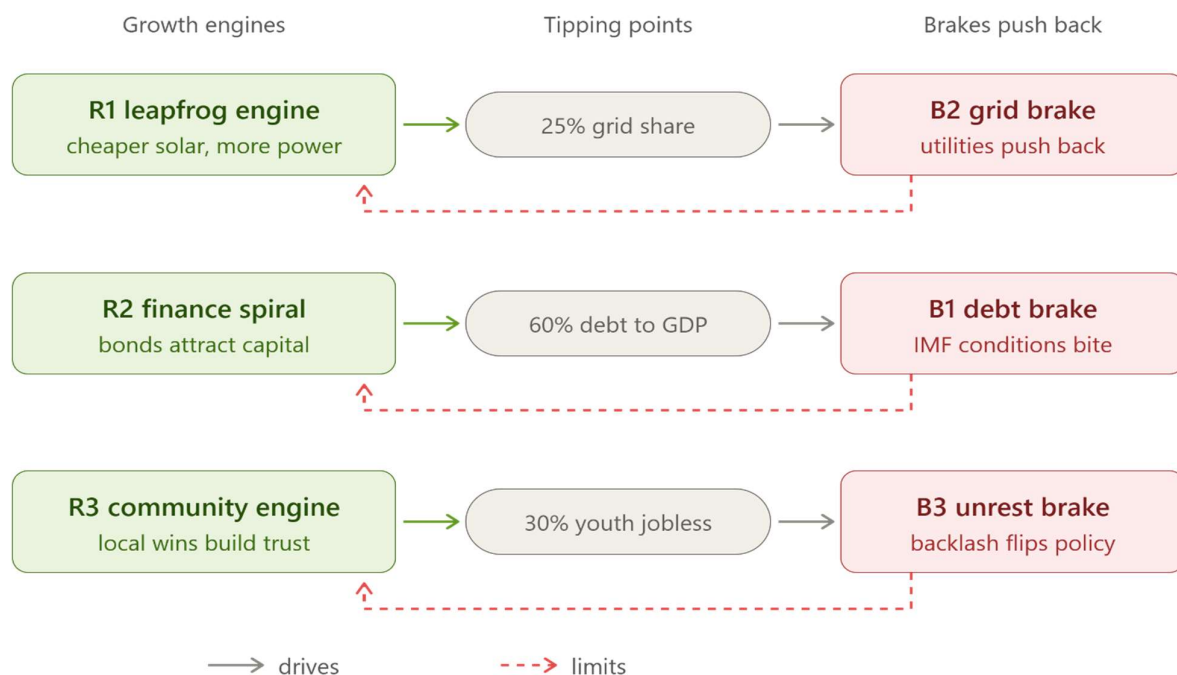
Against these engines stand three balancing loops that act as brakes.

- The sovereign debt brake (B1) activates as debt approaches roughly 60% of GDP, when conditionality shrinks fiscal space and chokes new capital.
- The grid stability sentinel (B2) activates as variable renewables approach roughly a quarter of the power mix, when curtailment, utility resistance and fossil protection limit further penetration.
- The social licence buffer (B3) activates when youth unemployment exceeds roughly 30%, when displaced informal livelihoods and unmet expectations convert into unrest and policy reversal.

Figure 1: Three reinforcing loops: The causal system engines

⁵³ Find a complete reading of the AGIE Causal Loop Diagrams in Annex 3.

⁵⁴ Casey, "Ember: African Imports".



Source: Compiled by authors

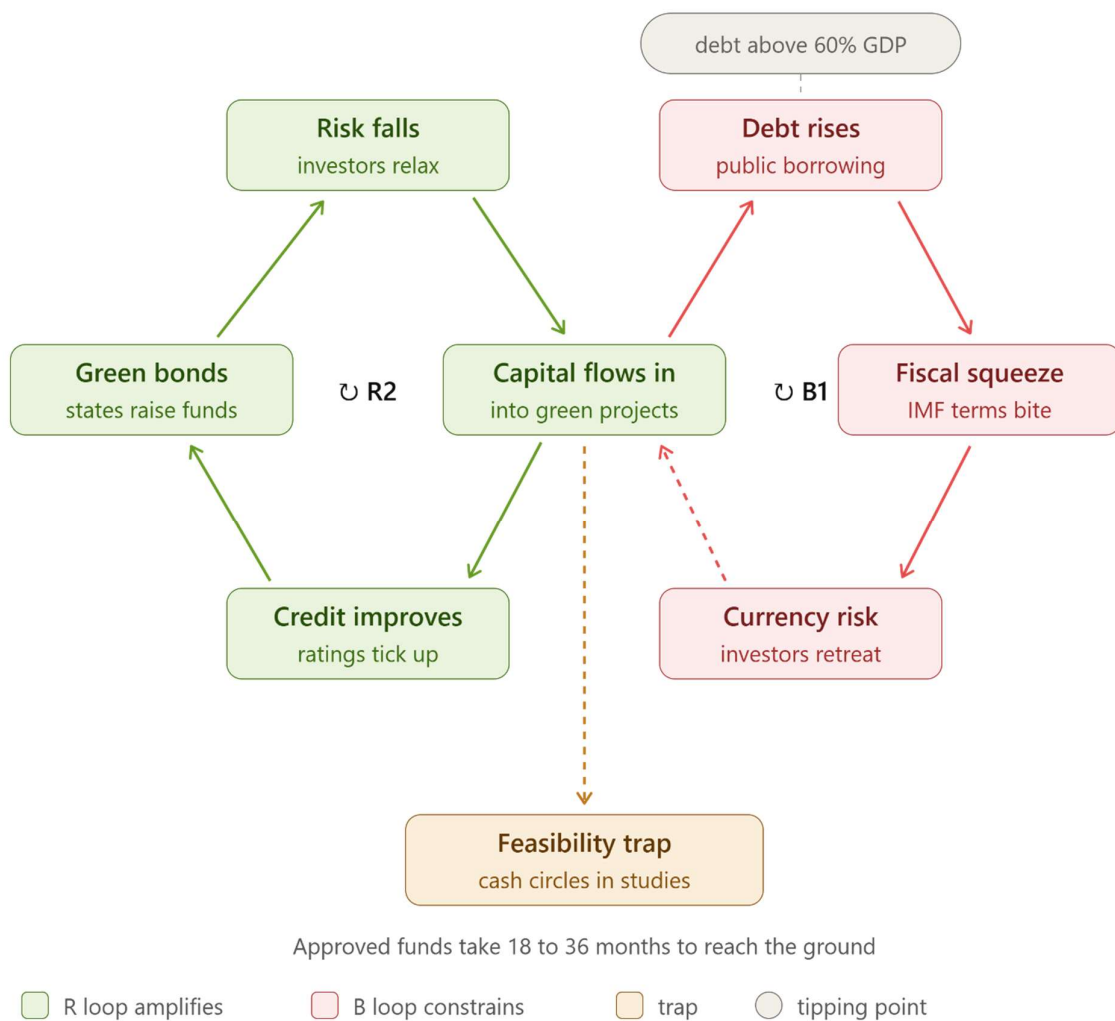
These thresholds are stylised parameters derived from the participatory mapping process, order-of-magnitude markers of where loop dominance shifts, rather than externally audited constants.

Three structural features complete the topology. System traps hold the loops in unproductive configurations.

The feasibility trap

The liquidity lock-in circulates approved finance through feasibility studies rather than projects (see Annex 3 for a detailed account).

Figure 2: The feasibility trap

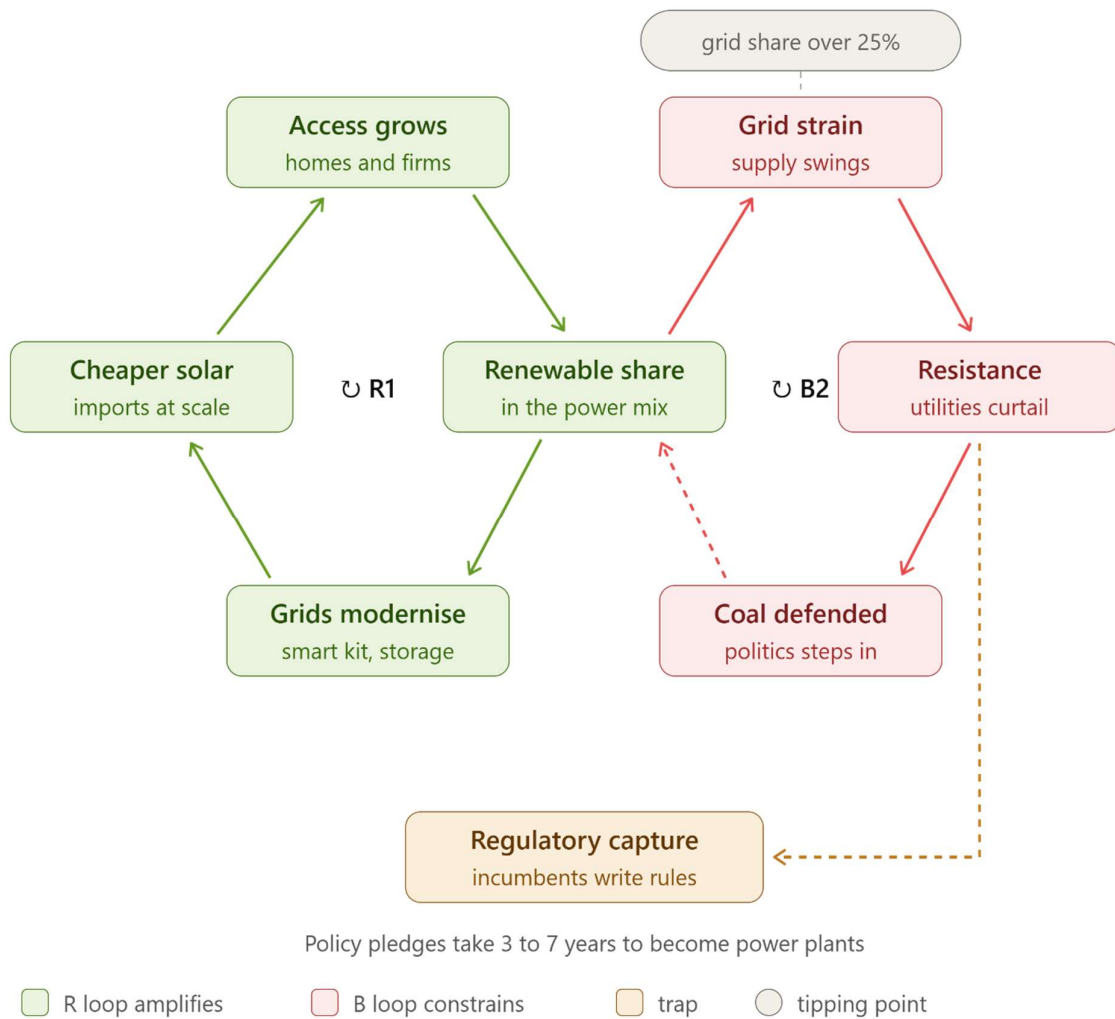


Source: Compiled by authors

The regulatory capture

Here, utilities write the rules that bottleneck decentralised entrants (see Annex 3 for a detailed account).

