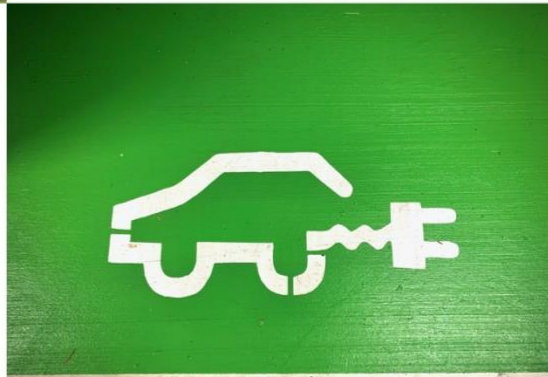


Unleashing Africa's Untapped Potential for Environmental Goods Manufacturing

October 2023



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ACKNOWLEDGEMENT

We are grateful for and acknowledge the opinions and insight provided by our practitioner and expert interviewees that contributed to the thinking and analysis expressed in this report through their own work as well as joint and one-to-one discussions with the team.

However, our opinions, insights, conclusions, recommendations, and errors are ours alone.

Special thanks also go to our excellent researchers Yixin Yu, Yunong Wu, Beryl Nana Ama Akuffo-Kwapong, Rugare Mukanganga, Meghna Goyal, and Hellen Okelo. Hannah Ryder, Leah Lynch and Yike Fu are also to be thanked for help with editing and production.

This report was commissioned by the African Climate Foundation (ACF). It was produced independently by Development Reimagined, and the contents represent the views of Development Reimagined.

CHAPTER 1

INTRODUCTION



1.1 INTRODUCTION

The African continent is at a critical juncture in its pursuit of sustainable development and addressing environmental challenges. Despite the fact that Africa, a continent making up almost 18% of world population, contributes mere 3.8% of global greenhouse gas (GHG) emissions, the continent is faced with some of the most severe climate hazards such as droughts and extreme weather.¹ The impacts of climate change are already evident in various African regions, making it imperative for the continent to adopt a different approach to manufacturing and industrialization. It is crucial that African nations embrace a green manufacturing path, one that prioritizes sustainability, resource efficiency, and environmental conservation while fostering economic growth and job creation.

Environmental goods (EG), encompassing products and technologies that contribute to environmental protection and sustainability, are playing an increasingly important role in the global efforts towards net zero emissions. As the demand for such goods rises worldwide, there exists a significant opportunity for African countries to leverage their vast resources, abundant labour force, and strategic geographical positioning to become key players in manufacturing environmental goods. By embracing local manufacturing, Africa can foster economic growth, create employment opportunities, and contribute to global efforts in mitigating climate change.

The goal of this report is to provide a comprehensive analysis of the economic case for local manufacturing of environmental goods in Africa. We aim to identify key regional hubs on the continent that are well-suited for the development and production of these goods. The report and its findings are tailored for decision-makers, policy drivers and business people, especially potential Chinese investors.

The significance of local manufacturing of environmental goods in Africa cannot be overstated. By developing and enhancing manufacturing capabilities within the continent, African governments can capitalize on the surging demand for environmental products while advancing sustainable development. This approach not only contributes to environmental conservation but also yields significant economic benefits, such as job creation, cost savings, technology transfer, and reduced reliance on imports.

The report adopts a comprehensive approach, utilizing both quantitative and qualitative research methods, including desktop research and interviews, to provide a thorough analysis. The desk research and analysis shed light on the status of environmental goods manufacturing in Africa and the associated opportunities and advantages. This encompasses a review of EG manufacturing goals and commitments at both continental and country levels, offering insights into Africa's readiness for EG manufacturing.

The selection of priority countries has been carried out through a rigorous research methodology, incorporating multiple data sources and indexes. Key factors considered in our methodology include manufacturing capacity, logistic performance index, installed renewable energy capacity, critical mineral production, Chinese Foreign Direct Investment (FDI) flows and EG trade volume with China. By integrating these critical elements, we aim to identify African regional hubs best positioned for the development and expansion of environmental goods manufacturing.

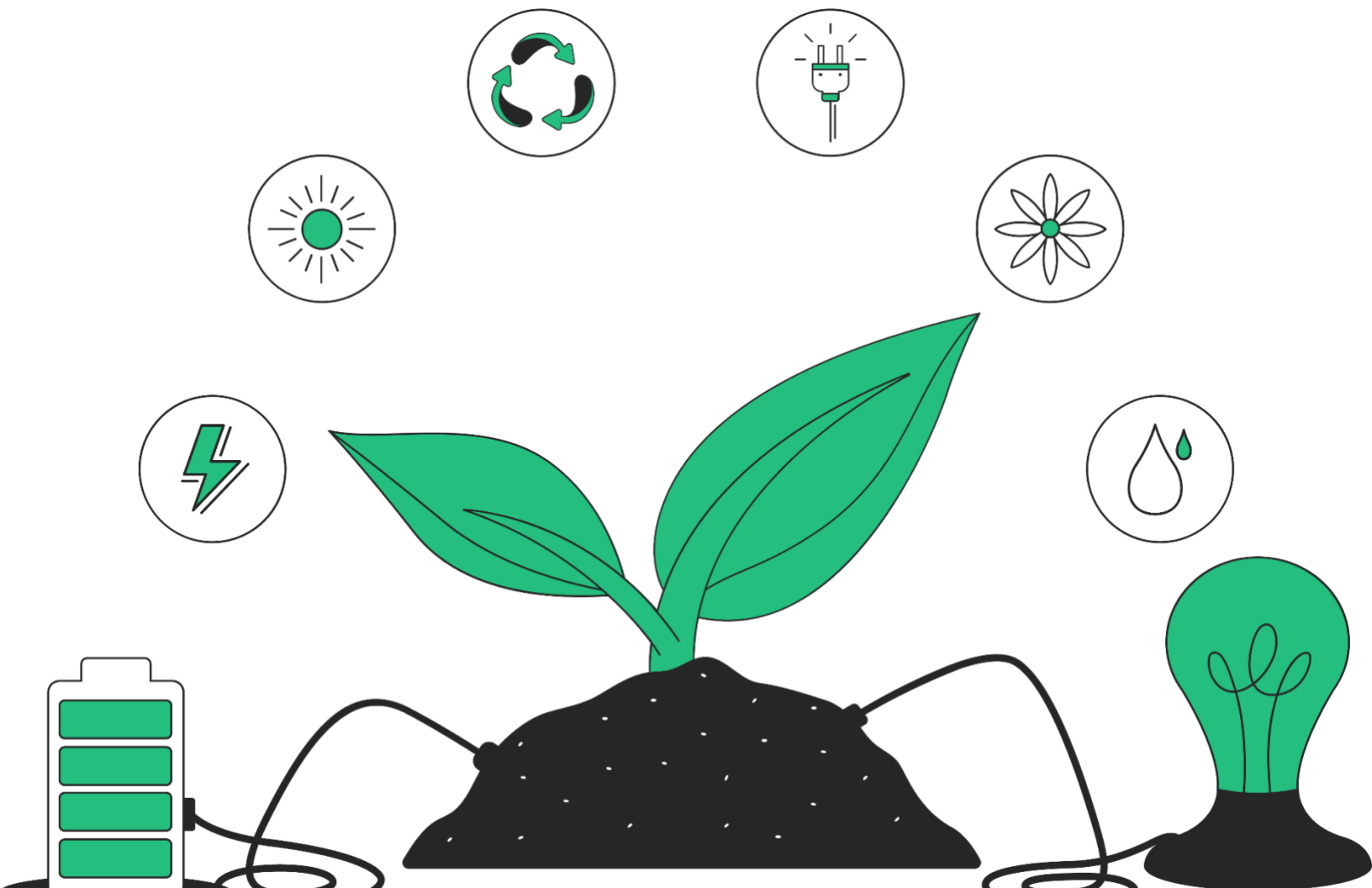
¹ CDP, "CDP Africa Report". March 2020. Accessed at: <https://www.cdp.net/en/research/global-reports/africa-report>

The report aims to serve as a strategic tool for African governments and stakeholders seeking to attract investment and foster the growth of local environmental goods manufacturing. By understanding the economic potential, harnessing available resources, and promoting sustainable practices, African countries can emerge as leaders in the production of environmental goods, driving both their own economic development and contributing to global sustainability goals.

In the subsequent chapters, we will delve deeper into the analysis and present a comprehensive assessment of the priority African countries, identifying their potential as regional hubs for environmental goods manufacturing. This will involve an examination of opportunities, challenges and recommendations, offering practical insights and actionable strategies for policymakers, investors, and other stakeholders involved in shaping the future of environmental goods manufacturing in Africa.

CHAPTER 2

STATE OF THE ENVIRONMENTAL GOODS INDUSTRY IN AFRICA



CHAPTER SUMMARY

- Defined by the OECD and APEC, environmental goods (EGs) encompass four main categories: Environmental Protection (EP), Renewable Energy (RE), Environmental Monitoring & Assessment (EMA), and Environmentally Preferable Products (EPP).
- The global EG market's growth is attributed to countries like the United States, Germany, Japan, and emerging economies such as China. Trade is a key driver of this growth, with global trade in environmental goods growing from \$437.9 billion in 1994 to \$3.16 trillion in 2021.
- In Africa, the trade of environmental goods is unevenly distributed, with South Africa, Nigeria, Egypt, and Morocco dominating. Africa accounted for only 1% of global EG trade (\$29.9 billion) in 2020, emphasizing the potential for increased participation.
- Africa has relevant environmental goods policies at the continental, regional and country levels. At the continental level, initiatives like the African Mining Vision (AMV), Science Technology Innovation Strategy for Africa (STISA), and Accelerated Industrial Development for Africa (AIDA) are related to EG manufacturing. At the regional level, RECs like ECOWAS and SADC have environment policies that promote environmental protection. At country levels, most African countries have national strategies on the development of clean energy.

In response to the urgent challenges of climate change and environmental pressures, the global environmental goods and services (EGS) industry has experienced rapid growth. This industry plays a pivotal role in addressing the pressing issues of global warming by actively contributing to the reduction of greenhouse gas emissions, enhancing climate resilience, and facilitating the transition to a low-carbon economy.

The EGS industry encompasses a wide range of products, technologies, and services that are specifically designed to mitigate environmental impact and promote sustainability. These include renewable energy systems, energy-efficient technologies, waste management solutions, water treatment systems, sustainable agriculture practices, and more.

For Africa, climate change is a pressing issue among others – industrialization, economic growth and job creation. The development of the EGS industry presents an opportunity for the continent to leap forward to green and sustainable manufacturing and industrialization. By capitalizing on green manufacturing, African countries can not only address environmental challenges but also drive economic growth and improve their global competitiveness.

2.1 DEFINITION OF ENVIRONMENTAL GOODS

The EGS industry, defined by the Organisation for Economic Cooperation and Development (OECD), are 'activities that produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise

and eco-systems.² The Asia-Pacific Economic Cooperation (APEC) has a slightly narrower definition of environmental goods including a list of 54 Harmonized System (HS) codes that focus more on industrial products.³ These products can be divided into four main categories: Environmental Protection (EP), Renewable Energy (RE), Environmental Monitoring & Assessment (EMA) and Environmentally Preferable Products (EPP). Environmental services are not specifically included in this APEC list, but they are closely linked.

For the purpose of this report, we follow APEC's definition and focus on these 4 categories of environmental goods:

- 1 **Environmental Protection (EP):** These are goods designed to prevent, control, or mitigate environmental pollution and damage. Examples include air pollution control equipment, water treatment systems, waste management products, noise reduction technologies, and environmental remediation products.⁴
- 2 **Renewable Energy (RE):** These are goods that facilitate the generation of energy from renewable sources, reducing reliance on fossil fuels and mitigating greenhouse gas emissions. Examples include solar panels, wind turbines, hydroelectric generators, geothermal systems, and biomass energy systems.⁵
- 3 **Environmental Monitoring & Assessment (EMA):** These are goods used to monitor, measure, and assess environmental parameters and conditions. They help in understanding and managing environmental quality. Examples include air and water quality monitors, remote sensing technologies, environmental sensors, and ecological assessment tools.
- 4 **Environmentally Preferable Products (EPP):** These are goods that have a lower environmental impact throughout their lifecycle compared to conventional alternatives. They promote sustainability and resource conservation. Examples include electric vehicles, energy-efficient appliances, eco-friendly cleaning products, recycled and recyclable packaging materials, sustainable furniture, and organic food products.⁶

2.2 OVERVIEW OF THE STATE OF ENVIRONMENTAL GOODS MARKET

The global market for environmental goods (EG) has witnessed substantial growth as the international community recognizes the importance of environmental protection and climate mitigation. Countries at the forefront of EG production and consumption include developed countries such as the United States, Germany and Japan benefiting from their well-established industries and advanced technologies, as well as emerging economies like China leveraging their abundant natural resources, growing manufacturing capacities and huge domestic demand.

² OECD, 2005, Environmental Goods: A Comparison of the APEC and OECD Lists, OECD Trade and Environment, Working Paper No. 2005-04

³ OECD, 2005, Environmental Goods: A Comparison of the APEC and OECD Lists, OECD Trade and Environment, Working Paper No. 2005-04

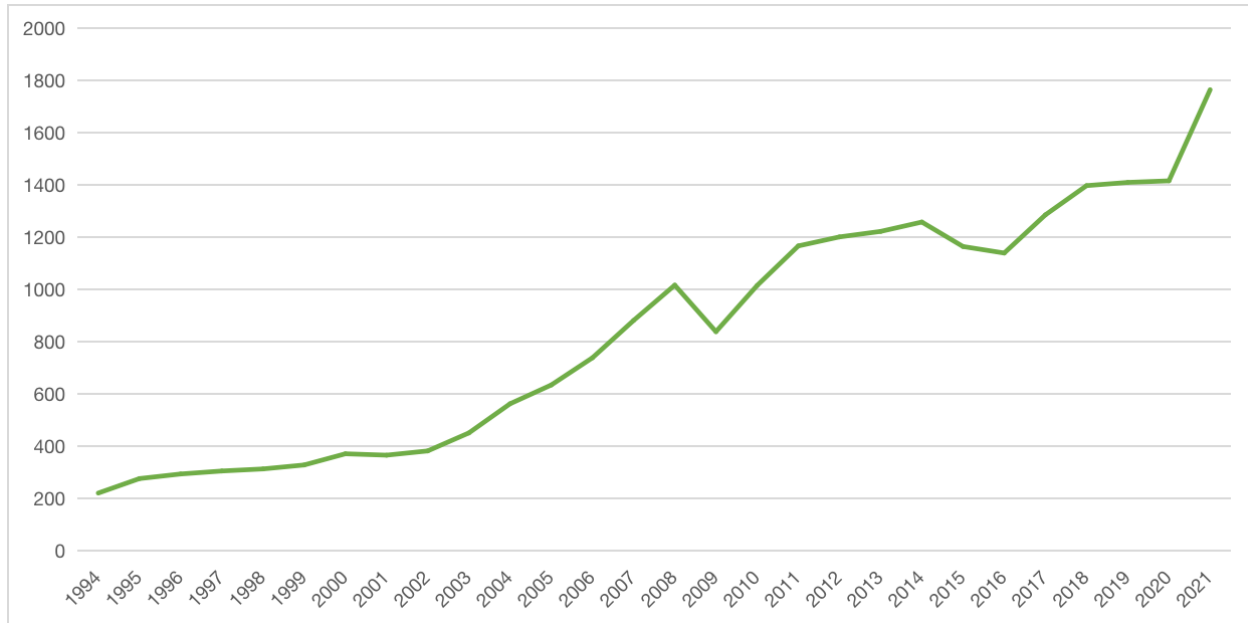
⁴ Eurostat. "Environmental goods and services sectors." https://ec.europa.eu/eurostat/cache/metadata/en/env_egs_esms.htm

⁵ US Department of Energy. "Types of Renewable Energy." <https://www.energy.gov/eere/renewable-energy#:~:text=Renewable%20energy%20sources%2C%20such%20as,Bioenergy>

⁶ U.S. General Services Administration. "Environmentally Preferable Products." [https://www.gsa.gov/climate-action-and-sustainability/buy-green-products-services-and-vehicles/buy-green-products/environmentally-preferable-products#:~:text=Environmentally%20preferable"%20means%20products%20or,that%20serve%20the%20same%20purpose.](https://www.gsa.gov/climate-action-and-sustainability/buy-green-products-services-and-vehicles/buy-green-products/environmentally-preferable-products#:~:text=Environmentally%20preferable)

Trade plays a crucial role in the expansion of the EG market. It facilitates the global exchange of environmentally friendly products, technologies, and services. It enables countries to access a wider range of environmental goods that may not be domestically available or cost-effective to produce. Global trade in environmental goods has been on steady growth path. Since 1994, world EG exports has grown eight-folds from \$219.3 billion to \$1.76 trillion in 2021.⁷

Figure 1: Global exports in environmental goods 1994 - 2021 (in US billion)



For African countries, trade in environmental goods expands their access to green goods and technologies, contributing to their environmental and climate protection goals. However, Africa's current engagement in the global EG market remains limited. In 2020⁸, the global total trade (including both exports and imports) in environmental goods reached a staggering \$2.819 trillion, with Africa accounting for a mere 1% of this trade, totaling \$29.9 billion. In comparison, China (including Hong Kong and Macau) emerged as the frontrunner, capturing 17.3% of global EG trade with \$487.76 billion, followed by the United States (11.5%), Germany (11.2%), and Japan (5%).⁹ This disparity highlights the significant potential for African countries to enhance their participation in the global EG market and foster deeper cooperation with China. By leveraging this opportunity, African nations can tap into the vast expertise, resources, and market access that China offers, thereby accelerating their own development in the field of EG manufacturing and trade.

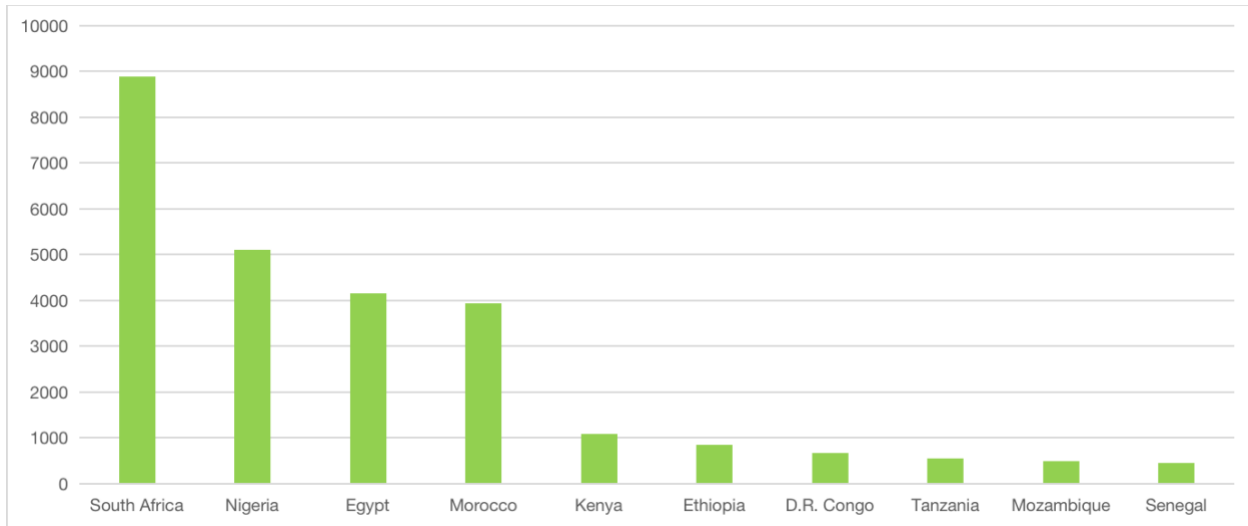
⁷ IMF. "Trade in Environmental Goods." Climate Change Dashboard. <https://climatedata.imf.org/pages/bp-indicators#cb1>

⁸ Note: Data for 2021 is missing for most African countries, so data for 2020 is used as a comparison.

⁹ IMF. "Trade in Environmental Goods." Climate Change Dashboard. <https://climatedata.imf.org/pages/bp-indicators#cb1>

Within the African continent, the aggregate trade in environmental goods for the year 2020 amounted to \$33.82 billion.¹⁰ Remarkably, imports dominated this trade arena, constituting 77.5% of the overall trade volume, equivalent to \$26.22 billion. The distribution of total EG trade displayed significant disparities across the continent, with a quartet of nations commanding more than 70% of the cumulative trade volume. South Africa emerges as the foremost contender, commanding nearly 30% of the total trade, followed by Nigeria at 17%, Egypt at 13.9%, and Morocco at 13.2% (see Figure 2).

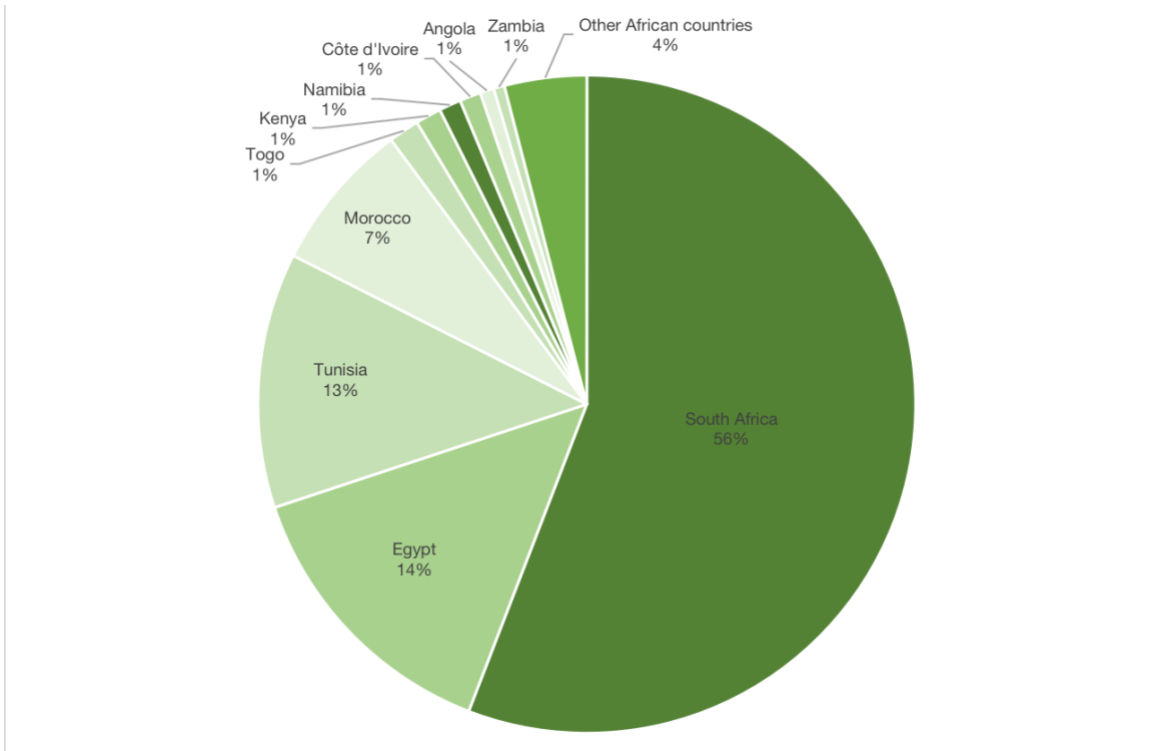
Figure 2: Top 10 African countries in total environmental goods trade in 2020 (in US million)



The asymmetry extends further in the domain of EG exports (see Figure 3). South Africa takes the lead, contributing a substantial 55.8% to the continent's total EG exports. Moreover, the top four countries, namely South Africa, Egypt, Tunisia, and Morocco, jointly account for an impressive 90% of African EG exports.

¹⁰ IMF. "Trade in Environmental Goods." Climate Change Dashboard. <https://climatedata.imf.org/pages/bp-indicators#cb1>

Figure 3: Top African EG exporters in 2020 (in percentage)



The dominance of these four African countries in the EG exports can be attributed to a combination of factors. Firstly, these countries possess abundant natural resources that are relevant to the production and export of environmental goods. Secondly, compared to other African countries, South Africa, Egypt, Tunisia, and Morocco have well-established industries and manufacturing capabilities that allow them to produce a wide range of environmental goods. Thirdly, the presence of a large domestic market drives the production and trade volume in these countries. Population size, urbanization, and economic growth contribute to the increasing demand for EG within these countries. Additionally, these countries have relatively well-established trade networks with both international partners and neighboring countries that further drive trade volume. While these prominent players exhibit formidable market presence, the concentration of trade underlines the imperative for other African nations to enhance their manufacturing capacities and actively engage in the global environmental goods value chain.

Environmental goods play an important part in Africa's efforts in environmental protection and climate change mitigation. They contribute to the reduction of greenhouse gas emissions, improvement of air and water quality, conservation of natural resources, and the attainment of national and international environmental goals, such as the Paris Agreement and the Sustainable Development Goals (SDGs). By expanding capabilities in EG manufacturing and fostering collaboration, African countries can contribute to a stronger and more diversified EG trade landscape, promoting sustainable development and environmental stewardship across the continent, and ultimately strengthening their resilience and reducing the continent's vulnerability towards climate change.

2.3 OVERVIEW OF AFRICA'S STRATEGIES ON EG MANUFACTURING

Africa's strategy for environmental goods (EG) manufacturing operates through distinct policy frameworks at both the continental and regional levels. At the continental tier, the African Union's (AU) Agenda 2063 serves as the guiding blueprint, executed through the First Ten Years Implementation Plan (FTYIP). This implementation plan outlines 20 Agenda 2063 Goals aligned with the seven Aspirations, each pinpointing priority domains for national-level execution. These collective efforts are designed to steer Africa toward its sustainable developmental aims.¹¹

Of particular significance is Aspiration 1, "A Prosperous Africa, based on Inclusive Growth and Sustainable Development." Within this aspiration, Goal 7 is dedicated to establishing environmentally sustainable and resilient economies and communities. This entails comprehensive measures for the prudent management of biodiversity, forests, land, and water resources, while adopting adaptive strategies to confront climate change risks.¹²

Agenda 2063 emphasizes the development of key sectors that are meant to enable African countries to achieve their development goals. These sectors are agriculture, trade, transport, energy and mining. In this regard, Agenda 2063 establishes six important initiatives, i.e. the Continental frameworks. These frameworks are the Comprehensive African Agricultural Development Programme (CAADP), The Programme for Infrastructural Development in Africa (PIDA), The African Mining Vision (AMV), Science Technology Innovation Strategy for Africa (STISA), Boosting Intra African Trade (BIAT) and the Accelerated Industrial Development for Africa (AIDA).¹³ Among these frameworks, the AMV, STISA and AIDA relate in one way or another to environmental goods manufacturing in Africa. **Table 1** below is an overview of these three frameworks, and the AU's Green Recovery Action Plan 2021-2027 which was established to accelerate Africa's sustainable recovery from the Covid-19 shocks and has outlined five key priority areas.

¹¹ AU, Agenda 2063 The First-Ten Year Implementation Plan, available at <https://au.int/agenda2063/ftyip>

¹² AU, Agenda 2063, available at <https://au.int/en/agenda2063/overview>

¹³ AU Agenda 2063 Continental Frameworks , available at <https://au.int/agenda2063/continental-frameworks>

Table 1: Continental Environmental Goods Manufacturing Strategies

Continental Strategy	Key Highlights	Does This Strategy Cover EG Manufacturing?
The African Mining Vision (AMV)	<p>Provides a Schematic Resource-based African Industrialization Phasing;</p> <p>Proposes an African Spatial Development Programme (SDP), consisting of a network of key Development Corridors across Africa to realize the continent's resources and associated potential;</p> <p>Downstream value addition: The use of the locational advantage (CIF-FOB) of producing crude resources to establish resource-processing industries (beneficiation) that could then provide the feedstock for manufacturing and industrialization;</p> <p>Technology/product development-development of niche technological competencies in the resource inputs sector</p>	Yes
Science Technology Innovation Strategy for Africa (STISA)	<p>Priority Sectors:</p> <ul style="list-style-type: none"> • Eradication of hunger and achieving food security • Prevention and control of diseases • Communication (Physical & Intellectual Mobility) • Live together – build society. • Wealth creation 	No
The Accelerated Industrial Development for Africa (AIDA)	<p>AIDA is an African initiative driven by the commitment to industrialize the continent. AIDA integrates industrialization into development policies.</p> <ul style="list-style-type: none"> • Focuses on local resource utilization, processing, and small-scale industries. • Improves investment and mining codes for local mineral processing. • Directs earnings from commodities towards economic diversification. • Encourages responsible industries and partnerships for technology transfer. • Strengthens financial markets for small-scale and rural industries. 	Yes
African Union Green Recovery Action Plan 2021-2027	<p>Has 5 key priority areas:</p> <ul style="list-style-type: none"> • Climate finance, including increasing flows, efficiency, and impact of funding. 	No

	<ul style="list-style-type: none"> • Supporting renewable energy, energy efficiency and national Just Transition programmes. • Nature-based solutions and focus on biodiversity through work on sustainable land management, forestry, oceans, and ecotourism. • Resilient agriculture, by focusing on inclusive economic development and green jobs. • Green and resilient cities, including a focus on water (flooding and water resources) and enhancing information, communication, and technology. 	
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2.3.1 REGIONAL STRATEGIES ON ENVIRONMENTAL GOODS MANUFACTURING

At the regional level, Africa’s environmental and Climate policies can be grouped into two categories. The first category is the Regional Economic Communities (RECs) with policies that broadly have steps needed to protect the environment. RECs in this category include ECOWAS’s Environmental Policy¹⁴ and SADC Green Economy Strategy and Action Plan¹⁵. These policies simply showcase best endeavor measures that member states ought to adhere to. The second category of policies spells out strategies for environmental goods manufacturing. An example is the East African Community’s Regional Bioeconomy Strategy through which the EAC intends to ‘catalyze and support innovative and sustainable use of bioresources as the major driver of inclusive economic growth and job creation in East Africa’.¹⁶ Table 2 below shows which among these regional strategies have environmental goods manufacturing as an express policy.

Table 2: Regional EG Manufacturing Strategies

Regional Economic Communities	Environment Policies covered	Does the Policy Have a Manufacturing component?
ECOWAS’s Environmental Policy		No
SADC Green Economy Strategy and action Plan		Yes SADC Protocol already eliminated tariffs on all the environmental goods identified by APEC.
EAC Regional Bioeconomy Strategy	<ul style="list-style-type: none"> • Food security and sustainable agriculture-through use of biobased technologies and 	Yes

¹⁴ ECOWAS Environmental Policy, available at <https://ecowas.int/wp-content/uploads/2022/09/Environmental-policy.pdf>

¹⁵ Southern African Development Community. Green Economy Strategy and Action Plan. July 2015. https://www.sadc.int/sites/default/files/2021-11/SADC_Green_Economy_Strategy_and_Action_Plan-English.pdf

¹⁶ EAC Regional Bioeconomy Strategy, available at <https://bioeconomy.easteco.org/wp-content/uploads/2022/12/EAC-Regional-East-Africa-Bioeconomy-Strategy.pdf>

	<p>solutions to strengthen food and feed production, ensuring food security.</p> <ul style="list-style-type: none"> • Health and well-being- developing a biobased healthcare sector contributing towards a healthy population with improved wellbeing, addressing regional priorities and building on indigenous knowledge and practices. • Bio-based Industrial Development- develop industries that stimulate sustainable economic growth and that add value to under-utilized renewable resources in the region. • Sustainable Energy- increasing the production and use of sustainable bioenergy and developing a range of bioenergy products for both household and industrial purposes. 	<p>Some of the products under consideration include biofuels, microbial products, biopesticides, biofertilizers, indigenous medicine, bio-based cosmetics, biodegradable packing materials, and biobased construction materials.</p>
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As has been shown above, the continental and regional strategies do give, in most instances, broad policy guidelines on environmental goods manufacturing. The section below looks at national strategies on EG manufacturing.

2.3.2 NATIONAL STRATEGIES ON EG MANUFACTURING

At the current stage, national strategies on EG manufacturing in African countries could be grouped into four categories, policies merely related to renewable energy projects, policies on environmental goods, policies on critical minerals, and policies on green hydrogen. **Table 3** below presents an overview of African countries' strategies on environmental goods manufacturing. In total, there are 40 African countries (ten from West African, four Southern Africa, ten East Africa, six Central Africa, six North Africa) have launched or currently are processing the policies to promote local manufacturing and countries took actions regarding the four different categories:

- There are 21 countries that have policies on promoting **renewable energy projects**, mainly focused on tax exemptions on renewable investments, for example, providing tax exemptions on renewable energy project investment and feed-in-tariff for renewable energy facilities.
- Policies advocating the **environmental goods manufacture and trade** taking the lead amid the four categories, with 28 countries using such policies, including tax exemption or reduction on EG products, policies to promote the implementation of electric vehicles, tax incentives on electric vehicles and value chain. For example, Kenya has tax exemptions on renewable energy products including solar and wind generation equipment and clean cooking solutions.¹⁷ Similarly, Madagascar provides tax incentives for investment in the renewable energy sector, exempting solar panels, wind turbines and batteries from value-added tax and import duties.¹⁸ Countries like Egypt and Algeria have policies to promote the implementation on electric vehicles. But among those policies, there are both import tariff and manufacture plus export incentives, causing dynamic but uncertain impacts on local environmental goods manufacturing.

¹⁷ GOGLA. July 2021. "A big win for Kenya: Government reinstates VAT exemption on renewable energy products." <https://www.gogla.org/a-big-win-for-kenya-government-reinstates-vat-exemption-on-renewable-energy-products/>

¹⁸ GET.invest. "Madagascar." <https://www.get-invest.eu/market-information/madagascar/>

- Significantly, as the continent hosts many of the critical minerals’ reserves for green transition, 6 major producers have already launched or plan a **ban on raw minerals exports**. For example, Ghana will soon develop clear guidelines and a fiscal regime for the exploitation of so-called green minerals in a manner that ensures it receives more local benefits from its resources.¹⁹ Countries like Namibia have imposed export restrictions on unprocessed lithium and other critical minerals as it seeks to profit from the growing demand for metals used in clean technology.²⁰
- Finally, a few countries including South Africa, Namibia, Egypt, Morocco have introduced **green hydrogen strategies and incentives**, which will be one of the key trends in the future to combat climate change and achieve net-zero in Africa.

Table 3: Country Environmental Goods Manufacturing Strategies

Region	Policies related to renewable energy projects/facilities			Policies on Environmental Goods			Policies on critical minerals	Policies on green hydrogen
	Tax exemptions on renewable energy projects investment	Feed-in-tariff (FIT) for renewables energy facilities	Only renewable energy goals or climate targets but still processing EGs incentives	Import Tax Reduction or VAT exemptions in EG products ¹⁹	Policy to promote the implementation EVs	Tax incentives on EV value chain manufacturers and import	Critical minerals development plan or export restrictions	Green hydrogen strategy & incentives
Western Africa	Ghana		Guinea	Sierra Leone (2016)		Nigeria	Ghana (export restriction-in progress)	
	Senegal (2020)		Guinea Bissau	Ghana		Cape Verde	DRC (export restriction - 2013)	
	Nigeria		Liberia (tax regime)				Nigeria (export restriction-in progress)	
	Gambia						Gabon (export restriction-in progress)	
	Mali (2014)							

¹⁹ Dontoh, Ekow. August 2023. "Ghana Approves Green Minerals Policies to Develop Lithium Industry." Bloomberg.

²⁰ Reuters. June 2023. "Namibia bans export unprocessed critical minerals."

<https://www.reuters.com/markets/commodities/namibia-bans-export-unprocessed-critical-minerals-2023-06-08/>

	Niger (2017)							
	Cape Verde (2023)							
Southern Africa	South Africa (2023)			Zimbabwe (2022)		South Africa (2023)	Zimbabwe (export restriction - 2022)	South Africa (2023)
				Malawi (2022)			Namibia (export restriction - 2023)	
				Namibia				Namibia
Eastern Africa	Madagascar (2015)			Kenya (2021)		Ethiopia (2022)		Kenya (in progress)
	Rwanda			Rwanda		Rwanda		
	Mauritius			Burundi		Uganda (2023)		
				Mauritius				
				Tanzania				
				Uganda				
Central Africa	Democratic Republic of Congo			Cameroon		Zambia & DRC (in progress)		
	Chad			Chad		Sao Tome		
	Sao Tome					Angola		
Northern Africa	Libya	Egypt		Algeria (2009)	Algeria (2013)	Tunisia (2023)		Egypt (2023)
	Egypt	Algeria (2014)		Egypt	Egypt	Morocco(2017)		Morocco (2017)
	Morocco (2021)			Mauritania (2012)				

It is clear that Africa does have policies that generally environment, climate change and sustainable development at the continental, regional, and national levels. However, these policies are mostly geared toward environmental protection as an aspiration or toward trade on environmental goods. No African country has yet been found to have a holistic environmental goods manufacturing policy. Nevertheless, Africa has great potential for critical minerals and environmental goods manufacturing capacity. The next chapter will explore the opportunities and economic benefits of EG manufacturing on the continent.

CHAPTER 3

ECONOMIC CASE FOR LOCAL MANUFACTURING OF ENVIRONMENTAL GOODS IN AFRICA



CHAPTER SUMMARY

- Africa's potential for green manufacturing, renewable energy development, and environmentally preferable products (EPPs) offers pathways to balance economic growth with sustainability. The continent's underdeveloped manufacturing sector, abundant renewable energy sources, and availability of resources like cobalt position Africa to become a frontrunner in environmental goods production.
- Localized environmental goods manufacturing in Africa presents economic advantages through job creation, research and development (R&D) stimulation, cost savings from reduced imports, and improved supply chain efficiency. It also promotes regional collaboration and technology transfer, propelling Africa toward sustainable prosperity while fostering innovation and self-sufficiency in green technologies.
- Africa has the potential to become a strong center for manufacturing environmental goods, leveraging its natural resources, renewable energy, agriculture, and mineral wealth, with the added benefits of integrated markets and regional collaboration, leading to economic growth, competitiveness, and sustainability, supported by regulations and policies promoting eco-friendly production.

For African countries, the COVID 19 pandemic and scramble for vaccines may be the most recent reference point for the need to invest in local manufacturing on the continent²¹. At a time when only Egypt and South Africa produced vaccines, research estimates that African countries needed to invest at least US\$5 billion to achieve a 20% vaccine coverage²². Estimated vaccine needs or potential demand for them was benchmarked at 60% of a population, with a projected regional demand of about US\$1 billion annually in Africa²³. Yet, vaccines produced in Africa represented 0.1% of global supplies.

Additionally, research indicates that the top 10 African countries with the highest active cases needed to spend as much as US\$485 million to match the World Health Organisation's (WHO) recommended two dose regimens. But, even with funds available to invest in vaccine needs through imports, African countries faced significant delays and challenges acquiring vaccines that were mostly produced outside of the continent. Both from time and cost perspectives, the availability of locally manufactured goods could have addressed market needs by using resources available on the continent.

In the case of environmental goods manufacturing, Africa has an opportunity to maximise its comparative advantages. Some of these are abundant natural resource endowment, production cost-friendly environments supported by investment incentives, and the efficiencies of scale that

²¹ United Nations Africa Renewal article, "The scramble for the COVID-19 vaccine: Africa must act now". 2020. <https://www.un.org/africarenewal/magazine/august-2020/scramble-covid-19-vaccine-africa-must-act-now>

²² Development Reimagined infographic, "COVID19 Vaccine: The Reality of Equal Access and what it means for countries across the continent". 2020-2021. <https://developmentreimagined.com/covid19-vaccine-the-reality-of-equal-access-and-what-it-means-for-countries-across-the-continent/>

²³ The Gavi Alliance research, "Expanding sustainable vaccine manufacturing in Africa: Priorities for Support". 2022. <https://www.gavi.org/sites/default/files/document/2022/Gavi-Expanding-Sustainable-Vaccine-Manufacturing-in-Africa-2022.pdf>

come with operating in the world's largest free trade area- the AfCFTA. According to the IMF data on environmental goods trade, African countries spent US\$525.29 billion importing environmental goods between 1994-2021²⁴. 73% of this foreign exchange was not recovered from environmental goods exports, meaning that Africa's environmental goods trade deficit was about US\$386 billion. From a macroeconomic point of view, the need is clear for more local manufacturing to dilute Africa's current deficit.

By investing in local manufacturing of environmental goods, the proportion of imports each country needs are reduced, freeing up more employment opportunities that may have otherwise been made redundant. To newly employed and trained labour joining Africa's growing environmental goods market, critical skills and knowledge become easily transferrable across Africa's labour market through the AfCFTA. Additionally, a cycle of benefits is created for national governments earning from an expanding income tax base, while the broader African manufacturing sector realises growth in production volumes and potentially, export revenues.

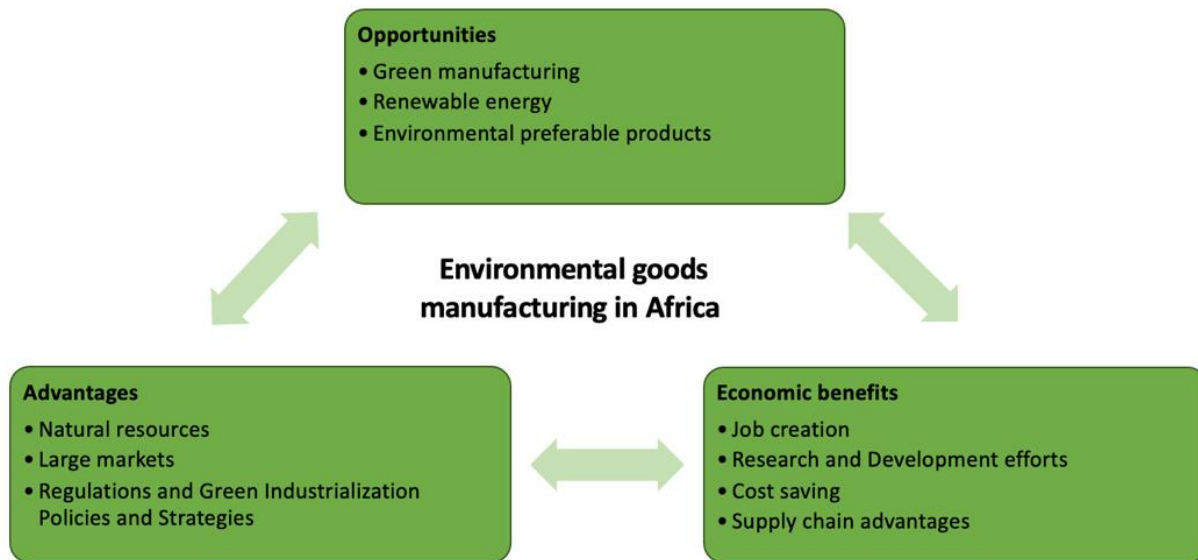
In making a case for local manufacturing of environmental goods, we assess opportunities for Africa from a natural resource perspective, opportunities for investors from an economic perspective, and conclude with an examination of key benefits and challenges African countries and manufacturing sector investors could face.

The economies of African nations face persistent challenges, including population growth and the rising demand for natural resources. Most African countries heavily rely on natural resource-based sectors such as mining, tourism, agriculture, forestry, and fishing. According to a UNCTAD report, 45 African countries are dependent on commodities in their merchandise exports.²⁵ In light of the pressing issue of global warming and the urgent need to combat climate change, it is crucial for Africa to prioritize the balance between economic development and environmental preservation. One key aspect of achieving this balance is through localized environmental goods manufacturing. EG manufacturing in Africa holds significant potential for driving economic growth, job creation, and sustainable development. This chapter delves into the opportunities, economic benefits and advantages associated with EG production in Africa (see **Figure 4** below). It explores how harnessing these opportunities can contribute to Africa's socio-economic advancement and environmental sustainability.

²⁴ International Monetary Fund (IMF) Climate Change Dashboard, "Trade in Environmental Goods". 2023. <https://climatedata.imf.org/pages/bp-indicators#cb1>

²⁵ "Rethinking the foundations of export diversification in Africa: The catalytic role of business and financial services", UNCTAD. 2022.

Figure 4: Three-step analysis of economic case for local manufacturing of environmental goods in Africa



3.1 THE OPPORTUNITIES FOR ENVIRONMENTAL GOODS MANUFACTURING IN AFRICA

The African continent possesses unique characteristics that provide a favorable pathway for pursuing EG manufacturing and positioning itself as a frontrunner in this field. With a relatively underdeveloped manufacturing sector, abundant renewable energy resources, an ample labour force and a fast-expanding domestic market, Africa has the potential to capitalize on several opportunities in this domain. This report identifies green manufacturing, renewable energy development, and environmentally preferable products (EPP) production as the top opportunities for Africa to seize.

3.1.1 GREEN MANUFACTURING

Manufacturing has been one of the leading emitters of greenhouse gases (GHGs). It is estimated that manufacturing accounts for 12% of global GHG emissions.²⁶ Meanwhile, developing manufacturing capacities is a top priority for the African continent (such as AU’s Agenda 2063 which aspires to make Africa the global manufacturing hub by 2063). At the moment, Africa is yet to develop its industries that are heavy GHG emitters. The African manufacturing sector represents only two percent of global Manufacturing Value Added (MVA).²⁷ The underdevelopment of industries presents a unique opportunity for Africa to pursue net-zero manufacturing emissions while unlocking significant economic potential. By embracing green manufacturing principles, Africa can leapfrog more developed nations and establish a sustainable and environmentally friendly industrial base.

²⁶ “Global Emissions”, Center for Climate and Energy Solutions. <https://www.c2es.org/content/international-emissions/#:~:text=by%20Sector%2C%202013-,Notes,72%20percent%20of%20all%20emissions.>

²⁷ United Nations Industrial Development Organization (UNIDO), November 2020. “African industrial competitiveness report: An overview of the manufacturing industry in the region”. https://www.unido.org/sites/default/files/files/2021-02/African%20Industrial%20Competitiveness%20Report_0.pdf

Green manufacturing is the practice of producing goods using processes that have minimal negative impact on the environment. It involves adopting technologies, materials, and processes that aim to reduce energy consumption, minimize waste generation, lower GHGs, and promote the efficient use of resources.²⁸ The development of a circular economy and the production and application of Environmental Production (EP) goods are integral components of green manufacturing.

EP goods encompass a range of products designed to address environmental challenges. They include pollution control equipment, waste treatment and recycling systems, eco-friendly materials, and technologies that enable energy efficiency and resource conservation. These goods play a vital role in mitigating the environmental impact of manufacturing processes and promoting sustainable practices. For instance, Ethiopia is actively pursuing “green industrialization” by establishing eco-industrial parks and implementing green technologies such as zero solid waste management and wastewater treatment and reuse.²⁹ These initiatives contribute to effective waste management within industries, reducing their environmental footprint and promoting a more sustainable manufacturing sector.