Figure 3: The regulatory capture



Source: Compiled by authors

Traditional authority veto

With the traditional authority veto, chiefs and elders control land access through channels other than formal permitting (see Annex 3 for a detailed account).



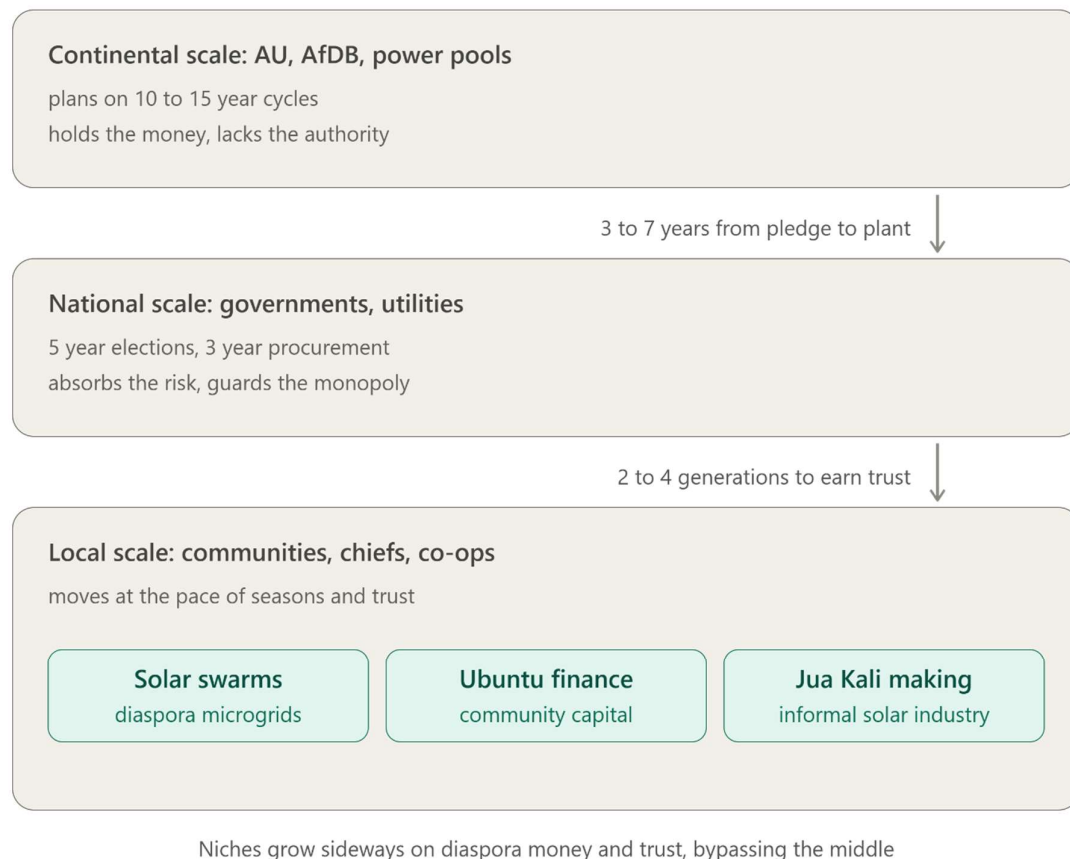
Read this way, power in the ecosystem is a property of the topology, not of the organisational chart.

- Technology colonises policy because import dependence lets equipment suppliers set standards and timelines.
- Finance colonises policy because the ratings and conditionality that operate the debt brake are controlled by actors outside the continent.
- Society captures technology because the community confidence loop spreads through channels that no ministry controls.
- Utilities capture regulators, traditional authorities hold the land veto and diaspora capital moves entirely outside official statistics.

Whoever controls a delay, a threshold or a rule controls more of the system's behaviour than most institutions do.

The implications for the AU follow directly. The AU cannot outspend the debt brake and it cannot out-legislate the grid sentinel in 55 member states. Its distinctive leverage, as a harmonisation and consultative body, lies in changing the rules that determine which loops dominate: recognition rules (what counts as infrastructure, an operator or collateral), information rules (open data that starves the feasibility trap of its rationale) and connection rules (protocols that let niches interlock across borders).

Figure 5: Causal systems implications for the AU



Source: Compiled by authors

It also lies in anticipation. Because causal relationships within this system can change once critical thresholds are reached, a linear continental plan based on stable assumptions may become ineffective as conditions change. An early-warning dashboard that monitors indicators such as debt ratios, grid penetration and youth unemployment can help the AU identify when these thresholds are approaching. This would enable the AU to adjust policies and interventions before existing feedback mechanisms constrain or reverse the intended outcomes, rather than responding only after those effects have materialised.

From seeds to niches: Protected spaces of disruptive potential

Niches are socio-technical experiments that shield alternative practices from regime hostility. They are not pilot projects but counter-regime infrastructures that accumulate learning, actors and rules until they can challenge the incumbent. In causal systems thinking terms, a niche is a protected space where a reinforcing loop is allowed to run under different rules, insulated from the balancing pressure the regime would otherwise apply.

Seeds of change and niches are complementary layers of this dynamic. Seeds are the diffuse cultural shifts, scientific breakthroughs, business-model experiments and value-driven initiatives that function at the margins and are not mainstream. Seeds of change represent new ways of seeing and doing, such as prosumer identity formation or peer-to-peer energy trading, that supply the imaginative code, re-orienting expectations and opening design space. Niches, such as green hydrogen corridors, advanced geothermal testbeds or locally governed microgrid experiments, provide the institutional scaffolding that translates promising seeds into operational, investable and politically legible alternatives.

This layering carries a practical instruction that is easy to miss: in a complex system, 'doing more of what works' does not mean replicating pilots. It means identifying which reinforcing loops are already running, extending the rule set that lets them run into new contexts and then letting the loops do the work of scale.

Equally, 'doing less of what is not working' means withdrawing energy from activities that feed the traps, above all the feasibility-study economy, rather than defunding experimentation itself. Five domains of niche innovation illustrate where the loops are already turning.

Five domains of niche innovation

- **Decentralised and off-grid electrification as the default model**

Community-run mini-grids, informal energy entrepreneurs and decentralised solar systems prototype energy architectures that grow outward rather than downward. Husk's AI-enabled distributed energy resources platform, launched with the ambition of powering prosperity for 30 million people in the Global South, marks the maturing of this model,⁵⁵ while EEP Africa has committed more than EUR⁵⁶ 70 million (\$81.7 million) to some 250 early-stage clean energy projects across Southern and East Africa since 2010, deliberately carrying grassroots niches across the 'valley of death' towards bankability.⁵⁷ The 600 million people without electricity are, in this

⁵⁵ Husk Power Systems, "[Husk Launches AI-Enabled Distributed Energy Resources \(DER\) Platform](#)", November 25, 2025.

⁵⁶ Currency code for the EU's euro.

⁵⁷ Energy and Environment Partnership Trust Fund, [Opportunities and Challenges in the Mini-Grid Sector in Africa](#), Report (EEP and Nordic Development Fund, 2018), NDC Partnership, "Energy and Environment Partnership Trust Fund (EEP Africa)", accessed

reading, less a backdrop than a catalyst: the unmet demand around which the community confidence loop organises itself. PAYG pioneers such as [M-KOPA](#), [Azuri](#), [Mobisol](#) and [Solar Run](#) fuse mobile money with lease-to-own solar, converting an unaffordable asset into an incremental investment and normalising bottom-up provisioning as a legitimate alternative to grid-first thinking.

- **Data, credit and financial spillovers from PAYG ecosystems**

Every micro-payment and usage record becomes a signal that can be translated into credit scoring for customers excluded from formal finance.⁵⁸ Analyses by the World Bank, CGAP and FSD Uganda show how PAYG operators convert these datasets into asset finance, school-fee loans, device upgrades and emergent micro-insurance, turning a solar home system into an entry point for broader economic participation.⁵⁹ This is the community confidence loop spilling into adjacent systems and recruiting finance to its side.

- **Green hydrogen and Power-to-X hubs**

At the opposite end of the scale spectrum, projects in Namibia, Egypt, Mauritania, South Africa and Morocco channel world-class solar and wind resources into green hydrogen and derivatives, opening pathways to green steel and fertiliser independence in coastal energy hubs, as framed by the Africa Green Hydrogen Alliance.⁶⁰ South Africa's Coega green ammonia project, which achieved flagship status in late 2025 and which its sponsors expect to create up to 20 000 jobs alongside desalination and port infrastructure, illustrates the pattern,⁶¹ as does Namibia's Hyphen project, valued at around \$10 billion.⁶²

- **Integrated e-mobility ecosystems**

Electric two- and three-wheelers, battery swapping and dense charging networks, built out by firms such as [Roam](#), [Spiro](#) and [Ampersand](#), tighten the coupling between clean energy supply and mobility demand, forming a low-carbon loop that reinforces both sectors from the ground up.

- **AI and Internet of Things for grid management and predictive maintenance**

December 9, 2025, <https://ndcpartnership.org/knowledge-portal/climate-funds-explorer/energy-and-environment-partnership-trust-fund-eeep-africa>

⁵⁸ World Bank, *Funding the Sun: New Paradigms for Financing Off-Grid Solar Companies* (World Bank, 2020).

⁵⁹ Martin Agaya, "[Solar Energy Lighting Up the Way to Financial Inclusion](#)", *FSD Uganda*, November 9, 2018.

⁶⁰ Green Hydrogen Organisation, "The Africa Green Hydrogen Alliance (AGHA)", accessed December 9, 2025, <http://gh2.org/agma>

⁶¹ "[Green Hydrogen: Two SA Coastal Hubs Power Africa's Future](#)", *Cape Business News*, November 10, 2025.

⁶² IMF, "Namibia: 2025 Article IV Consultation", *IMF Country Reports* 25, no. 132 (2025).

From forecasting variable generation to predicting equipment failures before they cascade, data-driven operations stretch limited infrastructure and raise the ceiling at which the grid stability sentinel activates, strengthening the connective tissue between utility-scale corridors and grassroots systems.

Regionally, the pattern is uneven but legible: North Africa consolidates manufacturing and hydrogen leadership; East Africa shows decentralised momentum that circumvents entrenched regimes; Southern Africa cultivates storage, private generation and hydrogen; West Africa advances through mini-grids, auctions and regulatory reform; and Central Africa anchors the critical minerals base. Deeper integration through the power pools offers a landscape-level mechanism for cross-border balancing.

Three high-potential niches for AGIE consolidation

Coherent consolidation focuses on niches that already demonstrate technical feasibility, political resonance and catalytic potential. The three below are strategic leverage points because each disarms a specific trap or brake in the causal loop structure.

Niche 1: 'Swahili Solar Swarms', the transnational decentralised energy commons

Self-organised networks of Somali diaspora investors, clan trust systems and Chinese solar suppliers in the Kenya–Ethiopia borderlands achieve near-universal local electrification without a national grid, subsidies or formal power purchase agreements. The protection mechanism is cultural opacity and jurisdictional arbitrage: operating in borderlands circumvents utility monopolies and exchange controls, while clan-based trust substitutes for formal credit, making the swarms invisible to DFIs but highly efficient. In causal systems terms, the swarms run the community confidence loop on social collateral, bypassing both the debt brake and the trust delay that defeat formal projects. The consolidation path runs through remittances: average fees for sending money to Africa remain close to 9%, triple the SDG target, and intra-African transfers cost even more.⁶³ Lowering these costs; enabling remittance providers to partner with banks, post offices and telecoms; and mobilising diaspora capital through bonds and securitisation of future flows would convert an invisible financing channel into recognised infrastructure. The AfCFTA's emerging energy trade protocols, with non-discriminatory tariffs and clearer cross-border trading rules, could then give swarm systems legal room to operate, which will require hybrid governance in which clan councils co-sign interconnection agreements.

Niche 2: 'Ubuntu Finance Clusters', non-extractive capital circulation

⁶³ Dilip Ratha, "[Keep Remittances Flowing to Africa](#)", Brookings, March 15, 2021.

South African community savings groups (stokvels) and underutilised municipal pension funds are creating reinvestment loops that prioritise social return. The protected market here is real but must be stated accurately: the REIPPPP requires a minimum 2.5% shareholding by local communities in each project company, structured through community trusts, alongside a 49% South African entity participation threshold in Bid Window 5.⁶⁴ In practice, community stakes in the early bidding rounds averaged around 12%, well above the formal targets.⁶⁵

Qualifying communities are projected to receive some ZAR 27.1 billion (\$1.35 billion) in dividend income over the 20-year life of committed projects.⁶⁶ This socialises a share of returns that would otherwise be entirely privatised and creates trustees and stokvel chairpersons whose fiduciary role inadvertently blocks purely extractive buyouts. The consolidation path requires granting stokvels legal personhood so they can enter procurement directly rather than through intermediaries; tax treatment that rewards verified social returns; and a replication template that lets municipal funds in Limpopo and KwaZulu-Natal channel dormant pension assets into community-owned projects. Each step reroutes capital around the sovereign debt brake rather than through it.

Niche 3: 'Jua Kali Industrial Symbiosis', the artisanal manufacturing upstart

Kenya's informal metalworkers use surplus commercial solar components to fabricate water heaters, cookstoves and battery enclosures, creating industrial output that is counted as informal but functions as genuine manufacturing. The protection mechanism is regulatory ambiguity and material scavenging; knowledge is shared within workshops rather than patented, making it immune to corporate capture. The deeper significance is a re-valorisation of artisanal labour as an innovation advantage rather than disguised unemployment, which directly weakens the skills-mismatch link in the social licence buffer. Consolidation requires product standards that recognise fit-for-purpose local designs rather than imposing external norms; a technology transfer bank through which commercial developers contribute end-of-life panels to jua kali networks, institutionalising the symbiosis and circular practice; and AfCFTA market access for 'Made in Jua Kali' appliances.

These niches will begin to coalesce once they can interoperate. A digital commons, such as a blockchain-based energy trade platform, would let trust scale laterally without centralised certification, unlocking synergies across finance, manufacturing and distribution. The general point stands above the

⁶⁴ South Africa, Department of Mineral Resources and Energy, "[Media Statement: Announcement of Preferred Bidders, Renewable Energy IPP Procurement Programme Bid Window 5](#)", October 28, 2021.

⁶⁵ Project 90 by 2030, [Ownership in the Renewable Energy Independent Power Producer Procurement Programme](#) (Project 90 by 2030, 2019).

⁶⁶ "[Renewable Energy Programme Attracts R209.4 Billion to SA Economy](#)", SAnews, February 24, 2025.

specific technology: consolidation is the moment when separately protected causal system loops connect and begin to reinforce one another.

The AU energy ecosystem

The AU cannot operate power systems, and it should not try to do so. Its institutional anatomy equips it for a different role: AUDA-NEPAD coordinates implementation and convenes finance; AFREC generates the data, statistics and technical harmonisation on which planning depends; and the AfCFTA architecture sets the market rules within which energy goods and services move.

In systems terms, the AU is a rule-maker and a legitimator. It changes what counts: what counts as an operator, as infrastructure, as collateral, as compliance. That is precisely the kind of intervention that shifts causal systems loop dominance, because every trap and brake identified in the causal loop structure is held in place by a rule about what counts.

How niches can consolidate and flip the regime

The evolution of the AU's involvement in the energy landscape towards a regime flip can be understood through two mechanisms:

- **Interoperability trigger:** As more niches are adopted by more member states, they begin to reinforce one another and separately protected loops connect.
- **Tipping point:** Once niches occupy a substantive share of the ecosystem, the centralised, extractive regime loses political legitimacy and ministerial directives flip from controlling distributed systems to enabling them.

Neither mechanism is driven by a central plan; both are driven by rules that lower the cost of connection.

The emerging green industrialisation regime should be defined by a fundamental shift in how energy systems are planned, financed, traded and governed:

- The planning phase begins with principles of energy democracy and circularity, ensuring that energy systems are designed for equity, resilience and sustainability from the outset.
- Finance should prioritise patient, social and non-repayable capital, including instruments such as cooperative licences, shifting investment logic away from extractive profit motives toward long-term societal impact.
- Trade dynamics should move from lateral, peer-to-peer transactions toward vertical export markets, enabling distributed, community-driven energy markets to flourish before integration into conventional supply chains.

- Data is crucial and operates as an open commons, enhancing transparency, enabling innovation and reducing reliance on costly feasibility-study services.
- Technology should be locally owned and open-source, fostering domestic innovation and limiting dependence on proprietary, centralised structures.

Table 11 sets out 15 AU-level niches, their host bodies and their consolidation paths. Its underlying logic deserves to be made explicit because each niche is aimed at a specific element of the causal systems loop structure.

- The AFREC data commons and open-source grid code library starve the feasibility-study trap by making the information that consultancies resell freely available.
- The distributed energy registry makes sub-1MW assets visible and countable, converting the grid stability sentinel's guardian, the power pool dispatcher, from foe to friend.
- The Africa Energy-Sovereignty Index re-prices risk on African terms, directly targeting the mechanism through which the sovereign debt brake operates.
- The traditional-authority energy licence template converts the land veto from barrier to enabler by letting chiefdoms hold micro-utility licences as legal persons.
- The Youth Green-Enterprise Corps compresses the skills mismatch that feeds the social licence buffer, and the gender-responsive indicators bring women's cooperatives into the community confidence loop as counted actors.
- The hydrogen domestic-use-first clause and the circular battery alliance rewrite extractive export rules into local value-addition rules.

Read this way, the niche portfolio is not a list of projects; it is a systematic programme for disarming the system's traps and resetting its thresholds.

Table 11: AU-level niche areas and regime flips

Niche code	Name & host AU body	What regime practice does it challenge	Novel actors – materials – rules	Consolidation path to regime flip
N-AU-01	AFREC Renewable-Energy Data Commons (AFREC – AEIS + Open-Energy Information) combining AFREC's African Energy Information System and Database (AEIS) with global community-driven databases like Open Energy Information (OpenEI), creating an open-access	An open access renewable-energy data commons challenges confidential, pay-walled energy statistics generated by a select few and commoditised by consultants	Real-time, open-source data platform; AFREC staff + African information and data specialists; creative-commons licence	As member states feed live data, planning shifts to transparent, cooperative planning, limiting decision gaps and misalignment

Niche code	Name & host AU body	What regime practice does it challenge	Novel actors – materials – rules	Consolidation path to regime flip
	platform for renewable energy data across Africa			
N-AU-02	AUDA-NEPAD Africa Cooperative Energy Finance Facility (ACEF) A coordinating node of entities, finance mechanisms and channels focused on capitalising renewable energy and supporting infrastructure development	Sovereign-guaranteed loans from AfDB/China	The Africa Energy Efficiency Facility (AfEEF); pension and sovereign-wealth funds pooled capital	As ACEF coordinates energy financing facilities, it contributes to unlocking needed finance to drive renewable energy-led industrialisation
N-AU-03	AU-Ecosystem-Based Adaptation Energy Corridors (AUDA-NEPAD + IUCN)	Linear grid expansion ignoring ecological limits	Maps where RE infrastructure <i>must not</i> go; uses biodiversity data to <i>design</i> corridors; rule = 'no-net-loss'	Adopted in 15 countries at the landscape-level planning flips regime from 'build-then-mitigate' to 'plan-then-build', protecting carbon sinks
N-AU-04	AFREC Distributed-Energy Registry (DER)	Only large (> 1MW) plants are licensed	Crowd-sourced register of sub-1kW to 1MW systems; IMEI-number of inverters = unique ID; off-grid assets become visible	Once DER covers > 1GW, mini-grids are counted in NDCs and power-pool dispatch, flipping B2 (grid-sentinel) from foe to friend
N-AU-05	AU solar-PV manufacturing (AU-SPRI) (AUDA)	Africa imported 15GW of solar panels (mostly from China, 85–90% share) in the 12 months to June 2025. This is a 60% surge from the prior year, led by South Africa (largest), Nigeria (1.7GW) and Algeria (1.2GW); 20	South Africa assembles ~620MW/year (eg, ARTsolar for solar manufacturing and JA Solar plant for modular assembly), far below 3GW demand; no full-scale cell/polysilicon production exists continent-wide due to supply chain gaps and infrastructure hurdles. Policies such as Nigeria's import bans and South Africa's 10% duties aim to boost localisation	When the first 100MW made-in-Africa panels are installed, PD1 (tech-colonises-policy) weakens; seeds continent-wide Jua-Kali component chain

Niche code	Name & host AU body	What regime practice does it challenge	Novel actors – materials – rules	Consolidation path to regime flip
		countries hit import records	African solar manufacturing efforts feature open-access Bill of Materials. Examples include Komati PS pilot specs for agrivoltaics with weather-resilient designs and Ethiopia's off-grid solar pilots in the Addis Ababa region	
N-AU-06	AFREC Peer-to-Peer Energy Trading Protocol (P2P-POT) represents a proposed continental framework by the AFREC to enable decentralised, blockchain-enabled direct energy exchanges between prosumers (eg, solar PV owners) and consumers, bypassing traditional energy utilities	Bilateral PPAs only between licensed utilities	Template smart-contract for cooperatives and municipals to trade kWh across borders; blockchain-anchored; endorsed by AFREC legal unit	Adopted and refined by at least two power pools. This will require setting up infrastructure to access, extract and refine the data as a continuous process. Over time, roll out the model to the remaining power pools
N-AU-07	AUDA-NEPAD Circular-Battery Alliance (DRC, Zambia, SA, Kenya) is a strategic partnership among these mineral-rich nations to establish a circular economy for batteries, focusing on extraction, manufacturing, recycling and second-life applications to support Africa's renewable energy expansion	Export raw cobalt/lithium; no circular policy	Common battery passport, shared recycling standards, mobile leaching plants; AU passport for second-life batteries	Once tipping point percentage of spent batteries flow through the alliance, the extractive regime flips to a circular-industrial regime, with strong sustainability embedded
N-AU-08	AU Green Hydrogen Domestic-Use-First Clause (AU Energy Strategy 2040)	Hydrogen MOUs target EU export	Draft regulation: green H ₂ must supply 40% local ammonia/steel before export; AU ministers vote by Q3-2026	Clause adopted for Namibia & SA projects re-design for African fertiliser, flipping export-oriented B1 risk into local value-add
N-AU-09	AFREC Gender-Responsive Energy Indicators	Planning was gender-blind; women were	Define quantitative indicators (eg. % women owners of kWh	Once > 20 countries report, planning rules shift; women's cooperatives (Solar Sister, etc.)