Africa's manufacturing sector is poised to experience substantial growth, with expectations of doubling in size over the next 2-3 decades.³⁰ McKinsey's modeling scenarios indicate that by aligning with global Nationally Determined Contributions (NDC) and implementing energy-efficient production processes, Africa could reduce its manufacturing emissions by approximately 25 percent.³¹ This presents a significant opportunity for the continent to mitigate climate change and leapfrog the traditional industrial development path by embracing green manufacturing. This transition to green manufacturing requires collaboration between governments, businesses, and other stakeholders to create enabling policies, provide access to financing and technology, and foster a culture of sustainable innovation.

Renewable energy

Energy production, across various sources, is the largest contributor to GHG emissions, accounting for approximately 72% of total emissions.³² Meanwhile, energy development plays a central role in poverty reduction and economic growth in Africa. According to IEA's estimate, still over five million people in Africa have no access to electricity.³³ Demand for energy is set to grow rapidly with increasing social and manufacturing activities. This highlights the critical need for Africa to transition to renewable energy sources, as doing so can have far-reaching benefits in reducing emissions in all sectors as well as increasing affordability for people and businesses.

Renewable energy development stands as a pivotal pillar driving the global journey towards achieving net-zero emissions. Presently, China spearheads this transition, boasting an impressive installed capacity of 1160 gigawatts (GW) in 2022, constituting roughly one-third of the world's total capacity.³⁴ The European Union (EU) follows closely with 569GW, trailed by the

²⁸ Goodwin University. “What is Green Manufacturing and Why is It Important?”.

<https://www.goodwin.edu/enews/what-is-green-manufacturing/>

²⁹ The Ethiopian Industrial Parks Development Corporation (IPDC).

<https://wedocs.unep.org/bitstream/handle/20.500.11822/33724/ISACE.pdf?sequence=1&isAllowed=y>

³⁰ McKinsey & Company. September 2021. “Africa's green manufacturing cross-roads”.

³¹ McKinsey & Company. September 2021. “Africa's green manufacturing cross-roads”.

³² International Energy Agency. November 2021. “Greenhouse Gas Emissions from Energy Data Explorer”.

<https://www.iea.org/data-and-statistics/data-tools/greenhouse-gas-emissions-from-energy-data-explorer>

³³ International Energy Agency. “Access to electricity”. <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity>

³⁴ International Renewable Energy Agency, 'Renewable Capacity Statistics 2023'.

United States with 351GW, while the number for the African continent is only 58GW in 2022.³⁵ For Africa, a monumental opportunity awaits to harness its abundant renewable energy potential. The continent's solar capacity alone is virtually limitless, estimated at a staggering 10 terawatts (TW). In addition, its resources encompass an abundant hydroelectric potential of 350 GW, wind energy capacity of 110 GW, and geothermal sources totaling 15 GW.³⁶ According to the International Renewable Energy Agency (IRENA), Africa has the potential to achieve a renewable energy capacity of 310 GW by 2030, positioning it as a top producer in renewable energy generation.³⁷

The accessibility and cost-effectiveness of clean energy alternatives in Africa are poised to reshape the continent's energy landscape. By attracting investments and funding into renewable energy sources, Africa can tackle future challenges, including emissions reduction and expanded energy access. The transition to renewable energy not only mitigates environmental impacts but also creates new employment opportunities, fostering economic growth and development across the continent. Africa's renewable energy potential positions it at the forefront of scaling-up renewable energy generation, contributing significantly to a sustainable future on both continental and global levels.

Environmentally preferable products

The production of environmentally preferable products (EPPs) is another significant opportunity Africa could utilize to strike a balance between economic development and sustainability and climate mitigation. EPPs are goods and services that have a reduced impact on the environment throughout their life cycle, from raw material extraction to disposal.³⁸ One notable example is electric vehicles (EVs).

It is widely recognized that electric cars are a preferable alternative to petrol or diesel cars in terms of GHG emissions.³⁹ A study conducted by Transport & Environment revealed that electric cars require fewer raw materials compared to fossil fuel cars.⁴⁰ Furthermore, EVs consistently outperform combustion cars in terms of carbon emissions over their operational lifespan, irrespective of prevailing conditions.⁴¹ This means that EVs have a lower overall carbon footprint and contribute less to climate change when compared to traditional vehicles.

Africa possesses abundant natural resources required for EPP production, particularly in the battery sector. The continent accounts for over 40% of global reserves of cobalt, manganese, and platinum, which are essential minerals for batteries.⁴² By capitalizing on these natural resources and embracing the production and adoption of EPPs like EVs, Africa can make significant strides in reducing its carbon footprint and contributing to global climate goals. This aligns with the

³⁵ International Renewable Energy Agency, 'Renewable Capacity Statistics 2023'.

³⁶ African Development Bank. "Why Africa is the next renewables powerhouse". <https://www.afdb.org/en/news-and-events/why-africa-is-the-next-renewables-powerhouse-18822>

³⁷ International Renewable Energy Agency. January 2019. "Scaling up renewable energy development in Africa".

³⁸ U.S. General Services Administration. <https://www.gsa.gov/climate-action-and-sustainability/buy-green-products-services-and-vehicles/buy-green-products/environmentally-preferable-products#:~:text=%E2%80%9CEnvironmentally%20preferable%E2%80%9D%20means%20products%20or,that%20serve%20the%20same%20purpose.>

³⁹ European Environment Agency. "Electric vehicles: a smart choice for the environment". <https://www.eea.europa.eu/articles/electric-vehicles-a-smart>

⁴⁰ "Electric car batteries need far less raw materials than fossil-fuel cars – study", Transport & Environment. March 2021.

⁴¹ "Insights into Future Mobility", MIT Energy Initiative. 2019. Accessed at <http://energy.mit.edu/insightsintofuturemobility>

⁴² International Energy Agency. "Africa Energy Outlook 2022." <https://www.iea.org/reports/africa-energy-outlook-2022/key-findings>

continent's commitment to sustainable development and can act as a catalyst for economic growth. Moreover, by actively participating in the production and supply chain of EPPs, Africa can tap into emerging markets and create new opportunities for job creation and technological innovation.

3.2 ECONOMIC BENEFITS OF LOCALIZED ENVIRONMENTAL GOODS MANUFACTURING

A comprehensive analysis of the economic case for manufacturing environmental goods in Africa reveals two key benefits. Firstly, it has the potential of fostering sustained economic growth by creating a productive industrial ecosystem that diversifies the economy, fosters innovation, and builds a skilled workforce through job opportunities. Secondly, it could pave the way for ecologically driven innovation that prioritizes sustainability, nature protection, resource efficiency, pollution reduction, and mitigation of climate change impacts. This approach has ripple effects on employment, skill development, innovation, and overall economic resilience. Prioritizing and supporting local manufacturing of environmental goods enables African nations to unlock their economic potential and pave the path towards sustainable prosperity.

Developing and scaling up the local manufacturing of environmental goods in Africa holds immense potential for job creation, reduced import reliance, and leveraging the expanding labour force, thereby unlocking economic opportunities and paving the way for sustainable growth and prosperity. With the possibility of generating earnings of \$666.4 billion by 2030 through the advantages of low labour and raw material costs, improved infrastructure, and regional integration efforts, embracing environmental goods production can catalyze the establishment of a robust industrial ecosystem, diversify economies, and tap into the increasing global demand for eco-friendly products and technologies in resource-rich African nations.⁴³

3.2.1 JOB CREATION

The growing labour force in Africa presents a dual challenge and opportunity for the continent's economic growth, particularly in the context of accommodating the expanding educated population. Local manufacturing of EGs emerges as a viable solution to address unemployment challenges and unlock significant job opportunities across various skill levels. With many large African countries experiencing rapid labour force growth and struggling with high unemployment rates, especially among educated graduates, the need for creating productive jobs becomes paramount. Failing to do so could lead to mass emigration which could have adverse long-term effects on productivity and growth, as seen in countries like South Africa, Nigeria, and Senegal.⁴⁴

Additionally, high unemployment rates are further compounded by import dependence prevalent in many African countries. Reliance on imports often creates an environment where domestic firms struggle to compete and meet local demands, resulting in job displacement and labour market segmentation. This import dependence also limits these countries' capacity to generate new jobs and harness the potential of their expanding labour force, hampering overall economic expansion. Thus, the focus on manufacturing environmental goods locally emerges as a compelling opportunity.

⁴³ Africa Business (2021), Africa's manufacturing sector in 2021, available online at <https://www.africanews.com/2021/02/04/africa-s-manufacturing-sector-in-2021-business-africa/>

⁴⁴ Ichikowitz Family Foundation. (2022). African Youth Survey 2022. Retrieved from <https://ichikowitzfoundation.com/storage/ays/ays2022.pdf>

Developing and scaling up the EG manufacturing sector in Africa would not only reduce dependence on imports, but also create significant employment opportunities throughout the value chain. From raw material extraction to production, assembly, distribution, and after-sales services, the robust green manufacturing sector provides diverse employment opportunities for individuals with varied skill sets. McKinsey estimates that emerging green businesses in Africa have the potential to create six million new jobs by 2050.⁴⁵ This job creation through local manufacturing presents an avenue for poverty alleviation, improved livelihoods, and enhanced social welfare across the continent. By strategically prioritizing localized production of EG, African nations can effectively address unemployment challenges and stimulate sustainable economic growth, ultimately leading to a more prosperous and resilient future.

3.2.2 RESEARCH AND DEVELOPMENT EFFORTS

One of the key advantages of promoting local manufacturing of environmental goods in Africa is the potential to catalyze research and development (R&D) efforts tailored to the region's socio-cultural context. By strategically investing in R&D, African countries can embark on a path of innovation, developing tools, technologies, and products that align with the unique needs, preferences, and cultural norms of local communities.

R&D in local EG manufacturing opens doors for cross-sector collaboration. African countries can foster partnerships between academic institutions, private enterprises, and government agencies to create an innovation ecosystem. These collaborations can lead to knowledge exchange and technology transfer, further fueling the continent's capacity to produce cutting-edge EG solutions that address specific challenges faced by the continent. For instance, in the renewable energy sector, African nations can collaborate with local research institutions and international partners to develop efficient and cost-effective solar panels, wind turbines, and other clean energy solutions tailored to the continent's climate and energy demands.

Besides, universities can play a critical role in conducting research on green materials and sustainable manufacturing processes, while industry partners can leverage these findings to develop eco-friendly products. In the long run, prioritizing R&D in the EG sector enables Africa to reduce its reliance on external imports. By developing self-sustaining manufacturing capabilities, the continent can achieve greater economic autonomy and resilience. For example, African nations can invest in R&D to develop cost-effective water purification technologies that address the continent's water scarcity challenges. These locally produced solutions can not only cater to domestic needs but also present export opportunities to neighboring countries facing similar water challenges.

3.2.3 COST SAVINGS

Local manufacturing in Africa will have significant advantages in terms of lower production costs. Specifically, cost-effective labour, lower logistics costs and proximity to natural resources make locally produced environmental goods more attractive to consumers and businesses in both domestic and international markets.

Firstly, one key aspect contributing to reduced production costs is the potential for lower labour costs in Africa compared to other regions. With a growing labour force and a pool of skilled workers, the continent can tap into cost-effective labour resources. Ethiopia and Kenya have

⁴⁵ McKinsey & Company. September 2021. "Africa's green manufacturing cross-roads".

become appealing manufacturing hubs due to their competitive wages, skilled workforce, and suitability for efficient and affordable production of environmental goods.⁴⁶

Secondly, by establishing a domestic manufacturing base, Africa can avoid transportation costs, customs duties, and other import-related expenses. Reducing dependence on imports of environmental goods not only leads to direct cost savings but also contributes to the reduction of foreign exchange demands, especially considering the fluctuating costs of foreign currencies. This, in turn, strengthens the region's economic stability and resilience.

Thirdly, establishing EG manufacturing locally allows firms to be close to key valuable natural resources needed to produce environmental goods, which would otherwise have been extracted and exported for manufacturing elsewhere. For example, Guinea alone holds nearly a quarter of the world's bauxite reserves. Aluminum extracted from bauxite is one of the most important materials used in the manufacture of solar photovoltaic (PV) devices, accounting for more than 85% of most solar PV components.⁴⁷ By being situated near access points to raw materials, companies can efficiently source inputs, reducing transportation costs and environmental impact associated with long-distance supply chains.

3.2.4 SUPPLY CHAIN ADVANTAGES

Localized environmental goods manufacturing in Africa brings several supply chain benefits. One significant advantage is the potential for regional collaboration and integration under regional economic blocs and the African Continental Free Trade Area (AfCFTA) framework. By fostering regional trade and collaboration, countries can tap into shared resources, expertise, and production capabilities, resulting in improved efficiency and reduced costs. Proximity to raw materials and local suppliers enables shorter supply chains, minimizing logistical challenges and ensuring timely delivery of products. Additionally, localized manufacturing allows for greater control over quality standards and customization to meet local preferences and regulatory requirements. This flexibility in supply chain management enhances the competitiveness and responsiveness of African manufacturers in meeting market demands. Furthermore, by reducing the reliance on international supply chains, Africa can enhance its resilience to global disruptions and achieve greater self-sufficiency. Specifically, now considering the costs of foreign exchange, investing in local manufacturing will bring with it a time-saving factor-turnaround time between making an order, international and foreign currency transactions being processed and receiving the ordered goods.

In conclusion, localized EG manufacturing in Africa offers substantial economic benefits. Job creation, R&D efforts, cost savings and supply chain advantages contribute to the continent's sustainable development and economic growth. By embracing and supporting this sector, Africa can foster inclusive economic development, promote innovation, and enhance its resilience in the face of global climate challenges.

3.3 EXAMINATION OF ADVANTAGES OF LOCAL MANUFACTURING IN AFRICA

African nations benefit from a confluence of advantageous conditions which makes them ideal manufacturing hubs. Abundant access to raw materials, a competitive labour market boasting

⁴⁶ Gelb, A., Meyer, C. J., Ramachandran, V., & Wadhwa, D. (2017). Can Africa Be a Manufacturing Destination? Labor Costs in Comparative Perspective (Working Paper No. 466). Center for Global Development (CGD). Retrieved from <https://www.cgdev.org/sites/default/files/can-africa-be-manufacturing-destination-labor.pdf>

⁴⁷ Mo Ibrahim Foundation. "Africa's critical minerals: Africa at the heart of a low-carbon future." <https://mo.ibrahim.foundation/sites/default/files/2022-11/minerals-resource-governance.pdf>

lower costs, a reservoir of highly skilled engineers, and continual advancements in export tax infrastructure all contribute to their favorable position. The region's growing dedication to green industrialization policies, complemented by technological progress, plays a pivotal role in reducing manufacturing expenses. Additionally, their strategically advantageous geographical location facilitates tapping into diverse markets and maintaining proximity to other continents, further augmenting their potential as thriving production centers. Below are some of the factors that make EG manufacturing in Africa advantageous.

3.3.1 NATURAL RESOURCES

The abundance of natural resources across countries in Africa presents a significant advantage for local manufacturing of environmental goods and services on both country-wide and continental scales. Leveraging these resources can foster economic growth, create job opportunities, and contribute to sustainable development.

Renewable Energy

Africa's renewable energy resources are diverse, unevenly distributed, and enormous in quantity — almost unlimited solar potential (10 TW), abundant hydro (350 GW), wind (110 GW) and geothermal energy sources (15 GW).⁴⁸ The continent also has great potential for utilizing renewable energy. Specially, on average, African countries use 40.5 percent of their electricity generated from renewable sources, which is higher than a global average of 34.1 percent and an EU average of 39.1 percent.⁴⁹ Thus, countries can harness their natural resources to produce clean and sustainable energy solutions by establishing local manufacturing facilities for solar panels, wind turbines, and hydroelectric equipment.

Agriculture and Biomass

African nations have vast agricultural resources and biomass materials. Local manufacturing of biodegradable packaging materials, organic fertilizers, and agro-based biofuels can help address environmental challenges and promote sustainable agricultural practices. Countries like Kenya have seen the emergence of companies such as Hyapak producing biodegradable packaging materials made from agricultural waste, reducing plastic pollution and promoting eco-friendly packaging alternatives.^{50,51}

Mineral Wealth

African countries are rich in minerals, including rare earth elements needed for the production of clean energy technologies and electronics. According to research by the Brookings Institute, due to natural resource wealth in Africa, much of the region's industrial production remains centered

⁴⁸ Carmona, Cesar. "Atlas of Africa - Energy Resources." <https://aquaknow.jrc.ec.europa.eu/en/wefe-nexus/documents/atlas-africa-energy-resources>

⁴⁹ Chandler, Ben. "Renewable Energy in Africa." Mo Ibrahim Foundation. [https://mo.ibrahim.foundation/research-spotlight-renewable-energy-africa#:~:text=As%20it%20stands%2C%20zero%2Dcarbon,40.5%25%20of%20their%20electricity%20generation.&xt=the%20UK%20\(37.9%25\)%2C%20Japan,and%20the%20US%20\(17.9%25\).](https://mo.ibrahim.foundation/research-spotlight-renewable-energy-africa#:~:text=As%20it%20stands%2C%20zero%2Dcarbon,40.5%25%20of%20their%20electricity%20generation.&xt=the%20UK%20(37.9%25)%2C%20Japan,and%20the%20US%20(17.9%25).)

⁵⁰ Hyapak. (n.d.). About Us. Retrieved [31st July 2023], from <https://hyapak.com/about-us/>

⁵¹ F6S. (n.d.). Sustainability Companies in Kenya. Retrieved July 31, 2023, from <https://www.f6s.com/companies/sustainability/kenya/co>

on resource-based manufacturing⁵² which accounts for approximately half of total MVA and manufacturing exports.⁵³ Moreover, according to UNEP, Africa is home to some 30 percent of the world’s mineral reserves, eight percent of the world’s natural gas and 12 percent of the world’s oil reserves. The continent has 40 percent of the world’s gold and up to 90 percent of its chromium and platinum. The largest reserves of cobalt, diamonds, platinum, and uranium in the world are in Africa. It holds 65 per cent of the world’s arable land and ten percent of the planet’s internal renewable fresh water source.⁵⁴ Some of the minerals are essential for the implementation of clean technologies and the establishment of energy security. For instance, electric batteries require lithium, nickel, cobalt, manganese and graphite, magnets are essential for wind turbines, electric vehicle motors require rare earth elements (REE), and electricity networks rely on a significantly on copper and aluminum.⁵⁵

From 2017 to 2021, 20 Africa countries produced identified minerals critical for the green transition (see Table 4) - with the leading producers including South Africa, Gabon, Ghana, and DRC (see Figure 5).

Table 4: Identified critical minerals and its scenario in the environment goods manufacturing.

Critical Minerals	Use for Products
Lithium	Battery
Nickel	Battery, wind turbines and EV motors
Cobalt	Battery
Manganese	Battery
Graphite	Battery
Rare earth elements	Wind turbines and EV motors
Copper	Wind turbines and EV motors, power lines
Aluminum	Power lines

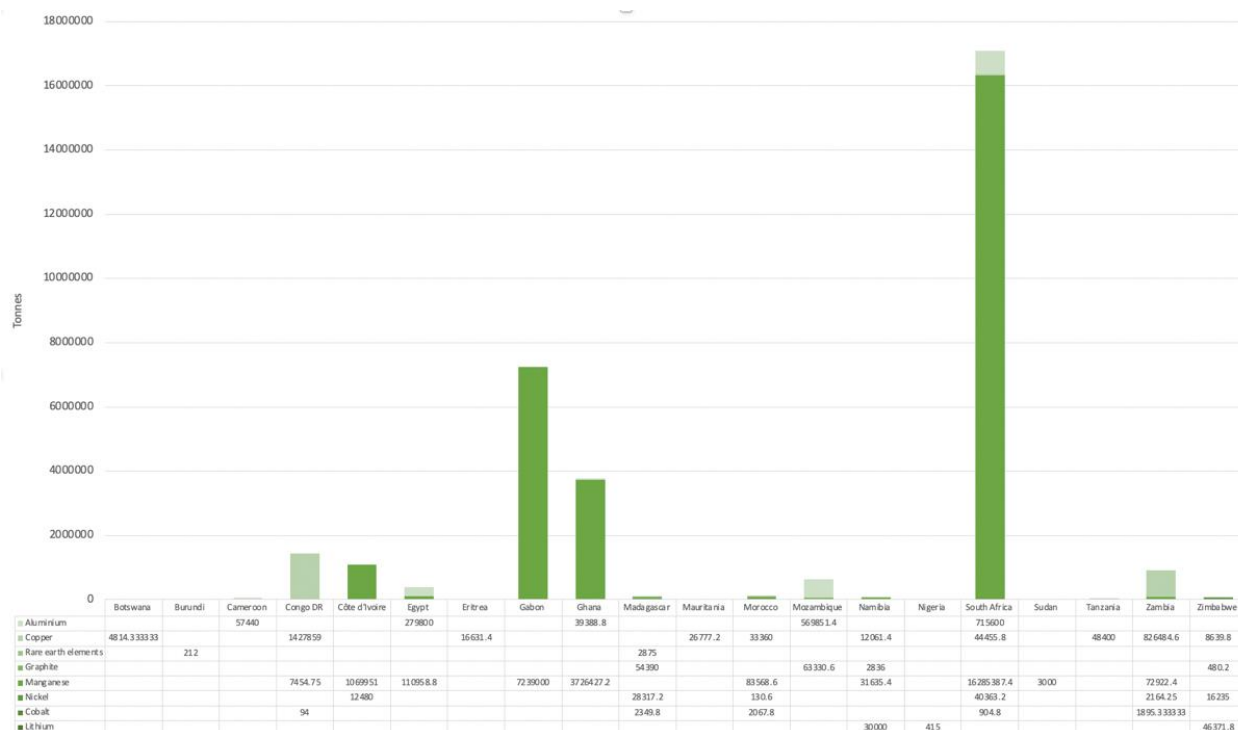
⁵² Signé, L. September 2018. "The potential of manufacturing and industrialization in Africa Trends, opportunities, and strategies." Brookings Institute. <https://www.brookings.edu/wp-content/uploads/2018/09/Manufacturing-and-Industrialization-in-Africa-Signe-20180921.pdf>

⁵³ Ibid.

⁵⁴ <https://www.unep.org/regions/africa/our-work-africa>

⁵⁵ Energy Capital and Power(2023), Five Critical Mineral Producers in Africa, available online at <https://energycapitalpower.com/five-critical-mineral-producers-in-africa/>

Figure 5: Critical Minerals Average Productions by Country (2017-2021)⁵⁶



As a result, African countries can add value to their mineral resources and stimulate economic growth by establishing local manufacturing facilities for green technologies like electric vehicles and renewable energy storage systems. For instance, The Democratic Republic of Congo's abundant cobalt reserves are attracting the attention of investors interested in establishing local battery manufacturing for electric vehicles, aligning with the government's objective to enhance domestic battery production capacity and increase the value of mineral exports, including cobalt and copper^{57, 58}.

3.3.2 LARGE MARKETS

The African Continental Free Trade Area (AfCFTA), launched in 2018, seeks to expand Africa's market and also deepen intra-African trade by eliminating tariffs on goods and services, to liberalizing the markets and removing barriers to capital, investment and labour.⁵⁹ The AfCFTA is the world's largest free trade area bringing together the 55 countries of the African Union (AU) and eight Regional Economic Communities (RECs). The overall mandate of the AfCFTA is to create a single continental market with a population of about 1.3 billion people and a combined

⁵⁶ Source: British Geological Survey-Critical Mineral Production (2017-2021)

⁵⁷ Sinyangwe, C. (August, 2022). "Zambia seeks Western financiers for EV battery project with DRC." The Africa Report. Retrieved from <https://www.theafricareport.com/234753/zambia-seeks-western-financiers-for-ev-battery-project-with-drc/>

⁵⁸ UN Economic Commission for Africa (ECA) - Sub-Regional Office for Central Africa (ECA-SRO-CA). (April 29, 2022). Zambia and DRC Sign Cooperation Agreement to Manufacture Electric Batteries. Retrieved from <https://www.uneca.org/stories/zambia-and-drc-sign-cooperation-agreement-to-manufacture-electric-batteries>

⁵⁹ Thomas D, (2023). "What you need to know about the African Continental Free Trade Area." <https://african.business/2022/05/trade-investment/what-you-need-to-know-about-the-african-continental-free-trade-area>

GDP of approximately US\$ 3.4 trillion.⁶⁰ The following are some of the key factors that illustrate how an integrated African market can bring advantages to local manufacturing of environmental goods.