Niche code	Name & host AU body	What regime practice does it challenge	Novel actors – materials – rules	Consolidation path to regime flip
		counted only as 'beneficiaries'	assets); mandatory in all AFREC country reports	become <i>counted</i> actors, accelerating R3
N-AU-10	AUDA-NEPAD Africa Energy-Sovereignty Index (AESI)	Credit ratings set by Moody's; sovereign risk provides a proxy for renewable risk	Index scores countries on <i>energy democracy</i> (local ownership, tariff affordability, governance); published annually by AUDA-NEPAD	When banks price loans, AESI ≥ 60 triggers a 50bps reduction, deactivating B1 and incentivising cooperative ownership
N-AU-11	AU Traditional-Authority Energy Licences (Draft AFREC guideline)	Only incorporated companies can hold generation licences	Template lets chiefdoms/communities apply as <i>legal persons</i> ; land tenure + social collateral equates to equity	Adopted by most villages, can hold their own micro-utility licence, flipping C1 (traditional veto) from barrier to enabler
N-AU-12	AFREC Open-Source Grid Code Library	Each country hires European consultants to rewrite identical grid codes	GitHub repo of AU-harmonised codes (frequency, protection, communication); editable by African engineers; creative commons	Once 50% of member states adopt, equipment suppliers standardise on African specs, cutting project cost and eliminating D2 (study spiral)
N-AU-13	AUDA-NEPAD Youth Green-Enterprise Corps (YGEC)	Youth are seen as 'beneficiaries' of job programmes	2-year paid apprenticeship inside RE projects; AU pays stipend, companies provide mentorship; exit credential = install 3 working systems	10 000 graduates to the labour force for distributed industrialisation; compresses M4 (skills mismatch) and feeds R3 loop
N-AU-14	AU Cooperative-to-Cooperative Energy Trade Protocol (C2C)	Co-ops forced to sell to national utility at low feed-in tariff	Template bilateral contract co-op to co-op (cross-border); AFREC legal stamp; price negotiated socially	Understand lessons learnt from the first 4 signed protocols. Expected results include surplus from the Kenya dairy coop can feed the Tanzania irrigation coop, scaling R3 laterally without a central utility

Niche code	Name & host AU body	What regime practice does it challenge	Novel actors – materials – rules	Consolidation path to regime flip
N-AU-15	AFREC Energy-Justice Ombudsperson	No continent-wide grievance mechanism for land-grab or tariff-gouging	Independent office attached to AFREC; accepts complaints in any AU language; can recommend suspension of AU finance to the offending project	Gives communities leverage over rogue investors; deters PD1 (tech-colonises-policy) by naming and shaming extractive actors

Source: Compiled by authors

Two practical disciplines follow for AU decision makers:

- The first is sequencing by systems loop condition rather than by calendar. Where a member state is near the debt threshold, the finance-repricing niches (the sovereignty index, cooperative finance facility and recognition of community capital) come first; where grid penetration approaches its ceiling, the registry and peer-to-peer protocols come first; where youth unemployment is critical, the enterprise corps and artisanal standards come first. Contextually appropriate action means reading each member state's loop conditions, not applying a uniform rollout.
- The second discipline is measurement: tracking niche adoption the way mobile money penetration was tracked. Once templates are published and a critical mass of countries implements them, the regime will have effectively transitioned and the AU's task becomes consolidation rather than persuasion.

Dynamics of change: How niche–regime–landscape interactions drive transition

The AGIE transition is not a linear succession from fossil to green. It is a regime bifurcation in which incumbent and emergent configurations compete for landscape legitimacy and niche support, and in which the outcome is decided by which side's reinforcing loops compound faster than the other side's balancing loops can brake.

Current dynamics: The grey space tug-of-war

The incumbent regime is not merely resisting; it is absorbing. Utilities launch their own renewable procurement and offtake programmes, and hybrid mini-grid rules fold decentralised systems back under utility control. This hybridisation is regime resilience, not weakness: it metabolises the challenger's technology while preserving the challenger's exclusion from the rules. At the same time, the emergent regime is scaling sideways. Swarms and Ubuntu clusters bypass the national scale entirely, creating a

vertical disintegration in which continental-scale finance can flow directly to local-scale niches, thinning the intermediary role of national governments. Both movements are happening at once, which is why snapshots of the system mislead: the tug-of-war is visible only in the loops.

Critical juncture: The 'debt-default window'

Zambia's 2020 default and Ghana's 2022 restructuring establish the pattern; the scenario risk is its spread to a larger economy such as Nigeria or Kenya. A further sovereign default would trigger harsher subsidy removal and utility unbundling under IMF conditionality. In causal systems loop terms, this is a paradox worth stating plainly: the same shock that maximises the debt brake also breaks the grid sentinel, because insolvent utilities can no longer defend their monopoly.

A default window would break utility monopolies; trigger social unrest but also activate community resilience as informal solutions become mainstream; and open space for diaspora capital and stokvels to become official regime actors. In a shock-driven transition, debt pressures destroy locked-in incumbents, and niches that were experimental become emergency infrastructure. Anticipatory governance means preparing the niche templates before the window opens, precisely because the window cannot be scheduled.

Pathway to consolidation: The 'Southern Alliance' scenario

Three conditions must align for niches to break through to regime status:

- **Landscape alignment:** A major climate shock coinciding with a debt crisis, forcing waivers of sovereign guarantee requirements for green projects, which deactivates the debt brake and lets community finance scale. The plausibility of such shocks is no longer hypothetical: the 2023/24 El Niño drought cut Zambia's available hydropower from roughly 3 800MW to about 1 000MW, reduced Kariba North Bank to a single unit generating some 215MW of its 1 080MW capacity⁶⁷ and pushed load-shedding to 21 hours a day.⁶⁸ This would deactivate B1 (Figure 2) and allow Ubuntu finance to scale.
- **Second, regime fracturing:** A utility insolvency cascade that breaks the grid sentinel and forces governments to legalise microgrid islanding and license swarm networks (deactivate B2 in Figure 2).
- **Niche interconnection:** Swarms, Ubuntu clusters and jua kali symbiosis interoperating through an African-owned digital commons, scaling trust without central authority.

⁶⁷ Kennedy Phiri and Freddie Clayton, "[As Drought Shrivels Hydro, This African Nation Pivots to Solar](#)", *Yale Environment* 360, November 21, 2024.

⁶⁸ Cyril Zenda, "[Zambia Faces 21-Hour Power Cuts as Lake Kariba Dries Up](#)", *African Arguments*, September 11, 2024.

When these align, the emergent regime does not replace the incumbent. It subsumes it, leaving the old regime as a legacy backup for heavy industry while the new regime becomes the primary provider of energy access and industrialisation. This is regime layering, not substitution.

The AGIE transition will be won not by filling gaps or closing delays, but by surfacing the invisible – turning diaspora capital, stokvels and jua kali into visible infrastructure through landscape shocks that make the old regime illegitimate and the new niches indispensable. The system is already transitioning. We are just mapping it too slowly.

Leading from the emerging future: Signs of change

The signs that the emergent regime's causality is strengthening are already measurable, and they should be read as leading indicators rather than anecdotes.

The emergent green industrialisation regime is coalescing around different principles:

- **distributed energy enterprises** creating new ownership models;
- **regional integration** bypassing national bottlenecks;
- **African capital** beginning to finance African projects; and
- **value addition** keeping mineral processing on the continent.

Competitive learning is compounding: successive REIPPPP bidding rounds cut South African solar tariffs to a weighted average of 43c per kWh (roughly \$0.03) by Bid Window 5 in 2021, down more than 80% from the first round a decade earlier.⁶⁹ Policy feed-in is spreading: 48 of 55 African countries now have renewable energy targets, up from 12 a decade ago.⁷⁰

Financial templates are replicating: Kenya's 2019 Acorn green bond, the country's first, was rated B1 by Moody's, one notch above the sovereign, and was the first non-governmental green bond in Africa to carry an international rating, creating a precedent for corporate issuers seeking institutional capital.⁷¹ Most significant is the rise of African financial capital itself. African pension funds control over \$300 billion

⁶⁹ CSIR, "[CSIR Welcomes 25 REIPPPP Bid Window 5 Winners](#)", Green Building Africa, November 15, 2021.

⁷⁰ UN Climate Summit News, "[Renewable Energy in Africa Set for Take Off](#)", November 26, 2023.

⁷¹ Climate Bonds Initiative, "[First Green Bond from Kenya: Acorn USD40m](#)," October 2019; GuarantCo, "[The Nairobi Securities Exchange Welcomes Its First Green Bond Issue](#)", January 2020.

in assets; a shift of just 5% into domestic green bonds would create some \$15 billion of endogenous capital, weakening dependence on external donors and their conditionalities.

Diaspora bonds extend the same logic relationally: Ethiopia pioneered issuances in 2008 and 2011, the latter for the GERD, and Nigeria's 2017 diaspora bond raised \$300 million and was oversubscribed,⁷² demonstrating that identity, trust and networks can mobilise capital that ratings cannot.

For the AU, leading from the emerging future means maintaining the threshold dashboard, holding the niche templates ready and acting on loop conditions rather than plan milestones.

Strategic opportunities: Where to focus effort

The transition will not happen automatically. Deliberate interventions must target the incumbent regime's weakest links and reinforce the emergent regime's strongest nodes.

Priority actions for policymakers:

- Reform utility governance to separate policymaking from operation, allowing independent power producers to thrive
- Harmonise standards across regional power pools, creating continent-wide markets for renewable energy equipment and services
- Mandate local content with teeth: require 30% domestic procurement backed by penalties, but also provide capacity-building support to African manufacturers
- Protect customary land rights through legislation that requires free, prior and informed consent from communities, not just central government approval
- End perverse subsidies: phase out diesel and kerosene subsidies over three years, redirecting savings to renewable energy vouchers for low-income households

Priority actions for business leaders:

- De-risk African capital: Pension funds and insurers must develop asset classes that match their liabilities while investing in domestic green infrastructure
- Build ecosystem partnerships: Off-grid solar companies should partner with mineral processors to create integrated industrial hubs powered by distributed energy

⁷² Suhas Ketkar and Dilip Ratha, "Diaspora Bonds: Tapping the Diaspora during Difficult Times", *Journal of International Commerce, Economics and Policy* 1, no. 2 (2010): 251–63; "[Nigeria's First Diaspora Bond Raises \\$300 Million](#)", *Reuters*, June 19, 2017.

- Embrace transparency: Publish supply chain traceability data to build trust with European buyers without waiting for mandatory requirements
- Skilling the workforce: Invest in training 100 000 African engineers and technicians through vocational programmes tied to project pipelines
- Patient capital: Accept seven- to ten-year payback periods for green industrialisation projects, recognising that market creation takes time

Priority actions for civil society and citizens:

- Demand accountability: Use community benefit agreements to monitor job creation, procurement and environmental performance
- Build social licence: Traditional leaders and women's groups should establish community energy committees that negotiate directly with developers
- Challenge narratives: Expose carbon colonialism rhetoric as defending elite interests, not African development
- Mobilise diaspora knowledge: Create platforms for engineers and finance professionals abroad to mentor African startups
- Vote on energy: Make energy industrialisation a central election issue, demanding clear plans from political parties

A choice of destinies

The AGIE is not a blank slate awaiting external solutions. It is a complex, contested system in which incumbents and innovators struggle over the continent's future. The fossil fuel regime remains powerful through sunk costs, political patronage and cognitive lock-in. But it is financially unstable, has negative environmental impacts and is increasingly socially illegitimate to the continent's youth.