Increasing demands for EG: Environmental concerns are driving global demand for a wide range of Environmental Goods and Services (EGS). Green consumption is growing rapidly in Africa too, but with greater expansion in emerging countries, such as South Africa and Nigeria. Also, the emergence of the middle class is likely to be a major turning point in the expansion of green consumption in the region as this could increase the demand for EG in Africa as consumer preferences shift to EG.⁶¹

Promoting cross-border trade: One of the key advantages of local manufacturing of environmental goods and services in Africa is the opportunity to tap into integrated markets. The continent's growing economic integration, exemplified by initiatives such as the AfCFTA, offers significant prospects for businesses engaged in local production. For example, by manufacturing environmental products locally, these firms can capitalize on the potential for increased intraregional cross-border trade, enabling the firms to access a wider customer base.

Shared resources and expertise: Integrated markets foster regional cooperation, allowing countries to leverage shared resources and expertise. By collaborating with neighboring countries, African manufacturers can pool resources, share best practices, and access specialized skills. For example, countries with abundant renewable energy resources can supply clean energy solutions to neighboring nations lacking such resources, promoting energy access and sustainability on a regional level.

Enhancing supply chain efficiency: Local manufacturing can enhance supply chain efficiency within integrated markets. By establishing production facilities closer to target markets, businesses can reduce transportation costs, minimize logistical challenges, and ensure timely delivery of goods. This proximity to customers enables manufacturers to respond quickly to market demands and customize products to meet specific regional requirements, strengthening their competitive advantage.

Economic diversification: Local manufacturing of environmental goods contributes to economic diversification within integrated markets. As countries shift from a reliance on raw material exports to value-added manufacturing, they can reduce their vulnerability to commodity price fluctuations and foster resilient and diversified economies. This economic diversification enhances Africa's ability to weather external shocks and achieve sustained economic growth.

By participating in integrated markets, African manufacturers can become more competitive globally. Access to a larger market allows companies to achieve economies of scale, reduce per-unit production costs, and improve their export potential. As a result, locally produced environmental goods can gain a stronger foothold in international markets, promoting African exports and enhancing the region's economic competitiveness.

3.3.3 REGULATIONS AND GREEN INDUSTRIALIZATION POLICIES AND STRATEGIES

A green industrial policy is “any government measure aimed to accelerate the structural transformation towards a low-carbon and resource-efficient economy in ways that also enable

⁶⁰ AU, AfCFTA. <https://au-afcfta.org/about/>

⁶¹ Traoré, L., Belinga, B., & Lescuyer, G. (2023). A Systematic Review of the Scope and Patterns of Green Consumption in Sub-Saharan Africa. *Sustainability*, 15(8), 6343. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/su15086343>

productivity enhancements in the economy”.⁶² Green policies and strategies at the International, regional and national levels will be catalysts for accelerating the manufacturing of EGs in Africa. For example, African countries are part of UNEPs the 10-Year Framework of Programmes on Sustainable Consumption and Production (10YFP) adopted in 2012 and which is a global commitment to accelerate the shift towards sustainable consumption and production in both developed and developing countries.⁶³ The Glasgow Breakthrough Agenda launched at the UN climate change negotiations in 2021, which seeks “to make clean technologies and sustainable solutions the most affordable, accessible and attractive option in each emitting sector globally before 2030”.⁶⁴

3.4 ENVIRONMENTAL GOODS MANUFACTURING CHALLENGES

While local manufacturing of environmental goods presents opportunities, there are also risks and challenges that need to be addressed. One key risk is the political will and the overall political environment, which plays a central role in the economic landscape. It is crucial to have a supportive policy environment, including favorable regulations, incentives, and stable governance, to foster the growth of the manufacturing sector. Political stability and consistency in policies are essential to attract investments and provide an enabling environment for sustainable development.

Lacking institutional framework and inadequate financial capabilities also leads to a “natural resource dilemma”. Research has shown that grabber-friendly institutions will only cause an impediment to growth while resource wealth tends to foster sustainable development under producer-friendly institutions.⁶⁵ As critical minerals have become the most spotted natural resources field, there have been also extra risks from investing in these sectors if the government and the foreign investors only focus on business benefits but ignoring the impacts on the local communities.⁶⁶ Take mining as an example, Mozambique’s Cabo Delgado region is suffering from violence partly driven by grievances over the development of mineral resources.⁶⁷ In early 2022 in Cameroon, hundred civilians took to the streets protesting the recent deal signed between the Chinese investor and the local government for iron ore to be exported as the interests of the host community are not well spelled out in the agreement.⁶⁸

Moreover, addressing structural constraints is vital for overcoming challenges in local manufacturing. These constraints can include inadequate infrastructure, limited access to financing, skill gaps in the labour market, and lack of technological capabilities. By recognizing and addressing these constraints, African countries can create an environment that supports local manufacturing initiatives and maximizes their transformative potential.

By leveraging its unique advantages, including its abundant natural resources, diverse ecosystems, and a growing market, Africa can establish a thriving environmental goods

⁶² Tony Blair Institute (2021). “Maximising the Green Path to Industrialisation in Africa.”

<https://www.institute.global/insights/climate-and-energy/maximising-green-path-industrialisation-africa>

⁶³ UNEP. “10 Year Framework of Programmes on Sustainable Consumption and Production Patterns.”

<https://www.unep.org/explore-topics/resource-efficiency/what-we-do/one-planet-network/10yfp-10-year-framework-programmes>

⁶⁴ UN Climate Change Conference 2021. “COP26 World Leaders Summit: Statement on the Breakthrough Agenda.”

<https://climatechampions.unfccc.int/cop26-world-leaders-summit-statement-on-the-breakthrough-agenda/>

⁶⁵ Elvis D. Achuo, Resource wealth and the development dilemma in Africa: The role of policy syndromes, Resources Policy, <https://doi.org/10.1016/j.resourpol.2023.103644>.

⁶⁶ <https://frontpageafricaonline.com/opinion/commentary/poor-in-the-midst-of-plenty-the-natural-resource-dilemma-in-west-africa/>

⁶⁷ <https://www.usip.org/publications/2023/06/challenging-chinas-grip-critical-minerals-can-be-boon-africas-future>

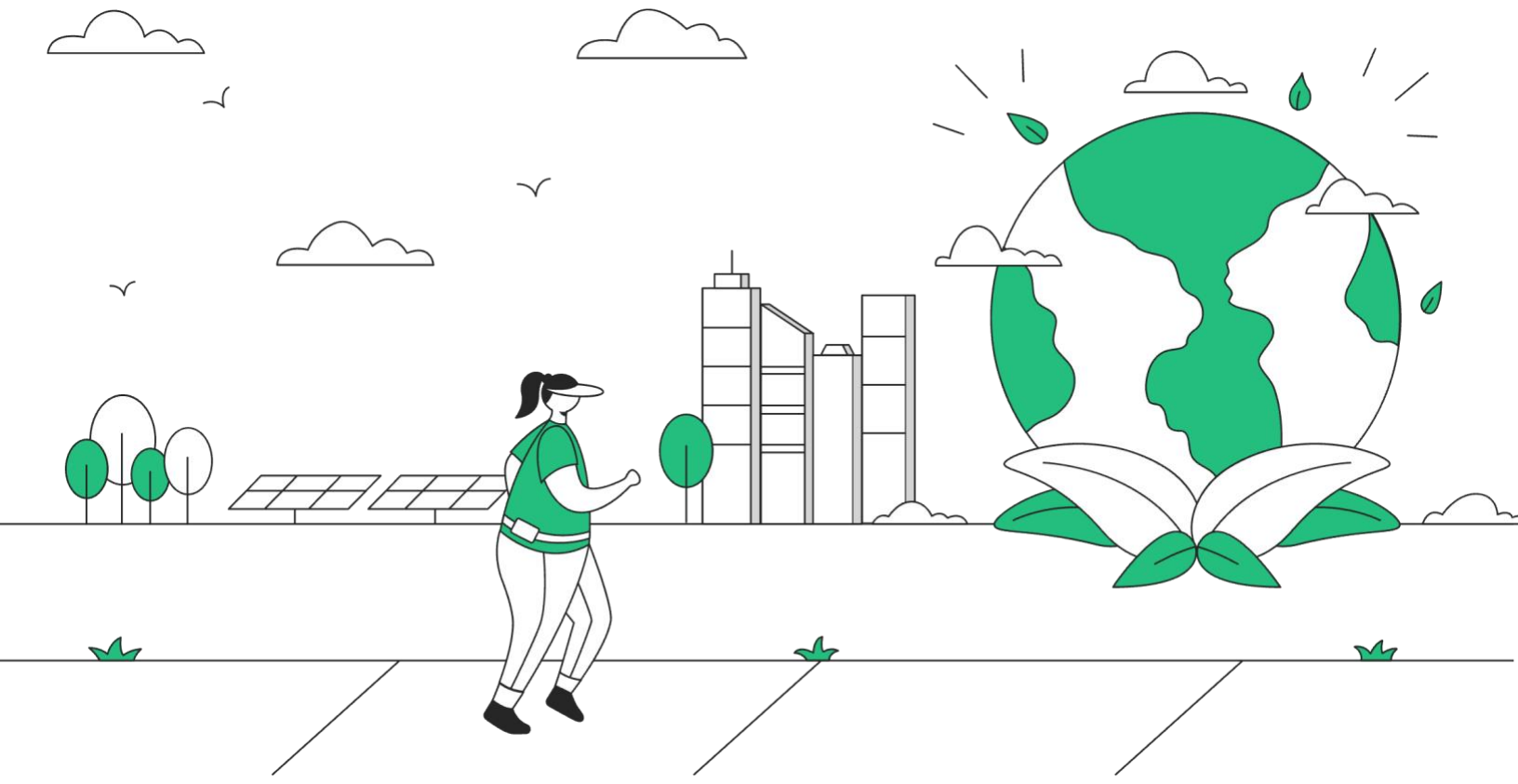
⁶⁸ <https://www.voanews.com/a/cameroonian-villagers-protest-china-iron-ore-mining-deal-/6585546.html>

manufacturing sector. This sector will not only address local environmental challenges but also presents opportunities for export and participation in the global green economy. Furthermore, localizing the production of environmental goods in Africa can lead to cost savings, supply chain advantages, increased intra-continental market access, as well as innovation and technology transfer.

Overall, environmental goods manufacturing in Africa is a catalyst for transformative change. It aligns well with the continent's goals of achieving sustainable development, preserving its natural resources, and combating climate change. By seizing these opportunities and maximizing the economic benefits, Africa can position itself as a leader in environmental goods production, contributing to both its own prosperity and the global efforts towards a more sustainable future.

CHAPTER 4

DETERMINING KEY REGIONAL HUBS FOR ENVIRONMENTAL GOODS MANUFACTURING



CHAPTER SUMMARY

- After identifying 20 base countries based on their export capacity, which are then assessed using 11 criteria with a weighted scoring framework to select the top two countries from each five regions, resulting in a list of 10 countries with the potential for environmental goods manufacturing in Africa.
- For Eastern Africa, Kenya and Tanzania are identified as regional hubs with high potential for EG manufacturing due to their renewable energy and critical mineral potentials. Also, both countries boast well-established manufacturing sectors and enjoy robust trade and investment ties with China, further enhancing their regional influence.
- For Western Africa, Ghana and Nigeria are highlighted as regional hubs for EG manufacturing. Ghana's rich mineral resources and local content initiatives position it as an attractive manufacturing hub, while Nigeria's abundant natural resources and renewable energy potential present promising opportunities for growth.
- For Southern Africa, South Africa and Zambia stand out. South Africa's leadership in critical minerals such as copper, nickel, and cobalt, along with its strategic position in the global value chain, positions it as a promising hub for environmental goods manufacturing. Similarly, Zambia emerges as a contender due to its rich reserves of critical minerals like copper and its efforts to attract green investment.
- For Northern Africa, Egypt and Morocco emerge as leaders in critical mineral production, with robust renewable energy potential. Additionally, they excel in environmental goods exports to China and attracting Chinese FDI, making them regional hubs.
- For Central Africa, Angola and the Congo Republic stand out as prospective regional hubs due to their strategic locations and commitment to environmental goals. Despite their heavy reliance on oil resources, both nations are proactively seeking economic diversification and endorsing eco-friendly technologies as part of their sustainability endeavors.

4.1 DATA AND METHODOLOGY

We make an investment case for manufacturing of environmental goods on the African continent by analyzing 12 key criteria, including Environmental good exports, Gross domestic product, Manufacturing sector's contribution to GDP, Energy interconnectivity and transmission, Renewable energy potential, Number of critical minerals produced, Volume of critical mineral production, Environment goods exported to China, Labour force participation, Logistic performance index, National determined contributions, and Foreign direct investment from China.

We have adopted a three-step framework to analyze the above criteria and to get the list of regional hubs with the greatest potential for environmental goods manufacturing in Africa.

Step 1:

- Use “Environmental Good Export” to get the base 20 African countries

Step 2:

- Using remaining 11 criteria to get top two African countries from each of five regions by applying a weighted scoring framework

Step 3:

- A supplementary, national-level analysis looking at comparative advantages, challenges and opportunities

First, we use “Environmental good export” to filter countries down from a continental assessment to a group of 20 countries (see Figure 6).

Figure 6: Base 20 African countries



Then, using the remaining 11 criteria, we develop a weighted scoring framework to rank the base 20 African countries mentioned above according to the five regional economic communities (REC). We selected the top two countries from each region as the manufacturing hubs of focus in our report. (see Annex for the detailed methodology and scoring system).

Finally, at a regional level, we make a supplementary, national-level analysis that includes and compares comparative advantages, challenges and opportunities countries have in the context of current and potential environmental good manufacturing.

By maintaining a focus on regional hubs, our assessment moulds the investment framework for strategic partnerships to be developed within and across Africa’s RECs. For stakeholders with a goal of manufacturing environmental goods on the continent, this becomes an investment model that incorporates the advantages of operating in the world’s largest free trade area, the African Continental Free Trade Area (AfCFTA).

4.2 REGIONAL ANALYSIS

4.2.1 EASTERN AFRICA

Overview

Country	Avg. Manufacturing Sector Value Added (2017-2021, % GDP)	Labor force participation (% of total population ages 15+)	Logistic performance (LPI 2023)	Total Renewable Energy Capacity (MW) 2022	Critical mineral production (2017-2021)	Total EG Trade with China (2021, USD)	Avg. Chinese FDI in the country (2017-2021) in million USD
Comoros		44.16		5	-		0.17
Djibouti	3.64	31.39	2.7	20	-	136,964,950.00	11.322
Eritrea		77.60		12	16,631.40	9,249,118.00	17.556
Ethiopia	5.50	80.58		5589	-	170,253,663.00	223.608
Kenya	7.98	74.36		2659	-	447,796,673.00	326.07
Madagascar	9.59	85.90	2.3	197	87,932.00	69,249,424.00	50.5993
Mauritius	11.23	58.54	2.5	271	-	55,762,421.00	136.34
Rwanda	8.32	54.90	2.8	151	-	16,258,052.00	20.38
Seychelles	5.24			24	-	5,558,898.00	91.474

Somalia		33.97	2	51	-	40,307,696.00	
South Sudan		70.93		14	-		3.164
Sudan		48.76	2.4	1871	3,000.00	146,064,299.00	67.6659
Tanzania	8.20	82.60		677	48,400.00	414,867,101.00	126.964
Uganda	15.80	69.75		1222	-	84,032,267.00	109.588

The above data highlights the strong potential of the Eastern African region for environmental goods manufacturing. While it may not boast the highest endowment of critical minerals compared to other regions, Eastern Africa showcases a robust manufacturing base, huge renewable energy potential and strong trade and investment relations with China, which provide a solid foundation for the region to further expand its production capabilities and venture into the environmental goods sector.

One of the region's most significant strengths lies in its abundant renewable energy resources, particularly in Ethiopia, Kenya, Sudan and Uganda. The presence of ample solar, wind, and hydroelectric power opens up a wealth of opportunities for harnessing clean energy to power the manufacturing of environmental goods and the transition to zero emission. This renewable energy advantage positions Eastern Africa as a sustainable manufacturing hub.

Moreover, Eastern Africa has become an attractive destination for Chinese investment, with countries like Kenya, Ethiopia, Mauritius, Tanzania, and Uganda receiving substantial investments, averaging over US\$100 million between 2017 to 2021.⁶⁹ This signifies the region's attractiveness to Chinese investors seeking to expand their presence in the African market. Furthermore, the active engagement of Eastern African countries in trade with China offers a significant advantage for the region's environmental goods sector. Strengthening trade partnerships with China can facilitate technology transfer, access to an enormous market, and expertise, propelling the growth and development of the environmental goods manufacturing industry in Eastern Africa.

Besides, the region's commitment to addressing environmental challenges is evident through the implementation of policies and initiatives aimed at promoting a clean and sustainable transition. All Eastern African countries have submitted Nationally Determined Contribution (NDC) under the Paris Agreement, and most of them have introduced strategies and action plans for climate change. These efforts demonstrate Eastern Africa's proactive approach to embracing green technologies and contributing to the global fight against climate change.

⁶⁹ Ministry of Commerce, PRC, The Statistical Bulletin of China's Outward Foreign Direct Investment 2018-2022.

Regional hubs

Based on the scoring system introduced in 4.1, this report identifies 2 regional hubs for environmental goods manufacturing in East Africa - Kenya and Tanzania.



4.2.2 KENYA

Kenya has demonstrated a strong commitment to addressing climate change and promoting sustainable development through its national climate policies. The national blueprint Vision 2030 has taken on a bold green growth initiative that aims to achieve 100 per cent renewable energy by 2030.⁷⁰ As part of this green initiative, Kenya is actively promoting green manufacturing to reduce its carbon footprint and enhance environmental sustainability. The National Climate Change Action Plan (NCCAP) for 2018-2022 outlines comprehensive strategies for both adaptation and mitigation.⁷¹ In terms of mitigation, the country aims to reduce greenhouse gas emissions through the development of renewable energy sources, energy efficiency, and clean cooking technologies, for which environmental goods come into play.

Kenya is abundantly blessed with a rich array of natural endowment and favorable conditions that provide a strong foundation for the development of environmental goods manufacturing. One of the key advantages lies in its vast renewable energy potential, with ample sources of solar, wind, hydro and especially geothermal power spread across the country. These renewable resources not only are key to develop renewable energy as environmental goods but also offer an ideal

⁷⁰ The Standard Kenya, "President William Ruto sets ambitious goal for Kenya to go fully green by 2030". Accessed on <https://www.standardmedia.co.ke/article/2001467452/kenya-to-move-to-green-energy-by-2030-says-ruto>

⁷¹ Ministry of Environmental and Forestry, Republic of Kenya, National Climate Change Action Plan 2018-2022 (NCCAP).

opportunity to drive sustainable manufacturing processes that are not only eco-friendly but also cost-effective in the long run.

The country's strategic location and well-developed infrastructure also present a logistical advantage for EG manufacturing. Kenya serves as a major transportation hub in East Africa, offering easy access to regional and international markets. Its well-established ports, roads, and airports provide efficient channels for the import of raw materials and export of finished environmental goods.

Natural endowment

Kenya stands as a beacon of renewable energy potential in Africa, with significant achievements in the last decade. The country's installed capacity of renewable energy has witnessed remarkable growth, surging from 1096MW in 2013 to an impressive 2659MW in 2022.⁷² Kenya, as the largest geothermal energy producer on the continent, harnesses its volcanic geology to lead in clean energy, and with the largest wind farm in Africa, it showcases its commitment to sustainable power generation from diverse renewable resources (see **Table 5**).⁷³ Presently, more than 80% of Kenya's electricity is generated from renewable sources, including hydro, wind, solar, bioenergy, and geothermal power (see **Figure 7** below). Striding towards a greener future, Kenya is set to achieve a remarkable milestone of a 100% clean energy transition by 2030.

Table 5: Kenya's renewable energy structure (2022)^{74 75}

Source of energy	Current capacity (MW)	Potential (MW)
Hydropower	868	3,000
Wind	436	/
Solar	307	15,000
Bioenergy	99	/
Geothermal	949	7,000 - 10,000 MW
Total	2,659	/

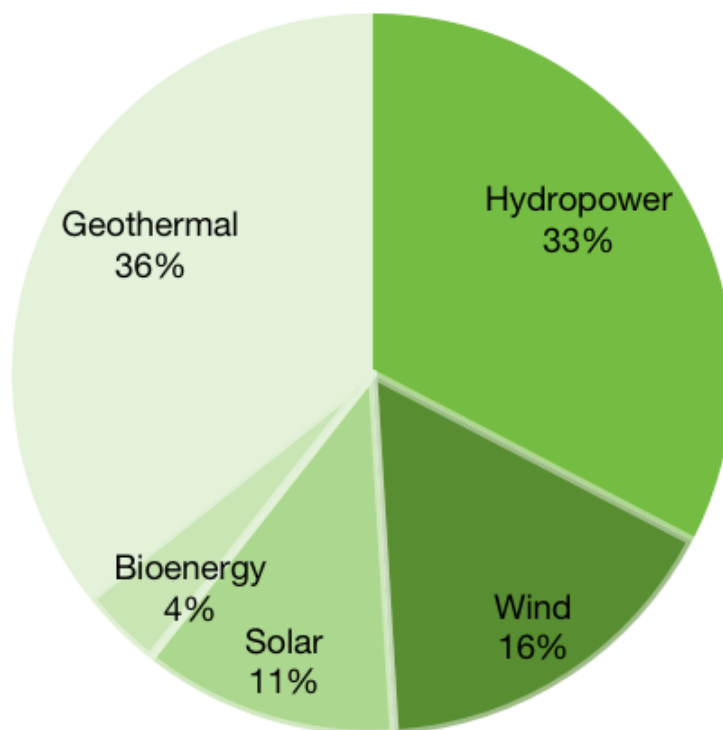
⁷² IRENA, Renewable Energy Capacity Statistics 2023.

⁷³ World Economic Forum, "The largest wind power plant in Africa has opened in Kenya", July 26, 2019. <https://www.weforum.org/agenda/2019/07/wind-power-project-opens-in-kenya/>

⁷⁴ IRENA, Renewable Energy Capacity Statistics 2023.

⁷⁵ Energy & Petroleum Regulatory Authority, Republic of Kenya. <https://renewableenergy.go.ke/>

Figure 7: Kenya's installed renewable energy distribution (2022)



Despite the significant progress in renewable energy adoption, Kenya's vast potential in this domain remains relatively untapped. According to Kenya's Energy & Petroleum Regulatory Authority, the country's untapped hydro potential is estimated at 3,000 MW, with geothermal resources ranging between 7,000 MW to 10,000 MW, and solar potential standing at an impressive 15,000 MW.⁷⁶ This abundance of renewable energy resources presents a golden opportunity for Kenya to further enhance its clean energy capacity and achieve its clean commitment by Vision 2030. But unlocking the full potential of these resources requires the development of local manufacturing capabilities for environmental goods including solar panels, wind turbines, and parts for hydro and geothermal development.