The emerging renewable-led regime is promising yet fragile. It depends on external finance, struggles with scale and risks replicating extractive patterns if minerals continue to be exported in raw form. Its stability can come from three sources: African capital circulating within Africa, distributed technologies that build community resilience and normative shifts that see green industrialisation as decolonised development.

The material artefact to watch is the [African Green Bond Standard](#), currently under development. If this standard embeds local content rules, Ubuntu ownership principles and transparent community benefit requirements, it will encode the emergent regime into the financial system. If it simply mimics European taxonomy, it will reinforce external control.

Africa can choose a future where it exports sun and wind as raw commodities, or a future where it captures value through green manufacturing, skilled employment and energy sovereignty. This map shows the actors, materials and rules that influence alternative futures. The question is whether Africans will have the power to write the rules for their own materials.

Table 12: Strategic intervention points for systems transformation

Intervention focus	Specific opportunities	Strategic significance
Weak links in the incumbent energy regime	Utility insolvency: eg, SA's Eskom \$25 billion debt renders it unable to finance new thermal plants	Creates fiscal space for renewable alternatives without confrontation
	Diesel subsidy fiscal burden: eg, Egypt's 7% GDP subsidy unsustainable post-COVID	Removes the artificial price advantage of fossil fuels, revealing true cost competitiveness
	Youth demographic pressure: 50% under-25 population rejecting status quo energy poverty	Provides political mandate for radical reform and innovation
Strongest nodes in emerging energy regimes	Mineral sovereignty stances, for instance the DRC, Zimbabwe banning raw ore exports, forcing local processing	Captures value addition within Africa, creating industrial ecosystems around renewable supply chains
	Regional integration such as the AU's single electricity market ambitions, and at sub-regional level, examples such as ECOWAS's 15-country grid code harmonisation creating a single renewable energy market	Enables economies of scale and cross-border investment that bypass national bottlenecks and build integrated regional capacity
Transformative tipping points	Mobile money penetration with an estimated 560 million subscribers enabling pay-as-you-go scalability	Establishes distribution infrastructure for distributed energy at near-zero marginal cost

Intervention focus	Specific opportunities	Strategic significance
	African pension fund allocation, shifting 5% of >\$300 billion assets to domestic green bonds	An untapped source of financing that could be deployed to drive green industrialisation

Source: Compiled by authors

A transformative vision for African green industrialisation

Africa's renewable energy frameworks are institutionally robust, but success depends on overcoming deep, interconnected challenges, including limited incentives, misaligned policies, capacity shortfalls and a crowded stakeholder landscape. Responses demand bold, adaptive leadership and inclusive governance aligned with Agenda 2063's vision of just, inclusive and climate-resilient transformation.

The broader landscape comprises powerful forces such as climate change, demographic shifts, global capital flows and political values, influencing both niches and regimes. The global push for decarbonisation, sustainable development and just transitions creates opportunities and tensions. Key landscape-level drivers include:

- **Global momentum for renewables**, which is bringing investment, technology transfer and industrial opportunities aligned with the AU's aim to use energy transitions as levers for structural transformation
- **Governance demands**, which see transparent, inclusive and adaptive institutions increasingly unlock international finance and deliver infrastructure at scale
- **Financial architecture**, including risk mitigation, fiscal incentives and return-on-investment criteria, that shapes renewable project viability and determines industrialisation pace
- **Societal perceptions**, in which community scepticism and fears of foreign-imposed solutions can enable or derail transitions, depending on how inclusively and equitably change is pursued

This vision recognises that energy transitions are deeply socio-political and economic processes determining how value, power and opportunity are distributed. By embedding foresight, inclusion and financial innovation at the transition's heart, Africa can craft a distinctly African model of renewable energy industrialisation reflecting developmental priorities, demographic strengths and cultural values.

Anticipating the future: Challenges and strategic opportunities

The Policy Innovation Lab activities fundamentally reframed how renewable energy-led industrialisation is conceptualised for the continent. Initially framed by fragmented sectoral approaches and narrow energy access definitions, the labs applied systemic foresight methodologies, Causal Layered Analysis⁷³ and Three Horizons Framework,⁷⁴ encouraging participants to surface hidden assumptions, challenge dominant narratives and imagine alternative futures.

These methodologies facilitated deep insights, including recognising energy as a basic human need and growing urgency for African integration, reframing it as a foundation for equitable development and continental sovereignty. Crucially, multistakeholder perspectives called for moving from incremental or technocratic views of transition toward ambitious, justice-oriented, continent-wide aspirations. Narratives evolved from portraying Africa as a passive technology recipient to envisioning proactive roles where Africa powers the world and achieves 100% renewable energy for the grid. This transformation was illuminated by breakthrough moments articulating a green Africa, calling for self-reliant financing and reframing narratives about agency, capacity and risk.

Towards a model strategic framework for green industrialisation

Purpose and guiding principles

This framework advances renewable energy-led industrialisation through transformative policy and strategic action to 2063, offering the AU and member states a systemic, anticipatory governance blueprint. Systemic innovations across three phases – 2025–2030, 2030–2040 and 2040–2063 – aim to

⁷³ Sohail Inayatullah, "Causal Layered Analysis: Poststructuralism as Method", *Futures* 30, no. 8 (1998): 815–29.

⁷⁴ Bill Sharpe et al., "Three Horizons: A Pathways Practice for Transformation," *Ecology and Society* 21, no. 2 (2016).

mitigate the climate crisis, advance energy democracy and extend electricity access across the continent. The long-term aspiration is to position Africa as a global energy powerhouse.

The framework is underpinned by principles essential for just and sustainable energy transitions:

- **Systemic understanding and anticipatory governance:** Fostering holistic understanding of interconnected renewable energy ecosystems and using proactive approaches to anticipate future opportunities and challenges, making anticipatory assumptions explicit
- **Energy democracy and access:** Ensuring energy is recognised as a basic human need, leading to equitable access to affordable and clean energy for all Africans, shifting from extraction to generative and democratic energy systems owned by communities
- **Transformative policy innovation:** Driving systemic change through proactive and ambitious policy innovations and actions going beyond traditional approaches
- **Collaboration and inclusivity:** Promoting trust among leaders and between actors, fostering active participation and ensuring benefits are distributed fairly across diverse stakeholders, sharing and leveraging resources and geographic commons
- **Self-reliance and sustainability:** Prioritising self-reliance in financing and investments, supporting local production, industrialisation and trade, investing in technologies tailored to regional needs, building resilient and sustainable energy systems
- **Learning and adaptation:** Cultivating 'transition-resilient' mindsets by shifting from theory to practical learning and designing adaptable policies responding to changing conditions and encouraging contextually relevant innovations

2025–2063 Strategic imperatives

The framework advances seven thematic priorities with differentiated actions across short (2025–2030), medium (2030–2040) and long-term (2040–2063) horizons:

Systems-aware, biophysical grounding: Mapping resource geographies, supply chains and stakeholders so interventions can be properly designed to meet contextual risks and opportunities. Short-term actions include conducting life-cycle assessments of renewable technologies; piloting circular economy and recycling; focusing on sustainable local storage; and mapping critical mineral supply chains. Medium-term actions scale circular economy infrastructure continent-wide; standardise life-cycle assessments and certification for minerals; and institutionalise community-based governance. Long-term vision establishes fully circular renewable industrial ecosystems with Africa as a global leader in sustainable mining and recycling.

Resource-constrained transition planning: Promoting renewable energy innovations that realistically respond to material and environmental limitations while meeting demand in underserved areas. Short-

term actions develop region-specific deployment scenarios; promote energy efficiency and decentralised low-tech renewables; and launch demand-side management. Medium-term actions include mainstream resource-constrained scenario planning, expanding decentralised renewables with grid integration and scaling energy efficiency. Long-term visions achieve energy systems within planetary boundaries with decentralised, community-managed renewables mainstreamed.

Local innovation and technology sovereignty: Boosting local innovation, manufacturing and technology, including mobilising necessary governance, financial and skills development structures. Short-term actions establish R&D hubs, launch open-source platforms, support small-scale local manufacturing, emphasise local content, invest in education and skills and innovate with contextualised finance. Medium-term actions scale Indigenous manufacturing, foster African-led IP and technology transfer and institutionalise open innovation ecosystems. Long-term vision positions Africa as a leader in renewable energy technology innovation and exports, integrating Indigenous knowledge with advanced technology.

Energy democracy and social equity: Driving expanded market access across the continent through community-centred integration. Short-term actions pilot community-owned RE projects, develop inclusive financing, review policies for community participation, integrate gender equity, align training with market needs and facilitate regional power pools. Medium-term actions institutionalise community ownership as a core pillar, ensure equitable access to capital and decision-making and standardise social equity outcome measurement. Long-term vision embeds community ownership and social equity in all energy infrastructure with universal access and participation.

Economic paradigm shift: Exploring alternative approaches to financial sustainability that decouple economic growth from exponential resource consumption. Short-term actions integrate resource-balanced frameworks in plans, launch public dialogues on decoupling growth from resource use, pilot circular economy policies and build local finance capacity. Medium-term actions institutionalise resource-balanced frameworks in budgets and indicators, scale progressive energy taxation and consumption limits and promote circular and regenerative economic activities. Long-term vision fully embeds resource-balanced frameworks with circular and regenerative economic activities as the norm.

Resilience and anticipatory governance: Strengthening anticipatory governance, relational systems thinking and foresight capabilities. Short-term actions build capacity for anticipatory governance, strengthen regional cooperation, develop early-warning systems, focus on decentralisation and prioritise infrastructure and governance reforms. Medium-term actions establish anticipatory governance networks, develop regional resource-sharing and conflict resolution mechanisms, institutionalise adaptive policy cycles and mobilise financing and political support. Long-term vision achieves fully adaptive,

anticipatory and resilient governance systems with integrated, responsive and inclusive energy markets and institutions.

Cultural and behavioural transformation: Emphasising links between energy use and environmental and social wellbeing. Short-term actions roll out education campaigns, partner with civil society and media and integrate sustainability into curricula and training. Medium-term actions normalise sufficiency and conservation values, support community-led stewardship, embed intergenerational justice in policy and education and incentivise energy efficiency and prosumer behaviour, highlighting experiential learning and storytelling. Long-term vision mainstreams societal values of sufficiency, stewardship and justice with universal energy literacy and prosumer culture.

Institutionalising strategic foresight

For the framework to effectively guide renewable energy industrialisation, it must be inherently flexible and responsive to changing dynamics and shocks. This means policies need to be designed to respond to rapidly evolving global green technologies, shifting market demands and escalating climate change impacts rather than relying on rigid directives. Adaptable approaches enable AU and member states to develop policies that are robust across various contexts and possibilities, allowing iterative policy cycles, stress testing and mechanisms for rapid adjustment.