Manufacturing capacity

Kenya has a large manufacturing sector serving both the local and the Eastern African markets. In 2007, the sector contributed approximately 13% of the Gross Domestic Product (GDP).⁷⁷ However, in recent years, the sector has faced challenges, leading to a decline in its contribution to the GDP. One of the key factors behind this decline is the influx of cheap imported goods, which has led to increased competition for local manufacturers.⁷⁸

To achieve long-term sustainable development, it is imperative for Kenya to bolster its manufacturing capacity. By focusing on enhancing the manufacturing sector, Kenya can create more job opportunities, reduce its reliance on imports, build robust supply chains, and add greater value to its products. This, in turn, will bolster its export competitiveness and foster economic

⁷⁶ Energy & Petroleum Regulatory Authority, Republic of Kenya. <https://renewableenergy.go.ke/>

⁷⁷ The World Bank Database, "Manufacturing, value added (% of GDP) - Kenya"

⁷⁸ PwC Kenya, "Industrial manufacturing". <https://www.pwc.com/ke/en/industries/industrial-manufacturing.html>

diversification. Recognizing the significance of promoting the manufacturing sector, the Kenyan government has identified it as one of the four main areas of focus in its economic agenda.⁷⁹ To support local industries, the government has implemented policies and incentives, including the establishment of industrial parks and offering tax incentives to manufacturers.⁸⁰

Moreover, Kenya's strategic location within the East African region positions it ideally to serve as a manufacturing hub for the Eastern African markets. Leveraging its connectivity and proximity to neighboring countries, Kenya can attract foreign direct investment (FDI) and augment its export capacity to cater to the broader African market through regional economic blocs such as COMESA, EAC, and AfCFTA. The demand for environmental goods in the region is substantial, and Kenya is well-suited to capitalize the regional and international markets. With its abundant renewable energy potential and commitment to sustainable development, Kenya has a unique opportunity to lead in the production of environmental goods, such as solar panels, wind turbines, and other eco-friendly products.

Trade and investment relations with China

Notably, Kenya stands as one of the top destinations for Chinese FDI in Eastern Africa, with an average of US\$326.07 million attracted between 2017 and 2021 (see Figure 8).⁸¹ Additionally, Kenya boasts the highest environmental goods trade with China in the region. In 2021, as shown in Figure 9 below, the trade in environmental goods between Kenya and China amounted to US\$447.8 million, making it the highest in Eastern Africa and the 7th highest in the entire African continent.⁸² This strong trade and investment relationship presents a prime opportunity for Kenya to capitalize on its strengths and attract Chinese investment to further develop its environmental goods manufacturing sector, reinforcing economic ties with China and fostering sustainable development for the nation.

⁷⁹ The Kenyan government, "The Big 4 Agenda".

⁸⁰ KenInvest, "Special Economic Zones". <https://www.invest.go.ke/special-economic-zones/>

⁸¹ Ministry of Commerce, PRC, "The Statistical Bulletin of China's Outward Foreign Direct Investment 2018-2022".

⁸² IMF climate change dashboard: Bilateral Trade in Environmental Goods.

Figure 8: Chinese FDI flow to Kenya (2012-2021 in USD million)⁸³

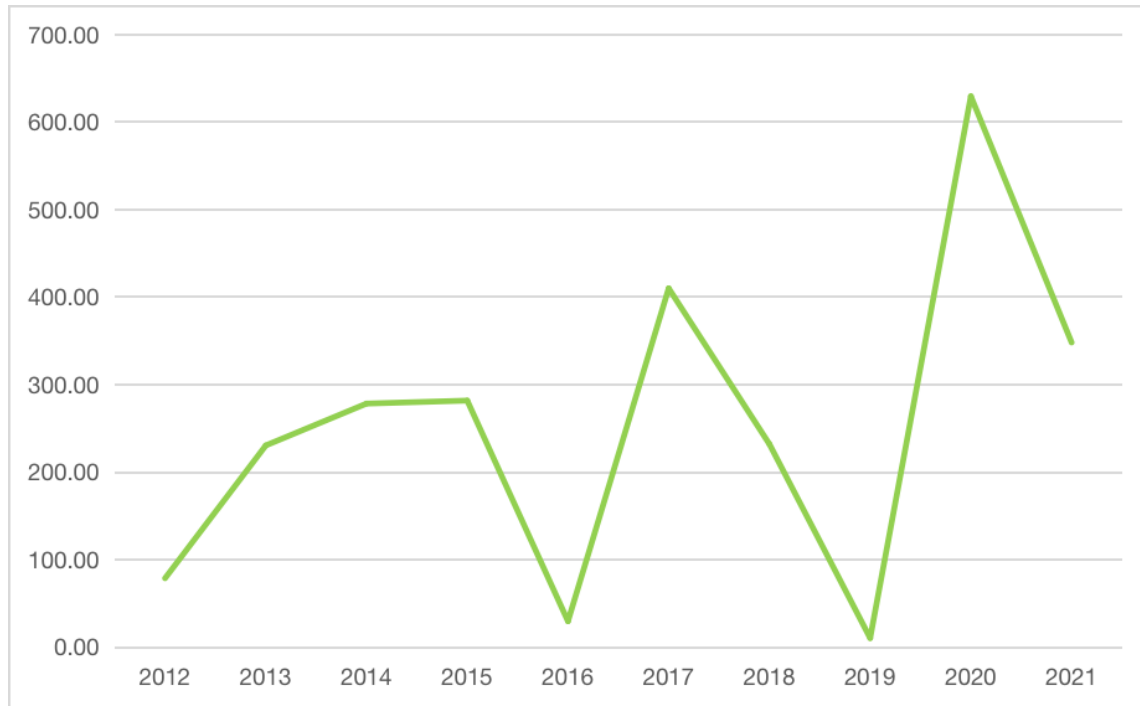


Figure 9: Kenya's EG trade with China in USD million⁸⁴



⁸³ Ministry of Commerce, PRC, "The Statistical Bulletin of China's Outward Foreign Direct Investment".

⁸⁴ IMF climate change dashboard: Bilateral Trade in Environmental Goods.

The development and expansion of Kenya's environmental goods manufacturing sector play a vital role in achieving the country's net-zero goals and ensuring long-term sustainable development. Leveraging Chinese investment, with China's accumulated experience in developing environmental goods, can be a strong force in accomplishing this objective. By fostering partnerships that combine resources, capital, technology, and talents, Kenya can unlock the full potential of its EG manufacturing sector and position itself as a key player in both the regional and global markets.

Production Focus

For Kenya, leveraging its unique advantage in renewable energy, a primary focus for environmental goods manufacturing should be on renewable energy-related products, such as wind turbines and solar panels. Expanding the production of these green technologies not only aligns with Kenya's commitment to sustainable development and climate change mitigation but also capitalizes on the country's vast renewable energy potential. By strengthening the manufacturing capacity of wind turbines and solar panels, Kenya can bolster its clean energy infrastructure, reduce carbon emissions, and enhance energy security.

Cost Analysis

Except for 2020, IMF data ranks Kenya among Africa's top 20 fastest growing economies in the period 2019-2022.⁸⁵ 2023 and 2024 forecasts anticipate a continuation of this trend, with 5.3% and 5.4% growth expected. In East Africa and one of the continent's largest economies, Kenya's manufacturing sector represents about 7.59% of overall economic growth.

In the period between 2019-2022, Kenya's 2021 and 2022 consumer price index (CPI) highlights a period of instability with respect to price movement. Prices recorded a 25.30% jump year-on-year, developments that motivated Kenya's Central Bank to pull borrowing costs up.⁸⁶ As a result, Kenya's real interest rates are the second highest in our group of regional hubs, ranging from 6.71% and 7.83% between 2019-2021.

2021 electricity data reflects recent cost increases, with average tariffs standing at US\$0.161 per kilowatt hour – the most expensive in our group of 10 regional hubs.⁸⁷ Diesel pump prices also rank poorly, with 2019-2021 pump price data ranging between US\$0.97-US\$1.15 per litre.⁸⁸ According to 2021 IRENA data on Kenya's weighted-average cost of capital (WACC) in solar photovoltaic (PV) and onshore wind investments, the minimum rates of return to target for these sub-sectoral investments would be 8.4% and 5.6% respectively.⁸⁹

Lastly, Kenya's labour costs as indicated by International Labour Organization (ILO) monthly minimum wage data, are the second highest in purchasing power parity (PPP) terms at \$308.46.⁹⁰

⁸⁵ Real GDP Growth, "IMF World Economic Outlook". April 2023.

https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/WEO_WORLD

⁸⁶ Consumer Price Index (CPI), Kenya National Bureau of Statistics. 2019-2022). <https://www.knbs.or.ke/publications/>

⁸⁷ Electricity prices, "The price of electricity per KWh in 230 countries". 2021.

<https://www.cable.co.uk/energy/worldwide-pricing/>

⁸⁸ Energy prices, "IEA End-Use Prices Data Explorer". 2019-2022. <https://www.iea.org/data-and-statistics/data-tools/end-use-prices-data-explorer?tab=Overview>

⁸⁹ IRENA renewable energy weighted average cost of capital (WACC), "The cost of financing renewable power".

2023. [https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-](https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/May/IRENA_Cost_of_financing_renewable_power_2023.pdf?rev=6b95)

[/media/Files/IRENA/Agency/Publication/2023/May/IRENA_Cost_of_financing_renewable_power_2023.pdf?rev=6b95edc23fa5468190745975681a71cc](https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/May/IRENA_Cost_of_financing_renewable_power_2023.pdf?rev=6b95edc23fa5468190745975681a71cc)

⁹⁰ International Labour Organisation (ILO) inimum wage rates in purchasing power parity (PPP) terms, "Statistics on wages". 2022. <https://ilostat.ilo.org/topics/wages/>

They are however, still 3% lower than a global benchmark of \$319 in PPP terms, as well as an international median of \$1,578 set by the top 20 environmental good exporters.

4.2.3 TANZANIA

Tanzania, like Kenya, has demonstrated a strong national commitment to environmental protection and climate change mitigation through various policy frameworks. The National Environment Policy of 1997⁹¹ and the National Climate Change Strategy of 2012⁹² laid the groundwork for addressing environmental challenges in the country, while the recent National Climate Change Response Strategy (NCCRS) 2021-2026⁹³ serves as a key document guiding Tanzania's current climate change initiatives, with a focus on developing a less carbon-intensive and climate change-resilient energy infrastructure.

Tanzania possesses a unique and favorable set of advantages that make it well-suited for environmental goods manufacturing. The country is rich in diverse natural resources, including renewable energy sources like hydropower, solar, and wind, as well as graphite, copper and other critical minerals that are vital for clean technologies.⁹⁴ This natural resource endowment provides a solid foundation for the production of environmental goods and creates opportunities for local content development and supply chain integration.

Furthermore, Tanzania's strategic location in Eastern Africa and its well-connected transport system to neighboring countries offer promising prospects for potential exports. The country's active and robust trade and investment relations with China further enhance its potential for collaboration and partnerships in the development of environmental goods manufacturing.

Overall, Tanzania's commitment to sustainable development, coupled with its comparative advantages in natural resources, renewable energy potential, and strategic location, position the country as a promising player in the regional and global environmental goods market. By leveraging these strengths and addressing challenges proactively, Tanzania can contribute significantly to its national climate goals and sustainable development objectives through the development and expansion of the environmental goods manufacturing sector.

Natural endowment

Tanzania's environmental goods manufacturing potential is complemented by its rich natural resource endowment and renewable energy potential. The country is home to significant deposits of lithium, cobalt, nickel, copper and rare earth elements, which are essential components in the manufacturing of electric vehicles, renewable energy infrastructure, and other clean technologies.⁹⁵ According to a study commission for Natural Resource Governance Institute (NRGI), Tanzania possesses significant deposits of minerals crucial to the clean energy

⁹¹ Vice President's Office, "National Environmental Policy". 1997. <https://www.nemc.or.tz/uploads/publications/sw-1576228807-NEP%201997.pdf>

⁹² Vice President's Office, "National Climate Change Strategy". 2012. <https://faolex.fao.org/docs/pdf/tan191137.pdf>

⁹³ Vice President's Office, "National Climate Change Response Strategy (NCCRS) 2021-2026". 2021. https://www.taees.org/wp-content/uploads/2021/09/NCCRS-2021-2026_Final_PK.pdf

⁹⁴ The Rare Earths and Critical Materials (CRIT) ETF, "Copper is Key to Delivering Green Energy". June 18, 2023. <https://www.critetf.com/posts/copper-is-key-to-delivering-green-energy>

⁹⁵ Tanzania Mining and Investment Forum, "Tanzania the Gateway to East Africa's Critical Minerals Investment Opportunity". <https://www.tanzaniamininginvestmentforum.com/media/ociepkvn/tmif-2023-press-release-may-2023.pdf>

transition.⁹⁶ Notably, **Table 6** below shows that the Kagera region hosts substantial nickel deposits, estimated to exceed 1.52 million tons. In addition, Tanzania holds impressive graphite reserves, totaling over 18 million tons, concentrated mainly in the Lindi, Morogoro, and Tanga Regions, ranking as the 5th largest graphite reserve globally. The Lake Rukwa Basin is a significant resource for the country, containing approximately 138 billion cubic feet of helium, making it the second-largest helium deposit in the world. Moreover, Tanzania boasts around 20 other critical mineral deposits, including copper, lithium, and more (see **Table 7**).⁹⁷ These minerals and rare earths are essential components of batteries, wind turbines, solar panels and EV motors, and therefore are crucial to environmental goods manufacturing and the advancement of net-zero transition.

Table 6: Part of Tanzania’s critical mineral distribution⁹⁸

Resource	Estimated deposit (million tons)	Regions
nickel	1.52	Kagera
graphite	18	Lindi, Morogoro, and Tanga
helium	138	The Lake Rukwa Basin
Copper	/	Dodoma

Table 7: Top critical minerals used in clean transition⁹⁹¹⁰⁰

Critical minerals	Products	Found in Tanzania
Lithium	Battery	Yes
Nickel	Battery, wind turbines and EV motors	Yes
Cobalt	Battery	Yes
Manganese	Battery	Yes
Graphite	Battery	Yes
Rare earth elements	Wind turbines and EV motors	Yes
Copper	Wind turbines and EV motors, power lines	Yes
Aluminum	Power lines	No

⁹⁶ Natural Resource Governance Institute (NRGI), “Critical Minerals and Energy Transition: Findings from Tanzania’s Scoping Study of Critical Minerals Potential and Implications for Tanzania”.

⁹⁷ Policy Forum, “Critical Minerals And Energy Transition In Tanzania: A New Dance, Maybe?”.

<https://www.policyforum-tz.org/blog/2022-06-14/critical-minerals-and-energy-transition-tanzania-new-dance-maybe>

⁹⁸ Natural Resource Governance Institute (NRGI), “Critical Minerals and Energy Transition: Findings from Tanzania’s Scoping Study of Critical Minerals Potential and Implications for Tanzania”.

⁹⁹ World Resources Institute, “Overcoming Critical Minerals Shortages Is Key to Achieving US Climate Goals”. May 3, 2023. Accessed at: <https://www.wri.org/>

¹⁰⁰ International Energy Agency, “Critical minerals”. Accessed at: <https://www.iea.org/topics/critical-minerals#>

Apart from its abundance of critical minerals, Tanzania is also blessed with a diverse and rich renewable energy potential, encompassing biomass, hydro, wind, solar, and geothermal resources (see **Table 8**). Currently, the primary renewable energy source in Tanzania is hydropower, constituting approximately a third of the total installed capacity, followed by bioenergy.¹⁰¹¹⁰²

Table 8: Tanzania's renewable energy structure (2022)¹⁰³

Source of energy	Current capacity (MW)	Current percentage
Hydro	589	87.00%
Wind	2	0.30%
Solar	15	2.22%
Biomass	71	10.48%
Total	677	/

However, Tanzania's vast renewable energy potential, including hydropower, solar, wind, and geothermal resources, remains largely untapped. Despite having the potential to generate up to 4.7 GW of hydropower capacity, the current installed capacity stands at 589MW, indicating ample room for further hydro development.¹⁰⁴

Moreover, the country's abundant sunlight makes solar energy a viable and sustainable option for electricity generation. And its wind energy holds promise, especially in coastal and highland areas where strong and consistent winds can be harnessed through wind farms to generate clean electricity and bolster Tanzania's transition to a low-carbon energy system. Geothermal energy is also a key area of interest in Tanzania. The country possesses substantial geothermal resources, which hold the potential to provide a reliable baseload power supply. In line with this, the Tanzanian government has set a target to generate 200MW of power from geothermal sources by 2025.¹⁰⁵

By fully harnessing its renewable energy potential, Tanzania can expedite its progress towards a greener and more resilient energy landscape, aligning with its commitment to sustainable development and climate change mitigation. However, achieving this ambitious goal requires increased investment in environmental goods manufacturing, particularly in sectors like renewable energy components and electric motors. Tanzania's abundance of critical mineral resources provides a significant advantage that can be utilized to bolster the manufacturing capacity of essential components such as batteries, electric vehicle (EV) motors, and wind turbines, establishing a comprehensive end-to-end value chain locally. This will not only enhance energy and manufacturing security and reduce carbon emissions but also drive economic growth and social development.

¹⁰¹ IRENA, Renewable Energy Capacity Statistics 2023.

¹⁰² TanzaniaInvest, "Tanzania Power".

¹⁰³ IRENA, Renewable Energy Capacity Statistics 2023.

¹⁰⁴ International Trade Administration, "Tanzania - Energy". Accessed at: <https://www.trade.gov/>

¹⁰⁵ ThinkGeoenergy, "Tanzania's TGDC plans up to 200 MW geothermal development by 2025". Mar 9, 2021. Accessed at: <https://www.thinkgeoenergy.com/>

Manufacturing capacity

Tanzania's manufacturing capacity is characterized by both strengths and challenges. The country has made notable progress in developing its manufacturing sector, and it serves as an essential contributor to the national economy. However, the manufacturing sector's contribution to the GDP remains relatively modest compared to other sectors, accounting for around 8% of GDP.¹⁰⁶ Currently, the majority of the manufacturing activities focus on simple consumer goods, and like Kenya, the dependence on imported goods weakens its domestic value addition and manufacturing development.¹⁰⁷ It is therefore crucial for the country to develop local manufacturing capacity to absorb the rapidly growing labour force, boosting local production, produce products and services that are competitive in the domestic and international markets and improve people's livelihood.

Industrialization is a core pillar of the Tanzania Development Vision 2025, highlighting the country's strong commitment to advancing its industrial sector.¹⁰⁸ To achieve this goal, Tanzania has introduced and implemented several policies and strategies, such as the Sustainable Industrial Development Policy for Tanzania (SIDP 1996-2020)¹⁰⁹ and the Integrated Industrial Development State 2025 (IIDS). Additionally, the Mini-Tiger Plan, launched in 2005, aimed at establishing special economic zones (SEZs) and export processing zones to foster industrial growth.¹¹⁰ As part of these efforts, as shown in Figure 10 below, designated areas have been allocated for the construction of SEZs, and some have already been successfully developed.

¹⁰⁶ The World Bank Database, "Manufacturing, value added (% of GDP) - Tanzania".

¹⁰⁷ International Trade Administration, "Tanzania - Manufacturing". Accessed at: <https://www.trade.gov/>

¹⁰⁸ Planning Commission, "The Tanzania Development Vision 2025".

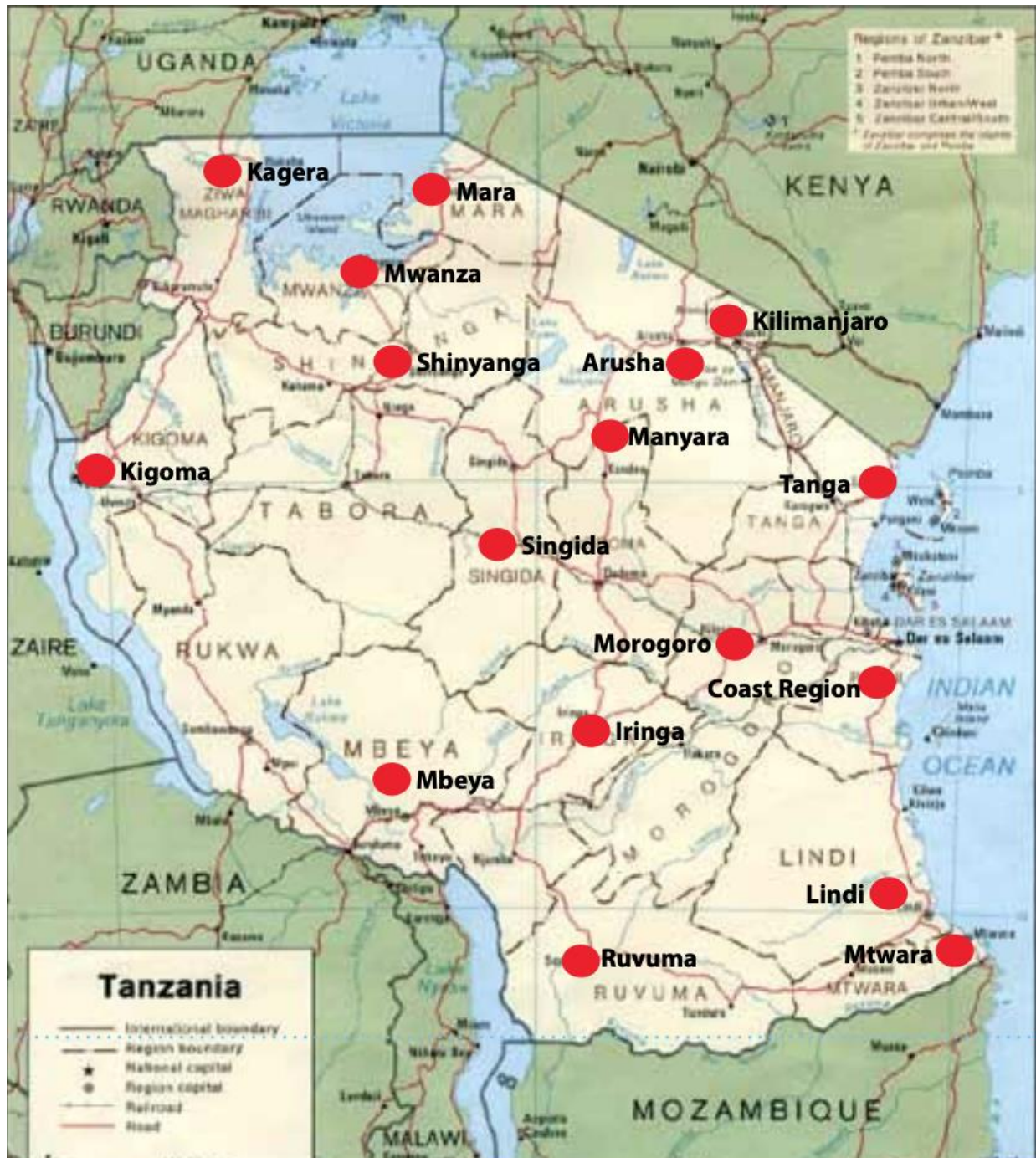
<http://www.tzonline.org/pdf/theTanzaniadevelopmentvision.pdf>

¹⁰⁹ Ministry of Industry and Trade, "Sustainable Industrial Development Policy 1996-2020".