Building anticipatory capacity involves equipping public institutions and officials with the skills, methods and knowledge to identify emerging trends, explore alternative futures and experiment with new policy approaches. Embedding and institutionalising strategic foresight ensures renewable energy industrialisation policies are truly long-term-focused through comprehensively and systematically integrating long-term, futures-oriented thinking. This includes leadership commitment to actively champion foresight and integrate it into core decision-making; establishing dedicated foresight units within AU and key ministries to provide institutional anchoring and expertise; fostering cultures of learning and experimentation, encouraging decision makers to test new approaches; and robust coordination and engagement mechanisms enhancing regional collaboration through cross-sectoral networks and multistakeholder platforms.

2025–2030 Green Industrialisation Sprint Plan

The strategic framework spans 2025–2063, but the next five years are decisive. The actions below constitute the AU's Green Industrialisation Sprint Plan, a prioritised, sequenced programme of work for the period 2025–2030 that translates the four policy recommendations into concrete outputs, assigns lead

institutions and sets measurable milestones. It is designed to be tabled at the AU Assembly and adopted by AFREC's Governing Board as an operational mandate.

Table 13: Priority actions by phase

Priority action	Lead institution	Key milestone	Target
Establish REIF as a blended finance vehicle, capitalise at initial \$500 million	AUC + AFREC + AfDB	REIF legal charter signed; first project pipeline approved	2026 Q4
Launch AFREC Energy Foresight Hub with real-time data dashboard and 3 pilot member states	AFREC	Hub operational; data protocols live in Egypt, Kenya, South Africa	2026 Q4
Mandate AMREC-PARC adoption: embed in national mining codes of 10 member states	AUC Minerals Division	10 member states notify AUC of AMREC-PARC integration	2027 Q2
Launch Community Energy Ownership Initiative: 20% local equity mandate for new large-scale projects	AFREC + RECs	Equity framework gazetted; pilot in 3 member states operational	2027 Q4
Scale REIF to \$2 billion; deploy across 5 regional energy corridors	REIF Governance Board	First 3 corridors in financial close	2028 Q4
Continental Digital Minerals Exchange operational; initial listings from DRC, Zambia, Zimbabwe	AMREC-PARC Secretariat	Exchange live; first price discovery sessions completed	2029 Q2
50GW of new renewable capacity financed or under construction through REIF and aligned DFIs	AFREC + power pools	Verified capacity data published by Energy Foresight Hub	2030 Q4
300 million people with electricity access (in line with Mission 300 and Agenda 2063 interim target)	AFREC + member states	Energy Foresight Hub access dashboard confirms milestone	2030 Q4

Source: Compiled by authors

Governance and accountability

The Sprint Plan requires a dedicated accountability architecture. AFREC should convene a biannual Green Industrialisation Progress Summit, the first by mid-2027, at which member states report against Sprint Plan milestones. The AFREC Energy Foresight Hub provides the independent data layer for this reporting. Progress is formally reviewed by the AU Executive Council at each ordinary session. A civil society observatory, anchored within the Community Energy Ownership Initiative, provides independent scrutiny of community equity commitments.

Financing the Sprint Plan requires an immediate mobilisation target: the AU Commission (AUC) should convene a Green Industrialisation Finance Summit in 2025 to secure \$5 billion in pledges from member states, DFIs and the African diaspora, seeding REIF and the Minerals Sovereignty Initiative in parallel. The G20 Energy Transitions Working Group provides an additional diplomatic lever for attracting concessional capital from Global North partners aligned with the just transition agenda.

Pathways for implementation and policy harmonisation

To maximise benefits and minimise risks from the opportunities and challenges of renewable energy-led industrialisation, the AU should adopt cooperative, data-driven and finance-mobilising approaches that are community-centred. Four policy recommendations directly support AFREC's strategic objectives, promote institutional building, call for embedding community engagement and underscore the necessity of sovereignty, financing, foresight and anticipatory governance.

Policy recommendation 1: Establish the AU-AFREC Renewable Energy Industrialisation Fund

AFREC, in partnership with the AU and key multilateral and private stakeholders, should establish a dedicated REIF as a catalytic pooled financing mechanism to mobilise and de-risk cross-border renewable energy investments, foster industrial development and strengthen energy security through diversified and reliable systems.

REIF aligns explicitly with AFREC's mandate to support joint development of Africa's energy resources, drive industrialisation and improve regional energy security. The fund aims to leverage Africa's vast renewable potential, such as solar, wind, hydro and green hydrogen, in regional corridors and hubs, integrating economies and maximising scale; address financing gaps by mobilising blended capital, reducing risks and attracting private sector and diaspora investment; foster industrialisation by supporting value chain development around renewable infrastructure, manufacturing and skills development; and

enhance energy security by supporting regional power pools to improve grid stability and cross-border trade.

Implementation pathways

Immediate actions (1–3 years): The AUC, in collaboration with AFREC and regional economic communities, establishes and operationalises REIF by mobilising blended finance from member states, the AfDB, private investors and the African diaspora. Concurrently, AFREC leads technical assistance initiatives to support member states in developing bankable renewable projects leveraging regional solar, wind, hydro and green hydrogen potential through advisory services and investor communications about business opportunities.

Medium-term actions (3–10 years): Regional power pools coordinate cross-border infrastructure integration to enhance grid stability and enable efficient power trade, driving industrialisation and strengthening continental energy security. REIF scales investments across priority corridors while building institutional capacity for project development and financial management.

Policy recommendation 2: Establish African Minerals Sovereignty and Capital Markets Initiative

The continent supplies the critical minerals powering the global green transition, yet remains structurally marginalised in the financial architectures that determine how those minerals are valued, traded and governed. Despite Africa's centrality to decarbonisation – through cobalt, lithium, nickel and rare earths – its mineral wealth is largely externalised via listings on dominant global stock exchanges, reflecting colonial financial legacies, regulatory fragmentation and capital scarcity.

To address systemic imbalances and position Africa's minerals sector more beneficially, the establishment of the African Minerals Sovereignty and Capital Markets Initiative is recommended. This bold, multi-pronged strategy, spearheaded by the AUC, AFREC and AMREC-PARC, localises mineral valuation, integrates ESG frameworks grounded in African realities and enables the continent to build sovereign, decentralised and transparent financial platforms. Africa can transition from a passive supplier to a platform builder, rule-setter and value capturer in a polycentric financial future.

The initiative rests on five strategic pillars:

- institutionalisation of AMREC-PARC across member states, embedding standards into national mining codes, stock exchange listing requirements and ESG frameworks while establishing National Focal Points;
- development of a Pan-African Mineral Exchange Network creating Continental Digital Minerals Exchange under AFREC's governance, integrating regional stock markets and enabling real-time, transparent trading of African mineral assets;

- exploration of African mineral-backed digital currency through a feasibility study led by an AFREC, AUC and African Central Bank task force supporting AfCFTA goals and intra-African trade;
- capital market innovation for sovereign financing, including issuing AMREC-backed green mineral bonds while introducing policies incentivising dual listings with mechanisms encouraging revenue repatriation;
- and establishment of an AMREC-PARC Observatory for Strategic Foresight, providing anticipatory intelligence through horizon scanning, early warning systems and scenario modelling.

Implementation pathways

Immediate actions (1–3 years): The AU, in collaboration with AFREC, establishes a Continental Digital Minerals Exchange underpinned by AMREC-PARC standards, mandates their adoption across member states and initiates a feasibility study for a blockchain-enabled, mineral-backed digital currency. This is complemented by issuing AMREC-certified green mineral bonds and building the AMREC-PARC Unit.

Medium-term actions (3–10 years): Scale adoption of AMREC-PARC standards continent-wide, operationalise digital minerals exchange with full regional integration, pilot mineral-backed currency in selected trade corridors and establish robust foresight and governance mechanisms for adaptive mineral policy.

Expected outcomes include greater control over valuation systems and trading mechanisms, a larger share of global mineral market capitalisation captured by African exchanges, AMREC-PARC recognition as a global ESG benchmark for ethically sourced minerals, sovereign tech-enabled financial infrastructure and enhanced investor confidence from ESG-aligned funds, diaspora capital and Global South sovereign wealth funds.

Policy recommendation 3: Establish the AFREC Energy Foresight Hub

To accelerate Africa's clean energy transition and strengthen energy sovereignty, the AU, through AFREC, should establish the Energy Foresight Hub, a dedicated, continent-wide foresight knowledge infrastructure to support anticipatory governance in the energy sector. The Hub serves as a central platform for real-time data aggregation, long-range scenario planning, climate risk modelling and anticipatory governance capacity-building across member states, enabling Africa to proactively shape its energy future and guide investment flows.

This recommendation aligns with AFREC's mandate to coordinate energy data and support integrated policy development. At present, fragmented and outdated energy data impairs Africa's ability to plan infrastructure, attract finance and participate in global energy markets with authority. However, it goes further by embedding foresight capacity and real-time analytics into governance architecture, enabling

African institutions to anticipate systemic shocks, climate-driven hydropower volatility or geopolitical energy disruptions, and to improve preparedness and responses.

Guided by the African Statistical Charter, AFREC established [AEIS](#) as an active continental energy platform integrating national and regional datasets into visualisation tools. Deploying the Strategic Foresight Unit as part of this initiative to produce regular scenario reports and conduct climate risk modelling tailored to African geographies and infrastructure would add value to African energy information applications and could result in more informed and resilient policymaking while significantly de-risking renewable energy investment.

Implementation pathways

Immediate actions (1–3 years): AFREC establishes a continent-wide Energy Foresight Hub integrating real-time data, climate risk modelling and scenario planning. In collaboration with the AUDA-NEPAD Policy Bridge Tank, African universities and think tanks, training programmes in energy foresight, systems modelling and policy simulation are launched. AFREC establishes data-sharing protocols and interoperability standards with existing continental platforms, including AfCFTA trade portals.

Medium-term actions (3–10 years): The platform integrates AI-enabled forecasting and geospatial technologies for enhanced monitoring and reporting while embedding energy justice metrics, such as access, affordability and gender equity, into energy planning structures. The Hub becomes a recognised platform for continental energy intelligence informing regional integration, climate adaptation and investment strategy.

Expected outcomes include institutionalised anticipatory governance, enabling member states to proactively align infrastructure and industrialisation with future energy scenarios; enhanced continental energy integration through interoperable systems, supporting regional coordination, climate-resilient infrastructure and trade in renewable energy; and strengthened energy diplomacy, positioning Africa in global climate and energy forums. The AFREC Energy Foresight Hub is a strategic investment in Africa's energy sovereignty, enabling a transition from reactive governance to future-oriented, globally influential energy architecture.

Policy recommendation 4: The AFREC Community Energy Ownership Initiative

To achieve universal energy access while advancing equity, resilience and local economic activity, AFREC should spearhead the Community Energy Ownership Initiative, positioning communities as beneficiaries, co-owners and co-producers at the core of Africa's energy transition. By embedding equity-sharing mandates, decentralised delivery models and gender-inclusive capacity building, the

initiative strengthens energy self-reliance and ensures the transition is participatory, inclusive, socially just and structurally transformative.