<http://www.tzonline.org/pdf/sustainableindustrial.pdf>

¹¹⁰ Oliver Morrissey, Vincent Leyaro. "Industrial Development In Tanzania" from: Routledge Handbook of Industry and Development Routledge. Accessed at: <https://www.routledgehandbooks.com/doi/10.4324/9780203387061.ch21>

Figure 10: Designated SEZs and EPZs in Tanzania^{111,112}



These strategic initiatives come with enticing policies and tax incentives, bolstered by Tanzania's abundant natural resource endowment, presenting lucrative opportunities for potential investors

¹¹¹ The Export Processing Zones Authority, "Investment Opportunities in Tanzania".

<http://images.mofcom.gov.cn/tz/201607/20160728143911261.pdf>

¹¹² Source: The Export Processing Zones Authority of Tanzania

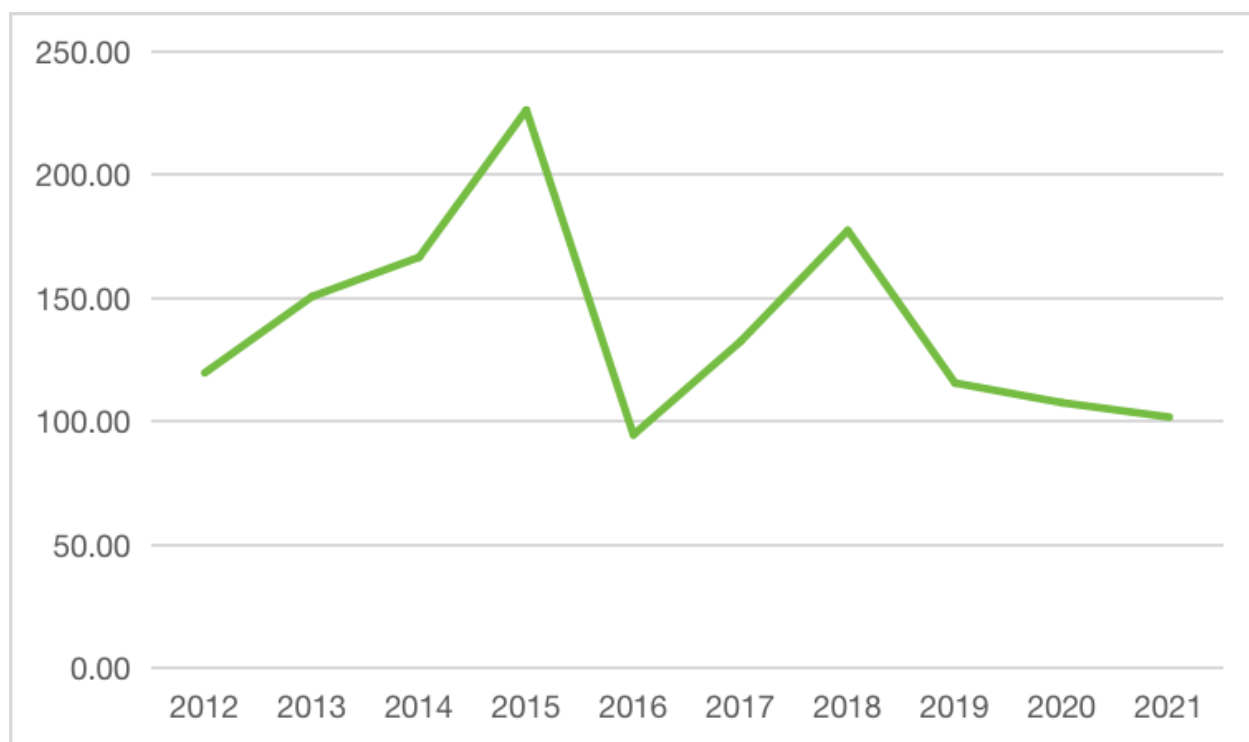
to explore and leverage for the development of environmental goods manufacturing in Tanzania. As these efforts gain momentum, the country's industrial landscape is poised to witness growth and diversification, aligning with its vision for sustainable and inclusive development.

Tanzania is emerging as a hub for green energy and critical minerals production. With its abundance of natural resources, favorable government policies, and increasing demand for sustainable energy, Tanzania is well-positioned to attract FDI in the EG sector from investors around the world, particularly China.

Trade and investment relations with China

Tanzania has enjoyed a strong trade and investment relationship with China since the 1960s. It has been a popular Chinese FDI destination, with annual FDI flows over US\$ 100 million in the past decade (see Figure 11).¹¹³ Trade relations are also robust. Figure 12 below shows that in 2021, the trade in environmental goods between Tanzania and China amounted to US\$414.87 million, making it the second highest in Eastern Africa and the 8th highest in the entire African continent.¹¹⁴

Figure 11: Chinese FDI flow to Tanzania (2012-2021 in USD million)¹¹⁵

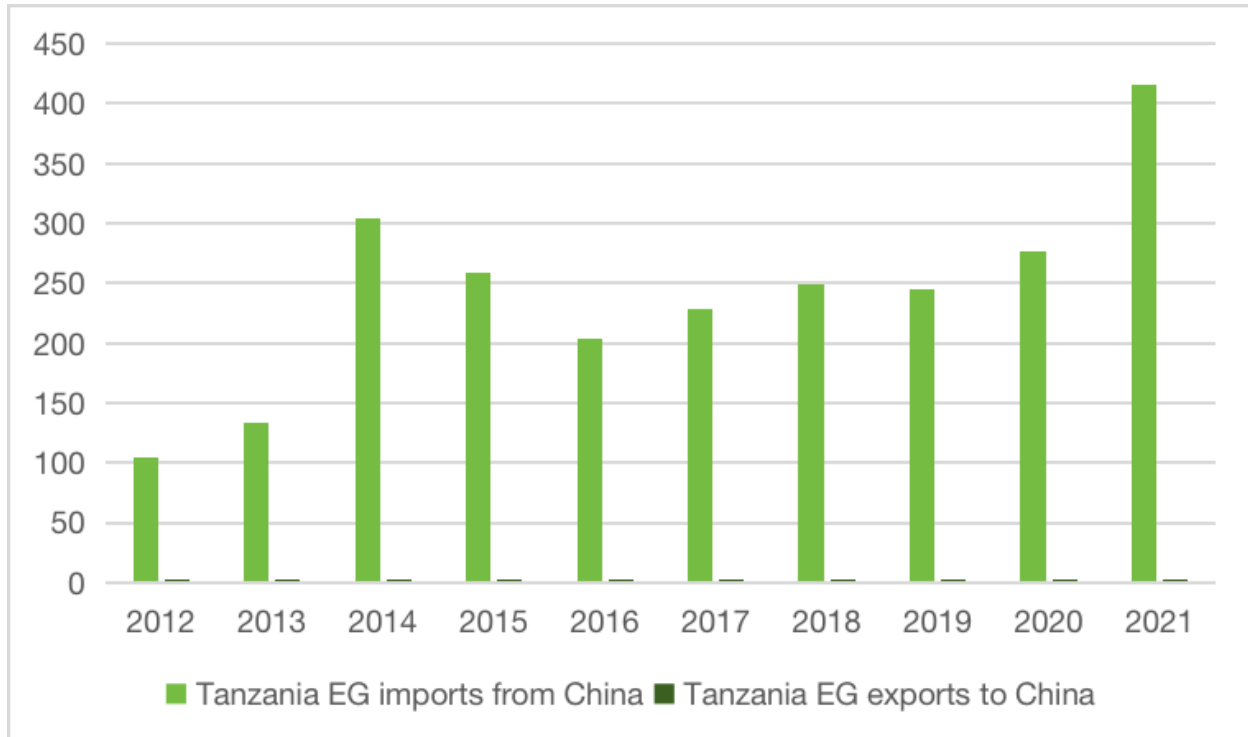


¹¹³ Ministry of Commerce, PRC, "The Statistical Bulletin of China's Outward Foreign Direct Investment".

¹¹⁴ IMF climate change dashboard: Bilateral Trade in Environmental Goods.

¹¹⁵ Ministry of Commerce, PRC, "The Statistical Bulletin of China's Outward Foreign Direct Investment".

Figure 12: Tanzania's EG trade with China in USD million¹¹⁶



Production Focus

For Tanzania, its significant natural endowment of critical minerals essential for clean technologies presents a prime advantage in developing environmental goods manufacturing, particularly in the production of batteries and electric vehicles (EVs). With abundant deposits of minerals like nickel and graphite, crucial components of batteries, and ample reserves of other critical minerals, Tanzania is well-positioned to play a key role in the regional and global supply chain for clean energy technologies.

Cost Analysis

IMF data identifies Tanzania as a leading economic growth driver in Africa. The country has almost consistently been in the continent's top 20 fastest growing economies between 2019-2022. 2023 and 2024 forecasts anticipate a continuation of this trend, with 5.2% and 6.2% growth rates expected¹¹⁷. In terms of sectoral contribution to economic growth, manufacturing contributes about 8.43% to overall growth¹¹⁸.

Among our group of 10 regional hubs, 2019 and 2020 data places Tanzania as the most expensive economy to borrow from in real terms. Looking at key manufacturing costs and using Tanzania's transport CPI as a proxy for underlying fuel price changes, January 2019 - June 2023

¹¹⁶ IMF climate change dashboard: Bilateral Trade in Environmental Goods.

¹¹⁷ IMF Real GDP Growth, "World Economic Outlook". April 2023.

https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/WEO_WORLD

¹¹⁸ World Bank World Development Indicators, "Manufacturing, value added (% of GDP)". 2017-2021.

<https://databank.worldbank.org/source/world-development-indicators#>

data notes a relatively stable rate of change, averaging 3.42% in the period. 2021 electricity tariff data is the third lowest in our 10-country regional hub dataset, an advantage for Tanzania and potential benefit for manufacturing sector investors. Labour costs are also competitively low. Although limited to manufacturing sector minimum wages and in US\$ terms, 2022 ILO data indicates competitively low rates of US\$61.48 per month.

4.2.4 WESTERN AFRICA

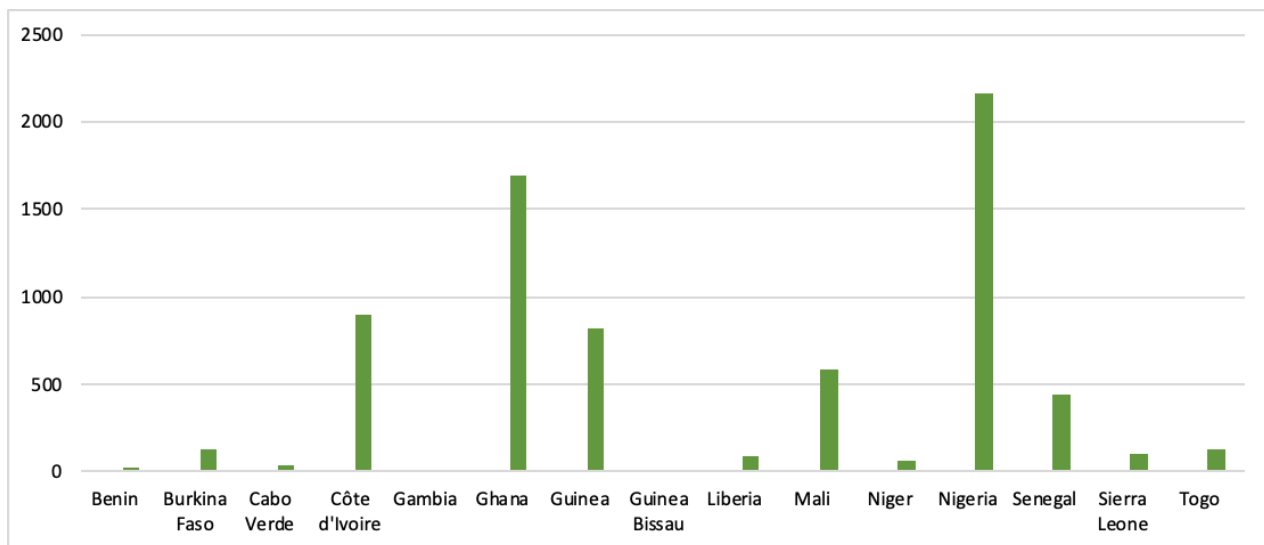
Overview

Country	Avg. Manufacturing Sector Value Added (2017-2021, % GDP)	Labor force participation (% of total population ages 15+)	Logistic performance (LPI 2023)	Total Renewable Energy Capacity (MW) 2022	Critical mineral production (2017-2021)	Total EG Trade with China (2021, USD)	Avg. Chinese FDI in the country (2017-2021) in million USD
Benin	9.62	62.59	2.9	28	-		5.898
Burkina Faso	9.93	65.55	2.3	128	-	35,867,851.00	1.378
Cabo Verde	7.09	56.13		35	-	3,458,685.00	0.262
Côte d'Ivoire	11.26	65.45		892	1,082,431.00	157,553,799.00	100.932
Gambia	3.40	61.48	2.3	4	-	20,747,204.00	3.1
Ghana	10.42	68.83	2.5	1691	3,765,816.00	527,846,881.00	67.38
Guinea	10.39	52.37	2.5	816	-	131,310,386.00	146.96398
Guinea Bissau	9.80	55.92	2.6	1	-		1.288
Liberia		76.59	2.4	95	-	241,553,443.00	21.122
Mali	6.49	67.50	2.6	585	-	48,057,872.00	-3.39
Niger	7.47	73.46		62	-	23,953,456.00	172.46
Nigeria	11.44	58.87	2.6	2158	415.00	1,342,759,927.00	193.305
Senegal	15.06	51.28		446	-	254,139,707.00	57.926
Sierra Leone	2.01	53.33		104	-	26,260,564.00	4.994
Togo	13.93	58.02	2.5	124	-	121,008,886.00	3.466

The Western African region boasts diverse demographics and economic landscapes, encompassing 16 countries rich in natural resources and varying levels of economic development. Despite this diversity, the subregion encounters common challenges, such as energy poverty, energy security concerns, extreme weather conditions, and pressing socio-economic issues like rapid urbanization and economic inequality. Spanning an expansive area of 5.1 million square kilometers and housing an estimated 400 million people as of 2017, the region is bound together by the Economic Community of West African States (ECOWAS) economic union, with Mauritania as the sole exception. Nevertheless, electricity access remains limited, with around 40% coverage in some countries and less than 20% in others, despite an untapped reservoir of renewable energy potential that could bridge the energy gap and increase electricity access.¹¹⁹ Recognizing the need for urgent action, ECOWAS countries adopted the ECOWAS Renewable Energy Policy (EREP) to elevate renewable energy's share in the overall electricity and energy mix to 48% and 19%, respectively, by 2030.¹²⁰ Through robust regional cooperation and integration, the region aspires to carve a path towards a sustainable energy future that benefits both its citizens and the environment.

Renewable energy holds the key to addressing the energy deficit in the region. The total renewable energy capacity in megawatts for 2022 highlights the capacity for sustainable energy generation. Among the listed countries, as Figure 13 shown below, Nigeria leads the pack with the highest total renewable energy capacity of 2158 MW followed by Ghana with 1691 MW. This indicates a significant opportunity for Nigeria to generate renewable energy, making strides towards sustainability and reducing reliance on fossil fuels. However, countries like Guinea Bissau (1 MW) and Gambia (4 MW) have recorded lower renewable energy capacity and may face challenges in achieving energy security solely through renewable sources.

Figure 13: West Africa Total Renewable Energy Capacity (MW) 2022



¹¹⁹ ECOWAS Renewable Energy Policy. <http://www.ecreee.org/page/ecowas-renewable-energy-policy-erep#:~:text=The%20EREP%20vision%20is%20to,access%20to%20electricity%20by%202030>

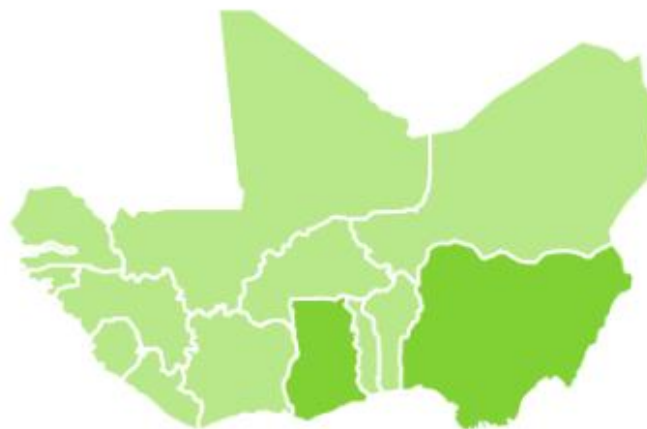
¹²⁰ Economic Community of West African States. ECOWAS Renewable Energy Policy. http://www.ecreee.org/sites/default/files/documents/ecowas_renewable_energy_policy.pdf

The trade and investment relations with China provide insights into the economic ties and opportunities for these countries. Nigeria stands out with substantial trade at US\$1.342 billion, while Liberia has the lowest trade at US\$241.55 million. On the other hand, Guinea has attracted the highest average Chinese FDI at US\$146.96 million, potentially indicating its attractiveness for foreign investment.

The average manufacturing sector value added as a percentage of GDP for the period 2017-2021 indicates the relative contribution of the manufacturing sector to the countries' overall economic output. Senegal boasts the highest average value added, accounting for 15.06% of its GDP, signalling a robust industrial foundation. Togo and Côte d'Ivoire also display healthy figures, contributing 13.93% and 11.26%, respectively, to their GDP through manufacturing activities. Sierra Leone has the lowest value at 2.01%, suggesting limited diversification in its economy.

Regional hubs

Based on the scoring system introduced in 4.1, this report identifies 2 regional hubs for environmental goods manufacturing in West Africa – Ghana and Nigeria.



4.2.5 GHANA

Ghana is the second-largest economy in West Africa, with a political stable, conducive business climate, abundant natural resources, and a thriving economy, it is a prime candidate for the production of environmental goods.¹²¹ The Ghanaian economy is anchored in commodities, with significant government revenue hinging on key exports like gold, crude oil, and cocoa beans, constituting the bulk of the international trade value at US\$14.1 billion in 2021.¹²²

Environmental degradation costs are around US\$11 billion.¹²³ The adverse impacts include extreme weather events like flooding and rising temperatures, stand to disrupt the nation's economic activities, particularly those tied to the natural resource sector. With nearly 44.7% of the labour force engaged in agriculture, the economy's foundation is closely intertwined with its

¹²¹ Ghana Investment Promotion Centre (GIPC). (2023). Manufacturing. <https://www.gipc.gov.gh/sector/manufacturing/>

¹²² OEC Ghana. (2021). <https://oec.world/en/profile/country/gha>

¹²³ Cudjoe, K. (June 8, 2021). Environmental degradation costs over US\$11bn annually. The Business & Financial Times. <https://thebftonline.com/2021/06/08/environmental-degradation-costs-over-us11bn-annually/>

environmental well-being¹²⁴. Furthermore, drought is projected to impact 13% of the population, while annual flooding affects around 45,000 individuals.¹²⁵¹²⁶ This pressing reality underscores Ghana's serious commitment to mitigating climate change, an effort complemented by its suitability for environmentally friendly goods manufacturing.

Ghana's updated National Determined Contribution (NDC) not only outlines adaptation and mitigation environmental targets but also positions the nation favorably for environmental manufacturing. These goals encompass an unconditional 15% reduction in emissions and an additional 30% reduction contingent upon external financial support.¹²⁷ Additionally, the NDC goals encompass 19 policy actions over the next decade, aiming for a substantial 64 MtCO₂e emission reduction, creation of over a million green jobs, and cumulative betterment of nearly 38 million individuals, with a focus on youth and women.

Ghana's advantageous geographic location and growing industrial base provide a strong opportunity for improved regional cooperation in trade. Ghana boasts a well-developed network of interconnected ports, roads, and railways, positioning it as a central hub with both regional impact and global connections. Its proximity to nearby West African nations provides an avenue to a consumer base of over 420 million people, solidifying its role as an entry point to the vast African market.¹²⁸ This strategic position makes Ghana an ideal destination for expanding market reach. Taking full advantage of its memberships in ECOWAS and AU, in addition to preferential trade agreements such as the African, Caribbean, and Pacific (ACP) nations, and its active involvement in the African Continental Free Trade Area (AfCFTA), Ghana stands poised to tap into previously unexplored export prospects along established and emerging trade routes¹²⁹.

Natural Endowment

Ghana's natural resources and strategic key minerals provide a promising pathway to stimulate industrial growth and business prospects, particularly within the environmental goods value chain. As shown in **Table 9** below, beyond the significant reserves of critical minerals like manganese, bauxite, silica sand, iron ore, graphite, and lithium, Ghana's also has close proximity and easy access to an extensive range of essential raw materials such as forestry products, agricultural products, resourceful waste, and pivotal renewable resources¹³⁰¹³¹. This advantage holds the potential for tangible benefits including accelerated production cycles, diminished reliance on

¹²⁴ Ghana Statistical Service. (2023). Ghana Facts and Figures. <https://statsghana.gov.gh/ghfactsheet.php>

¹²⁵ World Bank Group. (November, 2022). Ghana Can Turn Climate Challenges into Opportunities for Resilient and Sustainable Growth, Says New World Bank Group Report. Press release. <https://www.worldbank.org/en/news/press-release/2022/11/01/ghana-can-turn-climate-challenges-into-opportunities-for-resilient-and-sustainable-growth-says-new-world-bank-group-report>

¹²⁶ The Climate Reality Project. (2023, June 28). How the Climate Crisis Is Impacting Ghana. Blog post. <https://www.climateRealityProject.org/blog/how-climate-crisis-impacting-ghana>

¹²⁷ MESTI. (2021). Ghana: Updated Nationally Determined Contribution under the Paris Agreement (2020 – 2030) Environmental Protection Agency, Ministry of Environment, Science, Technology and Innovation, Accra. https://mesti.gov.gh/wp-content/uploads/2021/12/Ghanas-Updated-Nationally-Determined-Contribution-to-the-UNFCCC_2021.pdf

¹²⁸ Economic Community of West African States (ECOWAS). (2023). <https://ecowas.int>

¹²⁹ Obeng, C. K., Boadu, M. T., & Ewusie, E.-A. (2023). Deep preferential trade agreements and export efficiency in Ghana: Do institutions matter? *Research in Globalization*, 6, 100112. <https://doi.org/10.1016/j.resglo.2023.100112>

¹³⁰ Nyabor, J. (2018, January). Ghana Discovers New Mineral Lithium in Commercial Quantities. Citi FM Online. <https://citifmonline.com/2018/01/ghana-discovers-new-mineral-lithium-in-commercial-quantities/>

¹³¹ World Gold Council. (2023, June 7). Gold Production by Country - Global Mine Production. <https://www.gold.org/goldhub/data/gold-production-by-country>

imports, increased cost-effectiveness, reliable supply chain operations, and a contribution towards reducing carbon emissions.

Table 9: Estimated reserves of top critical minerals used in clean transition¹³²¹³³

Critical minerals	Products	Volume(Thousand Tonnes)
Lithium	EVs and Battery Storage	14500
Iron Ore	Steel Production	6000000
Bauxite	Aluminum	900000
Manganese	Battery	13000

Policies such as the Human Resource and Goods & Services framework have been pivotal in stimulating local employment and domestic growth, particularly in manufacturing.¹³⁴ Ghana's emphasis on local content also seeks to ensure that the sector makes a significant contribution to sustainable economic development and the creation of domestic jobs, all while maintaining its position as a favorable manufacturing hub.

Green Minerals Policy sets a new direction for the extraction, governance, and responsible stewardship of critical minerals, including lithium.¹³⁵ The policy's directives, financial frameworks, and encouragement of increased domestic engagement in the green mineral industry, contrasting the previous 10% state interest in mining operations, signify a proactive approach aligned with sustainable manufacturing. By banning the export of unprocessed critical minerals, Ghana ensures that these resources are utilized domestically, fostering local value addition and promoting sustainable manufacturing practice¹³⁶.