This aligns with AFREC's core mandate to promote clean energy access, strengthen cooperative governance and disseminate best practices across member states. Conventional top-down energy models are criticised for lacking local ownership, resulting in low community buy-in, weak resilience and limited developmental impact. In contrast, decentralised renewable energy systems, such as mini-grids, solar home systems and PAYG solutions, offer high-leverage pathways to electrify remote communities, foster grassroots innovation and catalyse socio-economic development.

Embedding community equity and ownership into large-scale renewable projects ensures local legitimacy and long-term sustainability, creating new revenue streams, strengthening social contracts and transforming energy from a commodity into a collective public good. This model supports Africa's broader push toward just transitions, circular value chains and regenerative economic systems.

Implementation pathways

Immediate actions (1–3 years): AFREC launches the Community Energy Ownership Initiative by 2026, mandating 20% local equity in large-scale renewable projects, scaling decentralised systems through technical support and embedding youth and gender-inclusive capacity-building programmes. AFREC develops a Community Equity Policy Framework for adoption by member states, incorporating legal mechanisms, financing tools and equity governance structures. Through this initiative, catalytic funding mobilises to support community buy-ins and de-risk decentralised renewable investments.

Medium-term actions (3–10 years): AFREC establishes regional training hubs in partnership with African technical universities and youth and women's energy networks to build local capacity and foster inclusive entrepreneurship. The Knowledge Platform is launched to document and scale best practices, showcasing replicable community-led models from across the continent. Community ownership models are mainstreamed across member states with measurable impacts on energy access, gender equity and local economic development.

Expected transformative outcomes include enabling electricity access for over 300 million Africans by 2030 through inclusive, decentralised renewable systems; strengthening local ownership and governance of energy infrastructure for long-term sustainability; empowering youth and women-led enterprises in rural and peri-urban areas, including persons with disabilities; and catalysing a continental shift from extractive to empowering energy models, redefining how energy is produced, owned and distributed.

Together with REIF, CMTF, AMREC-PARC and Energy Foresight Hub, the Knowledge Platform completes a strategic framework for just, integrated and locally anchored renewable energy industrialisation across the continent.

Co-creation and validation process

This research employed a participatory futures and action research approach, operationalised through the Transformative Energy and Climate Futures Policy Innovation Lab (TECF-PIL) process – both a research methodology and a collaborative platform designed to embed systemic anticipatory thinking and governance within the AU (see Annex 1 for detailed methodology).

The TECF-PIL uses participatory futures methods to engage policymakers, researchers, civil society, private sector actors and academics in co-creating visions and strategies for Africa's energy transition. This aligns with action research principles prioritising iterative cycles of reflection, dialogue and intervention to foster collective learning and systemic change. By enabling diverse stakeholders to experiment, evaluate and refine approaches collaboratively, the Project Innovation Lab promotes anticipatory governance and adaptive policymaking.

The research commenced with a detailed systemic mapping of AU renewable energy and industrialisation narratives and initiatives. Using a multi-level perspective framework, it situates niche innovations, regime structures and socio-technical landscape factors impacting transitions. This approach supported the identification of leverage points for systemic change and strengthening of niches as protected spaces for transformative innovation.

To anticipate emerging challenges and opportunities, the TECF-PIL employed Futures Literacy Labs (FLL), which build stakeholder capacities to question and reframe assumptions about the future. FLLs facilitate exploration of multiple plausible futures, enabling policymakers to develop flexible, forward-looking strategies reflecting complex socio-technical dynamics and shifting priorities.

Building on systemic insights and futures scenarios, the project developed a transformative theory of change, visualising systemic leverage points and outlining pathways for sustainable energy-led industrialisation. This iterative development involved expert interviews, policy dialogues and collaborative prototyping with the AU knowledge community, embedding principles of inclusive engagement and continual adaptation.

Strengthening the AU's research and policy community was a core method, facilitated through in-person and virtual collaborative workshops, dialogues and stakeholder interviews. This engagement strategy supported democratising foresight processes and co-creating innovation ecosystems, while synthesising lessons into actionable policy recommendations supported by a strategic foresight framework. The

research was validated through engagement with the G20 Energy Transitions Working Group and extensive stakeholder consultations, ensuring findings reflect diverse perspectives and priorities across the continent.

Building futures capabilities for a just green transition

Africa's renewable energy transition is the point at which vision, capability and context must converge to deliver the just, inclusive and climate-resilient futures envisioned in Agenda 2063. This report has illuminated structural and institutional dynamics shaping the continent's energy transformation. It underscores that while Africa's policy foundations are robust, progress depends on addressing deep systemic interdependencies spanning governance coherence, financial resilience, technological capacity and social inclusion.

Transformative change cannot be achieved through isolated interventions or technocratic fixes. It demands a systemic, foresight-infused approach that strengthens the AU's institutional capacity, aligns regional and national mandates and cultivates adaptive learning across all governance levels. By embedding anticipatory governance and participatory futures within Africa's energy institutions, the continent can move beyond reactive policymaking toward proactive, collaborative transformation. This approach enhances strategic autonomy and capacity for collective innovation.

Africa's renewable energy-led industrialisation must therefore be understood as a societal transformation, an evolving process that redefines how value, power and opportunity are distributed across generations. The research highlights the vital role of community equity, foresight and institutional experimentation in forging an energy ecosystem that is resilient, inclusive and distinctly African in design and ambition. The insights presented identify leverage points where policy, finance and governance can intersect to accelerate transition.

The four strategic policy recommendations provide an integrated roadmap for operationalising these insights. The AU-AFREC Renewable Energy Industrialisation Fund mobilises catalytic capital for cross-border infrastructure and industrial development. The African Minerals Sovereignty and Capital Markets Initiative reclaims financial agency through localised valuation and continental trading platforms. The AFREC Energy Foresight Hub institutionalises anticipatory governance through real-time data and scenario planning. The Community Energy Ownership Initiative ensures a participatory, inclusive transition by positioning communities as co-owners and co-producers.

By aligning foresight, innovation and equity, Africa can transition from a fragmented energy landscape to a cohesive, future-fit system, positioning the continent as a sovereign architect of new energy and industrial order grounded in resilience, inclusion and self-determined growth. Unlocking sustainable

continental futures requires reimagining Africa's political economy, governance systems and role in the global energy order. With visionary policies, strategic partnerships and sustained investment, Africa can redefine its trajectory from passive participant to active architect of just and sustainable global energy futures.

The choice is clear. Will Africa remain a supplier of raw materials or become a global leader in the green energy revolution? The answer lies in the decisions made today. The sun does not rise for a few; it rises for all. Africa's energy transition must do the same.

Annexes

Annex 1: Methods appendix

Transformative Energy & Climate Futures Policy Innovation Lab process

The TECF-PIL methodology employed a participatory futures and action research approach operationalised through iterative cycles of engagement, analysis and co-creation. The process comprised four integrated phases:

Phase 1: Systemic Mapping and Diagnosis – Desktop research, document analysis and stakeholder consultations generated comprehensive mapping of AU renewable energy ecosystem. Using Miro-based visual mapping tools, the research team identified actors, materials and rules across five subsystems: science, technology & infrastructure; policy & governance; investment & finance; society & culture; and markets.

Phase 2: Multi-Level Perspective Analysis – The MLP framework situated niche innovations, regime structures and landscape pressures across regional contexts. Analysis identified strategic leverage points for transformation and barriers requiring systemic intervention.

Phase 3: Futures Literacy Labs – Participatory workshops engaged 45+ stakeholders from the AUC, AFREC, member state governments, private sector, civil society and academia. Labs employed Causal Layered Analysis, Three Horizons Framework and scenario planning to surface assumptions, explore alternative futures and co-create strategic visions.

Phase 4: Theory of Change Development – Iterative synthesis of insights generated a transformative theory of change and policy recommendations through expert interviews, validation dialogues and collaborative prototyping with AU knowledge community.

Validation and Quality Assurance – Research underwent internal peer review by Dr Deon Cloete and external review by Dr Phumzile Ncube. Findings were validated through presentations to the G20 Energy Transitions Working Group and stakeholder consultations across North, East, West, Southern and Central Africa.

Annex 2: Data snapshots and table of key AU initiatives

Table 14: Major continental renewable energy initiatives

Initiative	Lead institution	Focus areas	Target outcomes
African Renewable Energy Initiative (AREI)	AU/AFREC	Renewable energy deployment, capacity building	10GW by 2020; 300GW by 2030
Programme for Infrastructure Development in Africa (PIDA)	AU/AUDA-NEPAD	Energy infrastructure, regional integration	Interconnected regional power pools
African Single Electricity Market (AfSEM)	AU/AFREC	Market liberalisation, cross-border trade	Unified continental electricity market
Desert to Power Initiative	AfDB	Solar deployment in Sahel	10GW capacity; 250 million beneficiaries
Mission 300	AfDB/World Bank	Universal electricity access	300 million connections by 2030
Continental Power Systems Masterplan (CMP)	AU/AFREC	Transmission infrastructure planning	Optimised regional grid integration
Sustainable Energy Fund for Africa (SEFA)	AfDB	Early-stage project financing	Catalytic funding for clean energy
Grand Inga Hydropower Project	AU/DRC	Large-scale hydropower	40+ GW generation capacity

Source: Authors

Energy access and generation snapshot (2024)

- Population without electricity access: 600 million (43% of total population)
- Current installed generation capacity: 266GW
- Agenda 2063 target capacity by 2040: 1 218GW
- Per capita electricity consumption (Sub-Saharan Africa): 518kWh/year
- Per capita electricity consumption (OECD average): 7 500kWh/year
- Share of hydropower in Africa's electricity mix: 60%

- Africa's share of global solar capacity: 1.48%
- Africa's share of global solar resource potential: 40–60%
- Member states in or at risk of debt distress: 28 (as of 2024)

Annex 3: Reading the AGIE causal loop diagram

This guide explains what each causal loop diagram shows, why it matters and what it means for decision-making. The diagrams use colour coding that is consistent across all five images:

- **Green boxes** = Reinforcing loops (virtuous cycles that amplify change)
- **Red boxes** = Balancing loops (vicious cycles that constrain change)
- **Yellow boxes** = System traps (hidden snares that block progress)
- **White/grey ovals** = Thresholds (tipping points where the system suddenly flips)
- **Dashed orange arrows** = Power dynamics (who controls whom)

Diagram 1: Engines and brakes overview

What the diagram shows

This is the master map. It displays three pairs of engines (green) and brakes (red), each connected by a threshold (white oval) and a feedback arrow (dashed red) that shows how the brake eventually weakens the engine.

How to read it row by row

Top row: The Technology Engine vs. The Grid Brake

- **R1 Leapfrog Engine** (green): Cheaper solar panels mean more power plants. More power plants mean more energy access. More access means industrial productivity rises. Rising productivity funds grid modernisation. Better grids make solar even cheaper. This is a virtuous cycle. It is the dream scenario.
- **25% Grid Share** (white threshold): But when renewable power exceeds roughly 25% of the grid, something breaks. Voltage swings become dangerous. The system becomes unstable.
- **B2 Grid Brake** (red): Utilities respond by curtailing, which means switching off renewable generators. Politicians hear complaints from businesses about unreliable power. New rules are written that favour coal and gas as back-up. Renewable growth is capped. The engine stalls.
- **Dashed red arrow**: The brake feeds back and weakens the engine. The more the grid brake activates, the less attractive solar becomes, slowing the leapfrog engine.