Renewable Energy Potential and Structure

Presently, about 60% of the country's total energy supply stems from crude oil and natural gas, while the remaining portion is contributed by renewable energy sources (see Figure 14).¹³⁷ However, with an existing renewable energy capacity of 1,691 MW, Ghana possesses significant opportunities to curtail its reliance on fossil fuels and amplify the integration of eco-friendly sources into its energy mix. The nation's renewable energy landscape encompasses hydro, solar, ocean energy, biomass, and wind, creating a diverse portfolio of potential sources for sustainable

¹³² Warden, E. W., & Acheampong, T. (2022, July 1). Energy Transition Minerals in Ghana: A critical time for Ghana's mining sector. Retrieved from <https://eiti.org/blog-post/energy-transition-minerals-ghana>

¹³³ International Energy Agency. (2023). Critical minerals. <https://www.iea.org/topics/critical-minerals>

¹³⁴ Minerals Commission Ghana. (2023). Local Content in Ghana's Mining Industry.

<https://www.mincom.gov.gh/local-content/>

¹³⁵ Ngnenbe, T. (2023, August 7). Cabinet approves lithium-policy - it covers other green minerals. Graphic Online.

<https://www.graphic.com.gh/news/general-news/ghana-news-cabinet-approves-lithium-policy-it-covers-other-green-minerals.html>

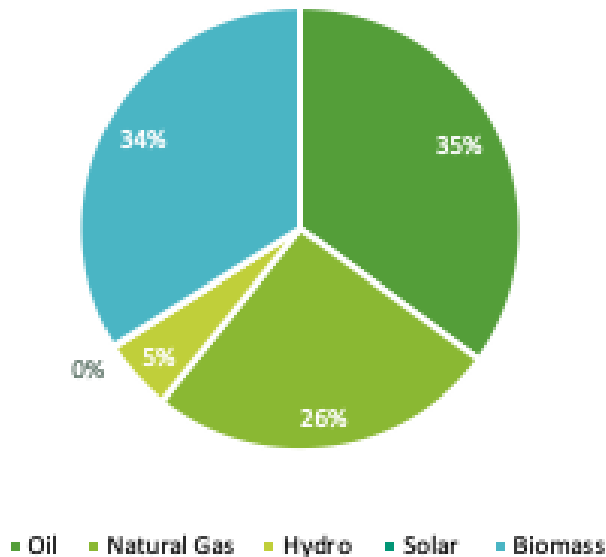
¹³⁶ ibid

¹³⁷ Energy Commission of Ghana, 2022 National Energy Statistics

<https://energycom.gov.gh/files/2022%20Energy%20Statistics.pdf> (accessed 14 August 2023).

energy access.¹³⁸ Notably, these renewable resources remain largely untapped, revealing a substantial opportunity for further exploration in clean energy generation and adoption.

Figure 14: Total Energy Supply (ktoe) in Ghana (2021)¹³⁹



Ghana's abundant and readily accessible biomass resources, sourced from agriculture, wood products, solid waste, forestry residue, and wet waste, present feasible avenues for energy generation. Biomass contributes around 34% to Ghana's total energy portfolio, and research indicates that biomass could effectively meet 7% of Northern Ghana's electricity demands¹⁴⁰. Beyond this, theoretical calculations reveal that agricultural crop residues hold a substantial energy capacity of 623.84 PJ^{141 142}

Ghana's wind potential is notable in the eastern coast and mountainous areas of Ghana regions, offering possibilities for utility-scale wind energy due to its low-cost requirements, high efficiency, and potential for enhanced energy generation. Wind speeds along the eastern coast and mountainous areas of Ghana display at least minimum of 6.4 m/s¹⁴³ and an annual generation potential of 300 TWh . The government's commitment to wind energy development is evident .

Ghana's significant solar energy potential, particularly in its northern regions, further highlight its renewable energy potential. The abundance of solar resources, with average radiation ranging from 4.4 to 5.6 kWh/m²/day and an annual exposure of 1,800 to 3,000 hours, unveils a strategic

¹³⁸ Takase, M., & Kipkoach, R. (2023). An Overview of Scientific Production of Renewable Energies in Ghana. *Journal of Energy*, 2023, Article ID 7414771, 10 pages. <https://doi.org/10.1155/2023/7414771>

¹³⁹ Energy Commission of Ghana. (2022). 2022 National Energy Statistics. Retrieved from <https://energycom.gov.gh/files/2022%20Energy%20Statistics.pdf>

¹⁴⁰ Nelson, N. , Darkwa, J. and Calautit, J. (2021) Prospects of Bioenergy Production for Sustainable Rural Development in Ghana. *Journal of Sustainable Bioenergy Systems*, 11, 227-259. doi: 10.4236/jsbs.2021.114015.

¹⁴¹ Otchere-Appiah, G. and Hagan, E.B. (2014) Potential for Electricity Generation from Maize Residues in Rural Ghana: A Case Study of Brong Ahafo Region. *International Journal of Renewable Energy Technology*, 3, 1-10.

¹⁴² Ibid.

¹⁴³ Sun, H., Khan et al. (2020). Energy insecurity, pollution mitigation, and renewable energy integration: prospective of wind energy in Ghana. *Environmental Science and Pollution Research*, 27(30), 38259-38275. <https://doi.org/10.1007/s11356-020-09709-w>.

opportunity landscape for versatile solar applications.¹⁴⁴ It is noteworthy that while solar energy already constitutes a substantial 90% of the renewable energy mix, a strategic imperative lies in harnessing the untapped potential within photovoltaic (PV) systems and solar water heaters.¹⁴⁵ To fully capitalize on this, targeted investments, technology advancements, and regulatory frameworks could position Ghana as a regional leader in solar innovation and deployment, thereby advancing its sustainable energy agenda and potentially enabling exports to neighboring markets.

Policy wise Ghana's Renewable Energy Master Plan (REMP) sets forth a strategic roadmap, targeting multifaceted objectives by 2030. These ambitions encompass elevating the share of renewable energy in the national energy blend, curbing biomass reliance for thermal applications, extending off-grid electrification to 1,000 communities, and nurturing grassroots involvement in the renewable energy sector¹⁴⁶. These prospects encompass a wide range of areas, including initiatives related to circular economy, ventures in clean energy, and groundbreaking agricultural technologies.

Ghana's aspiration to become an environmental hub is intricately woven into its renewable electricity sector, which draws heavily from its abundant water resources and thermal energy. The country's energy landscape has traditionally revolved around thermal and hydropower sources, with hydropower contributing significantly, accounting for almost 28.8% of the nation's total electrical power generation (see Figure 15).¹⁴⁷ The Akosombo Dam project, harnesses a substantial 1,020 MW and 160 MW, respectively, generated from the ample waters of the Volta River significantly contributing to electricity generation in the country.¹⁴⁸

However, this well-established reliance on hydropower faces challenges stemming from the escalating impacts of climate change which pose imminent risk to the stability of the electricity supply through hydropower.¹⁴⁹ Thus, Ghana is embracing a diversified and sustainable energy portfolio to counterbalance the vulnerabilities. Ghana's renewable energy is being enriched by the integration of Solar PV facilities strategically positioned across regions such as Navrongo (2.5 MW), Lawra (4 MW), and Kaleo (13 MW) in the Upper East and Upper West Regions.¹⁵⁰¹⁵¹ In the face of shifting climatic realities, Ghana's potential of becoming an environmental manufacturing hub is further recognized in its ability to transition its energy sector toward greater reliance on renewables like solar power.

¹⁴⁴ Kemausuor, F., et al. (2011). A review of trends, policies and plans for increasing energy access in Ghana. *Renewable and Sustainable Energy Reviews*, 15(9), 5143-5154.

¹⁴⁵ Gyamfi, S., Modjinou, M., and Djordjevic, S. (2015). Improving electricity supply security in Ghana—the potential of renewable energy. *Renewable and Sustainable Energy Reviews*, 43, 1035-1048.

¹⁴⁶ Energy Commission of Ghana, Ghana Renewable Energy Master Plan 2019, Ministry of Energy, Accra, Ghana, 2019. <https://www.energycom.gov.gh/files/Renewable-Energy-Masterplan-February-2019.pdf>

¹⁴⁷ Energy Commission of Ghana. (2022). 2022 National Energy Statistics. Retrieved from <https://energycom.gov.gh/files/2022%20Energy%20Statistics.pdf>

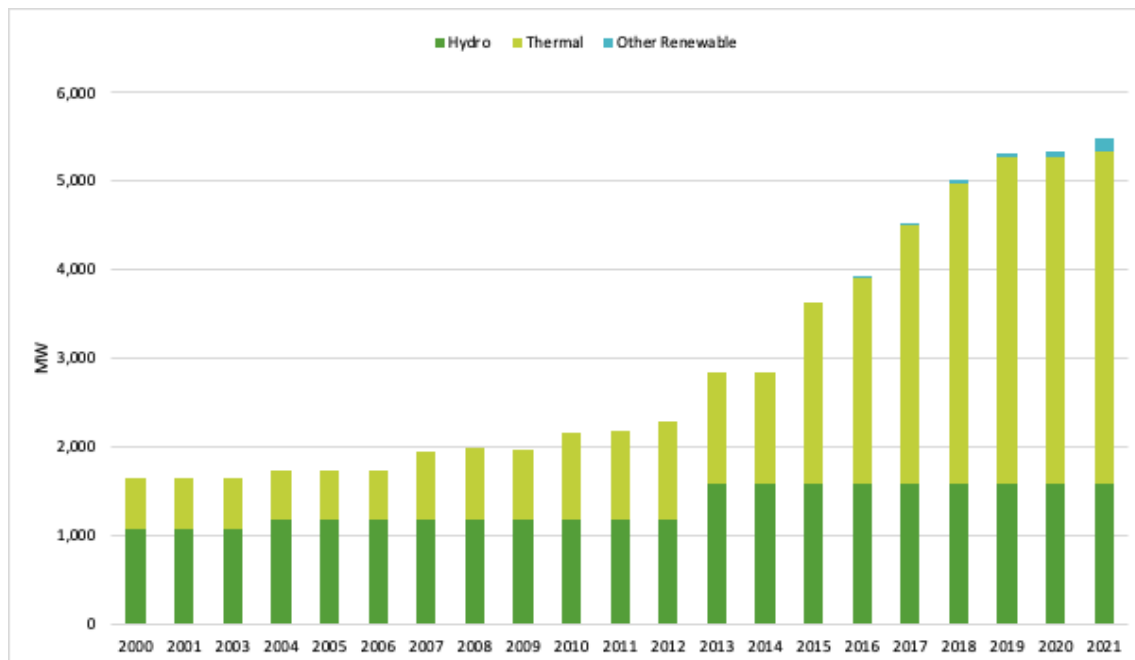
¹⁴⁸ International Hydropower Agency. (2022). Country Profile Ghana. <https://www.hydropower.org/country-profiles/ghana>

¹⁴⁹ Kayaga, S. M., et al. (2021). Cities and extreme weather events: Impacts of flooding and extreme heat on water and electricity services in Ghana. *Environment and Urbanization*, 33(1), 131–150. <https://doi.org/10.1177/0956247820952030>

¹⁵⁰ Volta River Authority (2022). Commissioning of The Kaleo Solar Power Plant <https://www.vra.com/media/2022/kaleo-solar-power-plant.php>

¹⁵¹ Bungane, B. (2020, February 6). Two Solar Plants to Bring Power to Ghana's Upper West Region. *ESI Africa*. <https://www.esi-africa.com/industry-sectors/generation/two-solar-plants-to-bring-power-to-ghanas-upper-west-region/>

Figure 15: Installed Generating Capacity (2000-2021)¹⁵²



Regulating Ghanaian Renewable Energy Sector

Ghana's government has a number of regulatory policies, fiscal incentives, and public investments to stimulate renewable energy growth. To promote renewable energy adoption, Ghana has implemented fiscal incentives, including Net Metering and feed-in tariffs (FITs), which encourage surplus energy contribution to the grid.¹⁵³¹⁵⁴ Research and development (R&D) incentives, duty waivers, and VAT exemptions on renewable energy equipment further demonstrate the government's pragmatic stance on building exploring its renewable energy potential. These incentives, despite modest initial gains, offer long-term cost savings and enhanced energy efficiency.

Additionally, the government has taken proactive steps to ensure that the benefits of the renewable energy sector are rooted within the country. Local content requirements have been introduced, mandating a minimum local equity ownership of 15% for entities engaged in licensed activities within the renewable energy sector¹⁵⁵. This requirement is set to increase to 51% over a decade, promoting indigenous participation and nurturing domestic capabilities. These measures underscore Ghana's unwavering commitment to economic growth, local empowerment, and the enhancement of its resource and energy sectors.

¹⁵² ibid

¹⁵³ Public Utilities Regulatory Commission. (2022). Rate Setting Guidelines for Net Metering of Renewable Energy Generation Systems Connected to Distribution Networks in Ghana. Retrieved from <https://www.purc.com.gh/attachment/772548-20221128101136.pdf>

¹⁵⁴ Public Utilities Regulatory Commission. (2013, September 13). Publication Of Feed-in-tariffs For Electricity Generated From Renewable Energy SourceS Ghana Gazette. Retrieved from <https://www.purc.com.gh/attachment/873945-20210309110350.pdf>

¹⁵⁵ Public Utilities Regulatory Commission. (2022). Renewable Energy (Amendment) Act, 2020 (Act 1045). Retrieved from <https://www.purc.com.gh/attachment/58406-20210701030745.pdf>

Key institutions responsible for managing and developing energy sources in this sector include the Ministry of Energy, Ghana Grid Company Limited (GRIDCo), Bui Power Authority (BPA), Energy Commission (EC), Volta River Authority (VRA), Volta River Authority Resettlement Trust Fund, VALCO Trust Fund, Electricity Company of Ghana (ECG), Northern Electricity Distribution Company (NEDCO), and the National Petroleum Authority¹⁵⁶¹⁵⁷.

Manufacturing Capacity

Ghana's manufacturing sector remains crucial, contributing around 10.42% to GDP (2017-2021) and employing about 18.6% of the labour force.¹⁵⁸ Key activities include wood processing, agro-processing, oil refining, vehicle assembly, aluminum smelting, textiles, garments, and pharmaceuticals.¹⁵⁹ However, due to historical import dependence and a commodity-based economy Ghana's potential as an environmental goods manufacturing hub remains untapped.

Ghana's commitment to realizing its industrial potential and achieving economic transformation is evident through intensified efforts and strategic policies. Government initiatives like the Industrial Transformational Agenda and the National Industrial Policy aim to attract manufacturing investments by offering compelling incentives¹⁶⁰. These policies emphasize expanding productive employment and technological capacity in the sector, facilitated by governmental support since 2017 through both public and private channels. The agenda particularly underscores private sector-driven development, leveraging Ghana's strengths in the West African region, such as stability, reliable power, security, a robust legal system, and a skilled, cost-competitive workforce. This strategic framework includes provisions for industrial parks, special economic zones, tax holidays, and rebates, all aimed at enhancing domestic value addition and export programs by leveraging trade agreements¹⁶¹¹⁶². Ghana's objective is to foster sustainable and diversified industrial growth, drive job creation, and establish itself as a prominent regional manufacturing hub.

Ghana's emerging environmental goods manufacturing sector presents an attractive opportunity for Chinese investors. Numerous Ghanaian companies are actively engaged in or progressing towards establishing solar PV module assembly and manufacturing plants for renewable energy components, tapping into a growing demand and exhibiting an expanding industry with significant growth potential¹⁶³¹⁶⁴.

¹⁵⁶ Ministry of Energy, Ghana. "Our Departments." Accessed July 26, 2023, from <https://www.energymin.gov.gh/our-departments>.

¹⁵⁷ Takase, M., & Kipkoeh, R. (2023). An Overview of Scientific Production of Renewable Energies in Ghana. *Journal of Energy*, 2023, Article ID 7414771, 10 pages. <https://doi.org/10.1155/2023/7414771>

¹⁵⁸ Oxford Business Group. (2022). Value Added Future: The Government's Drive to Further Develop the Industrial Base Creates Opportunities for Investment. <https://oxfordbusinessgroup.com/reports/ghana/2022-report/economy/value-added-future-the-governments-drive-to-further-develop-the-industrial-base-creates-opportunities-for-investment>

¹⁵⁹ Ghana Investment Promotion Centre (GIPC). (2023). Manufacturing, Oil and Gas. <https://www.gipc.gov.gh/manufacturing-oil-and-gas/#:~:text=Ghana%27s%20most%20important%20manufacturing%20industries,as%20textile%20and%20garment%20manufacturing.>

¹⁶⁰ Ministry of Trade and Industry Republic of Ghana. (2023). 10-Point Agenda Industrial Transformational Agenda 2023. Ministry of Trade and Industry Republic of Ghana. <https://moti.gov.gh/v2/10-point-agenda/>

¹⁶¹ ibid

¹⁶² Ghana Free Zones Authority. (2023). <https://gfza.gov.gh>

¹⁶³ PV Tech. (n.d.). Inside Ghana's first module manufacturing facility. Retrieved from <https://www.pv-tech.org/inside-ghanas-first-module-manufacturing-facility/>

¹⁶⁴ Annoh-Dompreh, H. (2022, February 15). Statement highlighting 'Progress for the Future of Renewable Energy in Ghana and the African Sub Region' by Hon. Annoh-Dompreh, Majority Chief Whip and M.P, Nsawam-Adoagyiri.

Investing in Ghana's environmental goods sector provides clear advantages, such as access to abundant natural resources, a favorable legal and tax framework, and a strong trade partnership with China, evident in a total environmental goods trade worth approximately US\$527 million. Chinese investors often favored Ghana, with an average of US\$67.38 million in foreign direct investment between 2017 and 2021. These factors collectively establish Ghana as a strategic gateway to West Africa, offering a promising path for mutual growth and collaboration.

Production Focus

Ghana possesses a substantial reserve of critical minerals crucial for clean technologies, providing a distinct advantage for the development of environmental goods manufacturing, particularly in the production of renewable energy equipment, such as solar panels and components, as well as in waste treatment technologies, agro-processing, organic agriculture, and e-mobility components such as batteries, charging infrastructure, and electric motor systems. With abundant reserves of critical minerals, a supportive policy environment, and a reliable energy supply, Ghana is in an advantageous position to assume a pivotal role in both the regional and global supply chain for clean energy technologies.

Cost Analysis

According to IMF growth forecast data, Ghana has regularly been among the top 20 fastest growing economies on the continent between 2019-2021. Within the same period, manufacturing as an economic sector contributed just under 11% to overall economic growth and should therefore be considered as a key growth contributor.

Inflation developments between 2019-2022 have pushed Ghana's Central Bank to hike interest rates as a way of dampening levels of borrowing, a move that has raised the cost of Ghana's loanable funds in nominal terms. But in real terms, domestic credit has favored borrowers. For Ghana's manufacturing sector, January 2019 to June 2023 Ghana Statistical Service data reveals an average 21% growth in manufacturing PPI. This indicator highlights underlying trends within Ghana's manufacturing sector, and the potential implications these had on manufacturing costs.

Diesel and by extension, production costs, have also been on the rise between 2019-2022. Pump prices grew from US\$0.99 per litre, up to US\$1.16, reflecting a 17% increase. Judging by Ghana's 2021 electricity costs of about US\$0.125 per kilowatt hour, energy may be a component of manufacturing that needs efficient generation and use, as parts of overall cost-management strategies. According to 2021 IRENA data, solar PV and onshore wind investments in Ghana both have WACCs of 9.5%. However, at \$147.35 per month in PPP terms, Ghana's labour costs partially offset the country's high energy costs. Additionally, the country's labour costs are at least 53% lower than Mexico's—the top environmental good exporter with the lowest labour costs.

4.2.6 NIGERIA

Nigeria's geographic location, abundant resources, educated workforce, and sustainable commitment — position it as an emerging environmental goods manufacturing hub in West Africa. Despite relatively low GHG emissions, Nigeria is a notable African carbon emitter at 0.71% of

MyJoyOnline. <https://myjoyonline.com/majority-chief-whip-reveals-progress-for-the-future-of-renewable-energy-in-ghana-and-african-sub-region/>

global emissions (369.38m/t).¹⁶⁵ Vulnerable to climate change due to its climate-dependent economy, Nigeria targets emissions reduction via the 2050 Long-Term Vision and National Determined Contributions (NDCs). The national blueprint of 2050 Long-Term Vision for Nigeria (LTV-2050) aiming to create a “low-carbon, climate-resilient Nigeria, and a mission of ensuring sustainable development and a climate proofed economy”¹⁶⁶. The NDCs seek a 20% unconditional and 47% conditional emission decrease by 2030, bolstering eco-friendly manufacturing¹⁶⁷. Adaptation plans prioritize resilient infrastructure and technologies as well as economic diversification and shift from oil-export dependence, complementing Nigeria’s environmental goods pursuit.

Nigeria’s accessibility via domestic markets, robust port infrastructure, and regional trade routes (ECOWAS, AU, AfCFTA) augments its hub potential. Domestic demand and neighboring market needs provide avenues for environmental goods supply, including renewable energy equipment, sustainable packaging, and waste management technologies.

Natural Endowment

Nigeria’s has abundant mineral resources, including tantalite, nickel, lithium, cobalt, and rare earth elements, highlighting its potential to play a pivotal role in global supply chains for eco-friendly technologies and products.

Nigeria’s significant hydrocarbon resources, such as crude oil, natural gas, and tar sands, have historically been the cornerstone of its economy, contributing substantially to export revenues and foreign exchange earnings.¹⁶⁸ As the largest oil producer in Africa, the country’s oil reserves of approximately 36 billion barrels have long defined its economic landscape. However, the heavy dependence on oil leaves Nigeria susceptible to commodity price fluctuations and external shocks, necessitating diversification strategies.

Diversification away from oil dependency aligns seamlessly with Nigeria’s commitment to sustainable environmental goods production and long-term economic sustainability. The nation’s extensive agricultural resources coupled with its abundant critical minerals offer a foundation for manufacturing diverse products such as biodegradable packaging materials and bio-based products. **Table 10** below provides a snapshot of critical minerals in clean transition in Nigeria.

¹⁶⁵ Climate Watch. (2023). Nigeria Country Profile.

https://www.climatewatchdata.org/countries/NGA?end_year=2020&start_year=1990

¹⁶⁶ United Nations Framework Convention on Climate Change (UNFCCC). (2020.). Nigeria’s Long-Term Low Emission Development Strategy (LTS1). https://unfccc.int/sites/default/files/resource/Nigeria_LTS1.pdf

¹⁶⁷ United Nations Framework Convention on Climate Change (UNFCCC). (2021). Nigeria’s Nationally Determined Contribution (NDC). https://unfccc.int/sites/default/files/NDC/2022-06/NDC_File%20Amended%20_11222.pdf

¹⁶⁸ Shaaban, M., & Petinrin, J. O. (2014). Renewable energy potentials in Nigeria: Meeting rural energy needs. *Renewable and Sustainable Energy Reviews*, 29, 72-84. doi:10.1016/j.rser.2013.08.078

Table 10: Top critical minerals used in clean transition^{169/170}

Critical minerals	Products	Found in Nigeria
Lithium	Battery	Yes
Nickel	Battery, wind turbines and EV motors	Yes
Cobalt	Battery	Yes
Manganese	Battery	Yes
Rare earth elements	Wind turbines and EV motors	Yes
Copper	Wind turbines and EVs and battery storage, Solar PV	Yes
Tantalite	Capacitor industry	Yes

Despite its resource abundance, Nigeria is vigorously addressing challenges and optimizing its natural endowment. Historically reliant on oil exports, Nigeria is now committed to diversification, driven by recognition of oil price vulnerability. Efforts extend to historically overlooked sectors, like the extractive industry, which has faced constraints, yielding N496 billion in earnings over 13 years.¹⁷¹ This realization fuels broader economic diversification, a priority embraced by the government for revenue expansion and stability.