What this means for policymakers: You cannot simply add more solar to the grid. You must either invest in storage and smart grids *before* hitting 25% or you must let decentralised microgrids operate outside the central grid entirely. The 25% threshold is not a suggestion but a structural ceiling.

What this means for investors: Grid-connected solar projects above 25% penetration face regulatory risk that is not priced into standard models. Factor in curtailment risk or invest in off-grid and mini-grid portfolios instead.

Middle row: The Finance Engine vs. The Debt Brake

- **R2 Finance Spiral** (green): A country issues green bonds. Investors see political commitment. Risk perception falls. Credit ratings improve. More capital flows in. More bonds can be issued. This is also a virtuous cycle. It is how developed markets finance infrastructure.
- **60% Debt to GDP** (white threshold): But when public debt crosses roughly 60% of GDP, the IMF intervenes. This is not a gentle suggestion. It is a structural intervention that rewrites fiscal policy.

- **B1 Debt Brake** (red): IMF conditions require spending cuts. Fiscal space shrinks. Currency risk rises. Investors retreat. Capital inflow stops. The engine stalls.
- **Dashed red arrow**: The brake feeds back and weakens the engine. The more the debt brake bites, the harder it becomes to issue green bonds, starving the finance spiral.

What this means for policymakers: Green bonds are not free money. They are sovereign debt with a green label. If your debt is already near 60% of GDP, every green bond brings the IMF closer. Consider non-debt finance instead, such as diaspora bonds, pension fund equity or cooperative capital.

What this means for investors: Green bond yields in high-debt African countries carry hidden IMF risk premiums. Price this in or shift to instruments that do not trigger sovereign debt thresholds, such as project finance with offtake from credit-worthy industrial buyers rather than state utilities.

Bottom row: The Community Engine vs. The Unrest Brake

- **R3 Community Engine** (green): A village microgrid succeeds. Trust grows through word of mouth. Local businesses adopt solar. Young people learn installation skills. More village schemes follow. Trust compounds. This is the only engine that runs on social capital, not financial capital.
- **30% Youth Jobless** (white threshold): But when youth unemployment exceeds roughly 30%, expectations collide with reality. The green transition promises jobs, but informal workers, such as charcoal sellers and diesel mechanics, are displaced faster than new jobs are created.
- **B3 Unrest Brake** (red): Skills mismatch means displaced workers cannot fill new green jobs. Social unrest follows. Politicians reverse green policies to restore order. The engine stalls.
- **Dashed red arrow**: The brake feeds back and weakens the engine. The more unrest rises, the less political space exists for community-led projects.

What this means for policymakers: Green job creation must be co-designed with informal sector workers, not imposed on them. Apprenticeship models that convert charcoal traders into solar installers, rather than training programmes that assume formal employment, are essential. The 30% threshold is a political red line.

What this means for investors: Community-led projects with genuine local ownership face lower social licence risk than top-down installations. Factor social collateral, such as chiefly endorsement and women's cooperative membership, into due diligence alongside financial collateral.

Diagram 2: Finance loops R2 and B1 (zoomed in)

What the diagram shows

This is a detailed view of the middle row from the overview diagram. It breaks the finance spiral and debt brake into six specific nodes, showing exactly where money gets stuck.

How to read the loop step by step

The Green Spiral (R2):

1. **Green bonds**: States raise funds by issuing bonds marketed as green.
2. **Capital flows in**: Money enters the country for green projects.
3. **Risk falls**: Investors relax because the bond signals commitment.
4. **Credit improves**: Ratings agencies tick up the sovereign credit score.
5. Back to **Green bonds**: With better credit, more bonds can be issued.

This looks like success. But look at what is missing. The arrow from capital flows to risk falls skips the physical reality. The money has entered the country, but has it built anything?

The Red Brake (B1):

1. **Debt rises:** Public borrowing increases to finance green projects.
2. **Fiscal squeeze:** IMF terms bite. Government must cut spending.
3. **Currency risk:** Investors retreat as the currency weakens.
4. Back to **Debt rises:** Less foreign capital means more domestic borrowing, accelerating the debt spiral.

The Yellow Trap (D2):

- **Feasibility trap:** The dashed orange arrow from capital flows points downward to a yellow box. This is the liquidity lock-in. Approved funds sit in bank accounts while consultants write feasibility studies. Cash circles in studies instead of reaching the ground. Less than 12% of approved finance becomes actual electrons.

What this means for policymakers: The problem is not lack of finance. It is that the financial system rewards *announcing* projects more than *building* them. Change the incentive structure. Tie bond disbursement to physical milestones, not planning milestones. Penalise issuers who spend more than 20% of funds on studies.

What this means for investors: Due diligence must include a feasibility-to-implementation ratio. If a project has spent three years and 40% of its budget on studies, it is not a delayed project. It is a trapped project. Walk away, or demand restructuring that shifts funds to implementation.

Diagram 3: Grid loops R1 and B2 (zoomed in)

What the diagram shows

This is a detailed view of the top row from the overview diagram. It breaks the leapfrog engine and grid brake into seven nodes, showing exactly where the energy transition stalls.

How to read the loop step by step

The Green Engine (R1):

1. **Cheaper solar:** Imports at scale drive down panel prices.
2. **Access grows:** Homes and firms gain electricity.
3. **Renewable share rises:** More solar enters the power mix.
4. **Grids modernise:** Smart kit and storage are added.
5. Back to **Cheaper solar:** Better grids reduce system costs further.

The Red Brake (B2):

1. **Grid strain:** Supply swings as clouds pass or wind drops.
2. **Resistance:** Utilities curtail renewable generators to protect grid stability.
3. **Coal defended:** Politicians step in to guarantee baseload power.
4. Back to **Grid strain:** The system is locked into fossil back-up.

The Yellow Trap (Regulatory Capture):

- **Incumbents write rules:** The dashed orange arrow from resistance points to a yellow box. Utilities do not just resist renewables. They capture the regulatory process and write rules that make curtailment the default response. The regulator becomes the defender of the incumbent, not the enabler of the transition.

What this means for policymakers: Grid modernisation must precede renewable penetration, not follow it. Invest in storage, demand response and grid flexibility *before* solar share approaches 25%. Alternatively, legalise microgrid islanding so that decentralised systems do not need to connect to the unstable central grid at all.

What this means for investors: Central grid-connected solar above 20% penetration carries curtailment risk that standard power purchase agreements do not address. Negotiate contracts that specify who pays when the utility switches you off. Or invest in behind-the-meter and off-grid systems where the central grid brake does not apply.

Diagram 4: Society loops R3 and B3 (zoomed in)

What the diagram shows

This is a detailed view of the bottom row from the overview diagram. It breaks the community engine and unrest brake into seven nodes, showing exactly where the social licence for green transition is won or lost.

How to read the loop step by step

The Green Engine (R3):

1. **Local wins:** Microgrids succeed in one village.
2. **Trust grows:** Word of mouth spreads confidence.
3. **Green jobs:** Installers and small businesses emerge.
4. **Skills spread:** Training pays off as more people learn.
5. Back to **Local wins:** More village schemes follow.

The Red Brake (B3):

1. **Hopes rise:** Expectations climb as green job promises multiply.
2. **Old trades lose:** Charcoal sellers and diesel mechanics are displaced.
3. **Unrest risk:** Protests and backlash follow.
4. Back to **Hopes rise:** Politicians dampen expectations by slowing the transition.

The Yellow Trap (Traditional Veto):

- **Elders control land:** The dashed orange arrow from local wins points to a yellow box. Traditional authorities hold veto power over land use. This is not formal law, but it is stronger than law in many places. A project with government permits but without chiefly endorsement will fail. The veto is invisible to formal planning but decisive on the ground.

What this means for policymakers: Community consent must precede project approval, not follow it. The sequence should be: chiefly endorsement, then government permit, then finance, then construction. Reversing this sequence is the single biggest cause of project failure.

What this means for investors: Social due diligence must include traditional authority consultation. A project with perfect legal title but contested social licence is not a bankable project. Budget six to 12 months for community negotiation before financial close. This is not delay. It is risk mitigation.

Diagram 5: Scales and niches

What the diagram shows

This diagram shows why the three engines and brakes operate at different speeds. It maps the three spatial scales of the African energy system and shows how time delays between them create the systemic friction that no single actor can resolve alone.

How to read the three scales

Top: Continental scale (AU, AfDB, Power Pools)

- Plans on 10- to 15-year cycles.
- Holds the money but lacks the authority.
- The AU can set targets, but it cannot force member states to implement them.

Middle: National scale (governments, utilities)

- 5-year elections, 3-year procurement cycles.
- Absorbs the risk, guards the monopoly.
- National governments sit between continental ambition and local reality. They absorb fiscal risk through sovereign guarantees and protect utility monopolies through regulatory capture.

Bottom: Local scale (communities, chiefs, cooperatives)

- Moves at the pace of seasons and trust.
- This is where the three consolidation niches live:
 - **Solar swarms:** Diaspora-funded microgrids that bypass the state entirely.
 - **Ubuntu finance:** Community capital that bypasses commercial banks.
 - **Jua kali making:** Informal manufacturing that bypasses formal industrial policy.

The time delays:

- **3 to 7 years from pledge to plant:** Continental plans take years to become national projects.
- **2 to 4 generations to earn trust:** Local communities observe for decades before accepting new technology.
- **The mismatch:** By the time a continental plan reaches the local level, the local solution has already emerged independently. The national government is bypassed.

What this means for policymakers: Stop trying to align the three scales through central planning. It will not work. Instead, create interoperability. Let continental finance reach local cooperatives directly. Let local solutions count toward national targets. Let national governments become facilitators rather than gatekeepers.

What this means for investors: The biggest returns are in the gap between scales. Where continental finance cannot reach local projects because national governments block the channel, there is an

arbitrage opportunity. Invest in vehicles that bypass the national scale, such as diaspora bonds, cooperative equity and peer-to-peer lending platforms.

Reading all five diagrams together

The five diagrams tell a single story. Africa's green industrialisation is not failing because of lack of money, technology or will. It is failing because the system is designed to amplify certain dynamics and constrain others, and the constraints are built into the architecture of finance, grid governance and social relations.

The core insight: Systemic power does not sit in any single institution. It sits in the configuration of relationships, time delays and scale mismatches. The AU cannot decree a green transition, but it can nurture the niches that are already scaling sideways, evading the brakes that stall centralised projects.

For policymakers: Your leverage is not in writing bigger plans. It is in removing the brakes. Reform utility governance so that microgrids can sell grid services. Legalise cooperative ownership of generation assets. Mandate local content with penalties and support. Protect customary land rights. End perverse fossil fuel subsidies.

For investors: Your opportunity is not in following the green bond herd. It is in finding the gaps where the brakes do not apply. Community-owned mini-grids with social collateral. Diaspora-funded solar swarms with clan trust. Jua kali manufacturing with regulatory ambiguity. These are not forms of charity. They are the highest-return segments because they operate outside the traps that kill conventional projects.

For both: The system is not broken. It is performing as designed. The question is whether you will work with the loops or against them.

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