To surmount challenges, Nigeria targets infrastructure limitations, bureaucracy, and regulatory inconsistencies while fostering sustainability. Nigeria's determination to overcome hurdles and attract private investment demonstrates its intent to fully leverage natural resources. Focusing on sustainable diversification and enhanced governance, Nigeria is poised for progress, capitalizing on its resource wealth for inclusive growth and environmental goods manufacturing.

Renewable Energy Potential and Structure

Nigeria boasts a substantial reserve of untapped renewable energy resources, presenting a promising opportunity for the nation's energy landscape. Solar, wind, and hydropower are the key contenders, with each offering immense potential for energy generation. Solar energy benefits from Nigeria's abundance of sunlight, making it an attractive option for expanding the renewable energy mix. Meanwhile, offshore wind power projects hold promise, given Nigeria's extensive coastline, and hydropower developments are viable due to the country's numerous rivers and water bodies.

Currently, Nigeria's renewable capacity is 2,158 MW, mostly from hydropower, biomass, and solar sources. Hydropower stands out at 10,000 MW, while wind boasts 150,000 terra joules per year potential. Solar radiation ranges from 3.5-7.0 kWh/m², and annual biomass resources reach 144

¹⁶⁹ IEA. (2021). The Role of Critical Minerals in Clean Energy Transitions. IEA, Paris. <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions>. License: CC BY 4.0

¹⁷⁰ Adams, J. (2023, July 19). Green Energy: Nigeria to Contribute 30% of Global Requirement. Sun News Online. https://sunnewsonline.com/green-energy-nigeria-to-contribute-30-of-global-requirement/#google_vignette

¹⁷¹ Eleanya, F. (2021, October 25). Nigeria Missing from Electric Vehicles Value Chain Despite Mineral Deposits. BusinessDay. https://businessday.ng/news/article/nigeria-missing-from-electric-vehicles-value-chain-despite-mineral-deposits/#google_vignette

million tons¹⁷²¹⁷³. Albeit the potential, renewables contribute less than 5% of total electricity output¹⁷⁴. Yet, Nigeria has the potential to transition to 100% renewable energy by 2050, led by solar (79.1%), onshore wind (20%), hydropower (0.8%), and wave energy (0.1%)¹⁷⁵.

Despite the abundant potential in the renewable energy sector, various challenges hamper its progress. Chief among them is the limitation of investment and financing options, posing a barrier to the realization of large-scale projects. The nature of certain renewable sources, like solar and wind, necessitates the establishment of effective energy storage solutions and grid integration mechanisms to ensure a dependable power supply. Also, policy and regulatory uncertainties, coupled with administrative hurdles, present additional challenges for investors and developers seeking to venture into the renewable energy domain. The country's longstanding reliance on small-scale fossil fuel generation further complicates the transition to renewable alternatives, requiring robust initiatives to break free from this entrenched dependence.

In response, Nigeria has proactively enacted Government initiatives like the Climate Change Act 2021, Energy Transition Plan, and the Renewable Energy Master Plan to increase the integration of renewable energy sources into its energy mix. These strategic frameworks set clear goals, aiming to achieve 75% electrification by 2025 and 36% renewable electricity by 2030.¹⁷⁶¹⁷⁷ Short-term measures like duty waivers for renewables and long-term strategies like tax credits, incentives, and loans further show Nigeria's commitment to sustainable energy and its potential as an environmental goods hub.¹⁷⁸

Manufacturing Capacity

Nigeria's manufacturing sector has grown steadily, contributing an average of 11.44% to its GDP from 2017 to 2021. The country's large population and natural resources provide a significant advantage for industrial growth. However, challenges such as inadequate infrastructure, regulatory bottlenecks, and inconsistent power supply hinder the sector's full potential.

Nigeria's large population provides a significant advantage for the manufacturing sector. With a diverse consumer base, the country offers a potentially vast market for various goods. Moreover, the availability of skilled labour, especially in urban centers, supports manufacturing activities. The strategic location of Nigeria in West Africa and its well-developed port infrastructure provide access to regional and international markets, enhancing the country's potential as a manufacturing hub for the region.

The manufacturing sector in Nigeria faces challenges that hinder its growth and competitiveness. Inadequate infrastructure, particularly in power supply and transportation, increases production costs and logistics inefficiencies. The high cost of financing and limited access to credit for small and medium-sized enterprises (SMEs) pose further challenges for businesses limiting the sector's potential to attract foreign direct investment and fully capitalize on its comparative advantages.

¹⁷² Adaramola, M., & Oyewola, O. (2011). On wind speed pattern and energy potential in Nigeria. *Energy Policy*, 39(5), 2501-2506.

¹⁷³ Akuru, U. B., & Okoro, O. I. (2010). Renewable energy investment in Nigeria: a review of the renewable energy master plan. In *Proceedings of the energy conference and exhibition (EnergyCon)*, 2010 IEEE International.

¹⁷⁴ 179 Eweka, E. E., et al. (2022). Energy Landscape and Renewable Energy Resources in Nigeria: A Review. *Energies*, 15, 5514. <https://doi.org/10.3390/en15155514>

¹⁷⁵ *ibid*

¹⁷⁶ Nigeria Energy Transition Plan. (2022). <https://energytransition.gov.ng>

¹⁷⁷ International Energy Agency (IEA). (2013, July 3). Nigeria Renewable Energy Master Plan. <https://www.iea.org/policies/4974-nigeria-renewable-energy-master-plan>

¹⁷⁸ *ibid*

To support local industries, the government has implemented policies and incentives, including the establishment of industrial parks and offering tax incentives to manufacturers to increase competitiveness, by removing barriers, and raising productivity.

Production Focus

Nigeria's dynamic population growth and urbanization present a distinctive advantage for environmental goods manufacturing. Focusing on production should pivot toward strategic sectors, encompassing e-mobility two-wheelers assembly, bioethanol production, solar panels, waste-to-energy solutions, and energy-efficient appliances. This precision-driven strategy not only satisfies market needs and propels sustainable expansion but also situates Nigeria as a central figure in the burgeoning regional environmental goods market. Aligning these production endeavors with local talent nurturing, technology sharing, and conducive regulatory environments is imperative for securing long-term success and regional leadership.

Cost Analysis

In Africa's largest economy, economic growth pre-COVID 19 and as of 2022, has been relatively slow when compared to the continent's leading growth drivers. At 3.2% and 3% respectively, 2023 and 2024 IMF growth forecasts put Nigeria almost at par with expected global growth rates. Between 2019-2021, Nigeria's manufacturing sector represented about 13% of overall economic growth, a sizeable contribution in nominal and monetary terms.

Like neighboring economy Ghana, Nigeria's Central Bank has used interest rates as a tool for inflation growth management, pushing up Nigeria's domestic borrowing costs. However, in real terms, has gone down 79.65% between 2019-2022. Looking deeper into the economy, 2021 electricity costs were about US\$0.139 per kilowatt hour, the second highest in our group of 10 regional hubs. Available diesel pump price data from 2019 and 2020 indicates a more competitive US\$0.44 per liter.

We also take note of the anticipated end to Nigeria's fuel subsidies in 2023 and the probable growth in manufacturing costs that comes with such a policy change. However, and in view of Nigeria's long-term economic outlook, the positive impact of more locally refined crude oil will gradually be realized through competitive fuel pump prices. Lastly, labour costs rank Nigeria a favorable third in our group of regional hubs at \$178.88 per month in PPP terms. Furthermore, when compared to labour markets in the world's leading environmental goods exporters, these costs are at least 43.91%, making them globally competitive and an attractive manufacturing sector investment consideration.

4.2.7 SOUTHERN AFRICA

Overview

Country	Avg. Manufacturing Sector Value Added (2017-2021, % GDP)	Labor force participation (% of total population ages 15+)	Logistic performance (LPI 2023)	Total Renewable Energy Capacity (MW) 2022	Critical mineral production (2017-2021)	Total EG Trade with China (2021, USD)	Avg. Chinese FDI in the country (2017-2021) in million USD
Botswana	5.93	64.96	3.1	6	4,814.33	15,235,552.00	-1.54
Eswatini	28.32	50.48		179	-	4,414,394.00	
Lesotho	15.63	64.33		75	-	1,787,737.00	4.42
Malawi	11.41	67.63		553	-	36,203,342.00	-6.416
Mozambique	8.30	78.48		2316	633,182.00	161,613,726.00	131.13
Namibia	11.85	58.87	2.9	533	76,532.80	69,823,845.00	0.79
South Africa	12.17	56.81	3.7	10445	17,086,711.20	1,937,610,088.00	412.4706409
Zambia	7.78	60.66		3303	903,466.58	66,733,093.00	353.996
Zimbabwe	13.41	66.06	2.5	1222	71,726.80	130,254,241.00	41.286

The above data highlights the strong potential of the Southern African region for environmental goods manufacturing. Significantly, the region's critical mineral production between 2017 to 2021 is in the highland across the continent. South Africa produces over 17 million tonnes as the top player, while Zambia (903,467 Tonnes), and Mozambique (633,182 Tonnes) all reached the millions level. Zimbabwe, Namibia and Botswana also ranked in the top 20 producers among African countries. The critical mineral production and the unveiled mining potential make the region a significant opportunity to be the EGs manufacturing hub.

Renewable energy is a critical pillar for environmentally good manufacturing, Southern Africa also shows competitive potential. According to International Renewable Energy Agency (IRENA)¹⁷⁹, South Africa, Angola, Zambia, as well as Mozambique and Zimbabwe, all stand out in their performance regarding renewable energy capacity in 2022. Compared to Ethiopia from Eastern Africa region, a well-known country with huge renewable energy potential, South Africa's 10,445

¹⁷⁹ 2023 International Renewable Energy Agency (IRENA), Renewable Capacity Statistics

MW almost doubled the number of Ethiopia. Angola, with 4,078 MW as the second place, still contains twice compared to Nigeria, the top country in the Western Africa region.

Moreover, the Southern Africa region maintains the base for the manufacturing industry to develop further. Most of the countries in the region have over 60% of labour force participation while their average manufacturing sector contributions to GDP are higher than 10% between 2017 to 2021, showing the fundamental industrialization progress as well as big development potential. The region also gets the top performance regarding electricity cost. According to the global electricity pricing in 2021, 10 countries listed on the cheapest 20 countries in the Sub-Sahara region are from Southern Africa region.¹⁸⁰

Finally, the region is also exposed to Chinese FDI, though highly centered in South Africa but reached US\$412 million, the biggest volume among the 20 selected countries. Regarding the current total EGs trade with China, except for the again biggest partner South Africa (US\$1.9 billion), Zimbabwe, Mozambique and Angola's volume are all around US\$150 million, making the region already a close trade partner and will boost the skill transfer, investment China that will contribute to the local manufacturing industry growth.

Generally speaking, the region contains huge internal gaps regarding critical mineral productions, renewable energy potential, as well as its manufacturing base and connectivity with Chinese investment and trade, South Africa and its neighboring BLNS countries (Botswana, Lesotho, Namibia, and Swaziland) show strong complementarities in their capability mix, making the 'hub and spoke' model possible for the whole region to connect with the global value chain through South Africa.

Regional Hubs

Based on the scoring system introduced in 4.1, this report identifies 2 regional hubs for environmental goods manufacturing in Southern Africa – South Africa and Zambia.



¹⁸⁰ Cable.co.uk, Global energy pricing league in 2021. <https://www.cable.co.uk/energy/worldwide-pricing/>

4.2.8 SOUTH AFRICA

South Africa is located within the called ‘drought belt’ and is the fifth most water-scarce country in sub-Saharan Africa. Approximately 50% of the country’s water supplies are used by the extensive and industrial agriculture sector,¹⁸¹ making its local ecosystem, economics and livelihoods all exposed to the climate impacts. Since 1990, the national average temperature has increased twice as fast as global temperatures. Meanwhile, South Africa’s dependence on coal as a primary fuel source for electricity generation makes it one of the world’s top 15 GHG emitters, mainly due to the country’s reliance on coal energy.^{182 183}

South Africa’s climate priorities span climate adaptation and mitigation. In the updated Nationally Determined Contribution, which is submitted in September 2021, the country commits to a fixed target for greenhouse gas emissions levels of 398-510 MtCO₂e by 2025, and 350-420 MtCO₂e by 2030, which shows significant progress from the old version. It has also set the goal to reach net zero emissions by 2050 in its Low-Emission Development Strategy. In the new NDC, critical sectors identified for mitigation were energy, waste, industrial processes and product use, agriculture, forestry, and other land use. It sets a policy base for South Africa to develop environmental goods manufacturing during the implementation of the updated NDC.¹⁸⁴

Though Coal is still the mainstay of the South African energy system, contributing to about 70% of installed power generation capacity, the government has announced a Just Energy Transition Partnership (JETP) together with the US, the UK, France, Germany and the EU during the COP26. The approximately US\$8.5 billion from the five donors over 3–5 years is supposed to be delivered through a combination of financial instruments to enable the just energy transition in South Africa, making the country to be an ideal destination for green manufacturing in the coming years.

As the leading economy of the region, South Africa is located in the center of the neighboring countries but meanwhile, hosts a relatively mature industrial base, also globally connected ports that will combine the potential power across the region and link with the global value chain regarding environment goods manufacturing and trade.

Natural Endowment

South Africa is the home to 53 mineral commodities and boasts the world’s biggest share of manganese and platinum reserves¹⁸⁵. It is a leading producer of several critical minerals, including platinum group metals (PGM), manganese, chromium and vanadium – all of which are essential to produce batteries and renewable energy components, while the country is additionally responsible for 60% of the global manganese supply, 75% of platinum supply and 40% of palladium supply.

South Africa is home to 75% of the world’s reserves of PGMs, such as platinum, ruthenium and iridium are key components in fuel cell catalysts and electrolyzers for green hydrogen production.

¹⁸¹ World Bank, Climate Change knowledge portal, <https://climateknowledgeportal.worldbank.org/country/south-africa/climate-data-historical>

¹⁸² UNEP, GHG emissions of all world countries - 2021 Report, https://www.unep.org/explore-topics/climate-action/what-we-do/climate-action-note/state-of-climate.html?gclid=CjwKCAjw52mBhB5EiwA05YKo_ctVL58vrmbccUCTVZ9-s4W954dj7oxw7M7v3Qo6Ao5P4uCSueD7RoC0GAQAvD_BwE

¹⁸³ IEA, South Africa Country Profile, <https://www.iea.org/countries/south-africa>

¹⁸⁴ <https://unfccc.int/sites/default/files/NDC/2022-06/South%20Africa%20updated%20first%20NDC%20September%202021.pdf>

¹⁸⁵ Mineral resources and energy, <https://www.gov.za/about-sa/minerals#reserves>

Table 11 below shows a snapshot of key critical mineral production in South Africa. In 2021, South Africa’s PGM production measured 285 metric tons. Regarding the rare earth elements, which are essential for electric vehicle motors, the country’s Steenkampskraal mine in the Western Cape has the highest grade in the world.

Table 11: Critical Mineral Production in South Africa¹⁸⁶

Critical minerals	Products	Avg. production (2017-2021)
Lithium	Battery	-
Nickel	Battery, wind turbines and EV motors	40,363
Cobalt	Battery	904.8
Manganese	Battery	16,285,387.4
Graphite	Battery	-
Rare earth elements	Wind turbines and EV motors	-
Copper	Wind turbines and EV motors, power lines	44,455.8
Aluminum	Power lines	715,600

However, the bulk of the commodities that are key for renewable energy lies underground in other SADC countries like the DRC, Zambia and Namibia. Take cobalt as an example, the top 3 global cobalt productions come from DRC (58%), Zambia (3.5%) and Madagascar (2.1%) which are not far from South Africa while SA itself and the neighbor countries, Zimbabwe, and Botswana also produce cobalt locally.¹⁸⁷ The government body, the Department of Mineral Resources and Energy (DMRE) on its five-year exploration strategy aimed at capturing 5% of the global exploration spend of US\$11.2 billion (in 2021).

Renewable Energy Potential and Structure

According to the Council for Scientific and Industrial Research (CSIR) in South Africa, Coal still dominates the South African energy mix, providing 80% of the total system load in 2022. The contribution of renewable energy technologies (wind, solar PV and CSP) increased in 2022 to a total of 6.2 GW installed capacity and provided 7.3% of the total energy mix.¹⁸⁸

With an average of 2,500 hours of sunshine per year, and 4.5 to 6.6 kWh/ m² of radiation level, South Africa is among the top three in the world. The total wind power potential of South Africa is

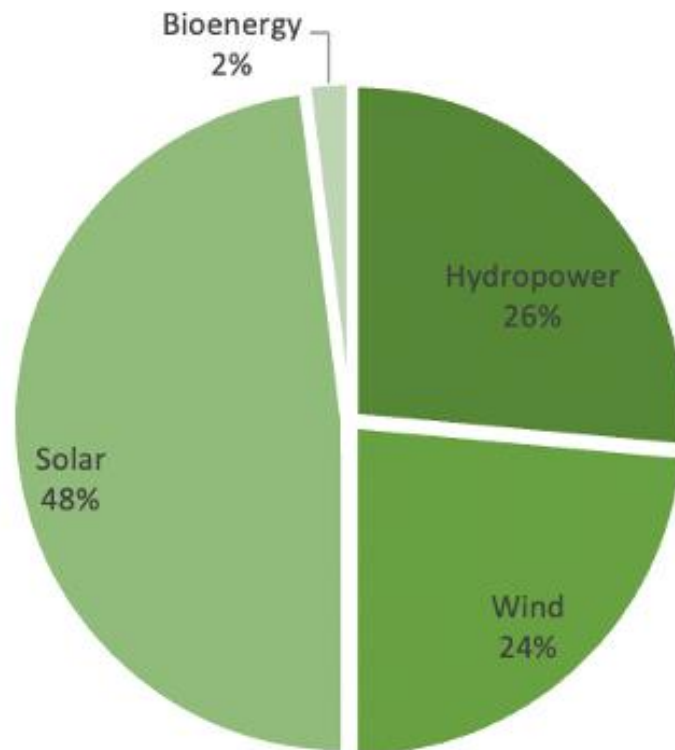
¹⁸⁶ Source: British Geological Survey-Critical Mineral Production (2017-2021)

¹⁸⁷ European Commission, Critical Raw Materials in Africa,
<https://storymaps.arcgis.com/stories/79b2db81b98a42e69ef2a9390b2aab42>

¹⁸⁸ The Council for Scientific and Industrial Research, statistics on power generation in South Africa for 2022,
<https://www.csir.co.za/sites/default/files/Documents/Statistics%20of%20power%20in%20SA%202022-CSIR-%5BFINAL%5D.pdf>

estimated to be 6,7000 GW and is found to be competitive with the solar potential.¹⁸⁹ In general, South Africa holds significant renewable energy capacity, reaching 10,455 MW capacity in 2022 to be the top place in the African region.¹⁹⁰ The Figure 16 below shows that solar energy accounted for 48% of South Africa installed renewable energy distribution, followed by hydropower (26%) and wind (24%). It is also important to see that the renewable energy share of the country's electricity capacity keeps increasing from 3.3% in 2013 to the 17% in 2022 (see Figure 17).¹⁹¹

Figure 16: South Africa installed renewable energy distribution (2022)¹⁹²



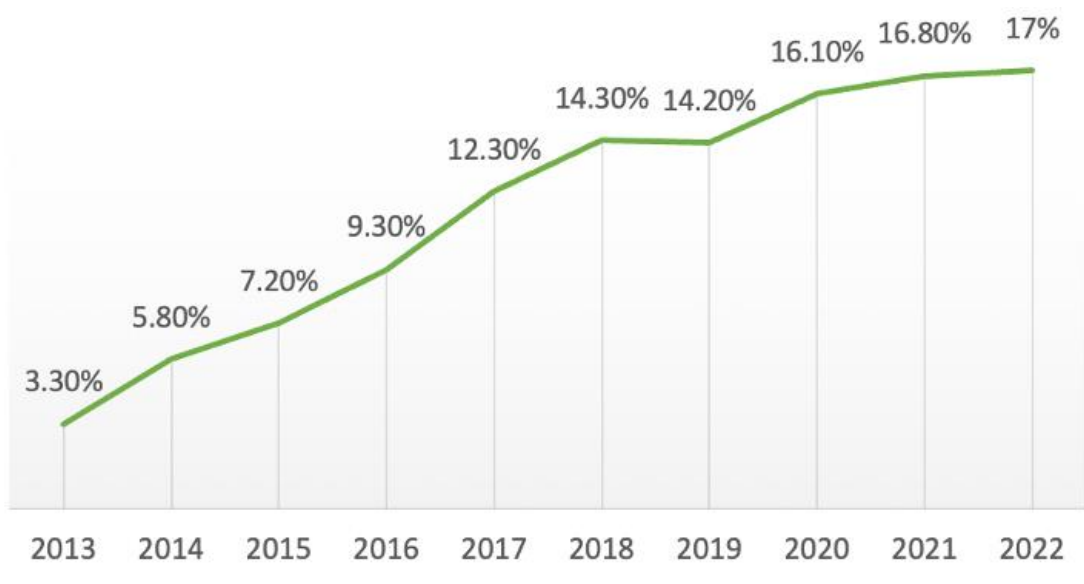
¹⁸⁹ IRENA, RENEWABLE ENERGY PROSPECTS: June 2020 SOUTH AFRICA, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jun/IRENA_REmap_South_Africa_report_2020.pdf?rev=4c91c220ae4b441dbbfaf1ce36c2d3ec

¹⁹⁰ IRENA, Renewable Capacity Statistics (2023), <https://www.irena.org/Publications/2023/Mar/Renewable-capacity-statistics-2023>

¹⁹¹ IRENA, Renewable Capacity Statistics (2023), <https://www.irena.org/Publications/2023/Mar/Renewable-capacity-statistics-2023>

¹⁹² IRENA, Renewable Energy Capacity Statistics 2023

Figure 17: South Africa Renewable energy share of electricity capacity (2022)¹⁹³



South Africa's government moves fast on promoting the energy transition these years. The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) has driven a rapid expansion of renewable energy in the country since 2011, which is a public procurement program that allows Independent Power Producers (IPPs) to submit competitive bids to design, develop and operate large-scale renewable energy power plants across South Africa (see **Table 12**).

As of the end of 2021, 6,323 MW of renewable energy had been procured through the REIPPPP, with 5,661 MW generation capacity added to the national grid; 71,073 GWh of energy has been generated by renewable energy sources procured under the REIPPPP since the first project became operational in November 2013.¹⁹⁴

¹⁹³ IRENA, Renewable Energy Capacity Statistics 2023

¹⁹⁴ Independent Power Producer Office, Independent Power Producers Procurement Programme Overview, As at 31 December 2021

Table 12: REIPPPP highlights to date, based on Eskom (2022) and DMRE (2022d) ¹⁹⁵

REIPPP Bidding Window	BW1	BW2	BW3&B W3.5	BW4&4b	RMIPPP	BW5	BW6
Projects amount	28	19	18	26	11	25	6 preferred bidders announced
Capacity	1415 MW	1033 MW	1628 MW	2205 MW	2000 MW	2583 MW	Only 1 000 MW of 5 200 MW listed as preferred bidders
Progress	All projects connected	All projects connected	17 projects connected, 1 project in execution phase	25 projects connected and 1 in execution phase	11 preferred bidders. 3 projects currently in construction (150 MW PV with BESS)	25 preferred bidders. 6 PPAs signed. Financial close expected in January 23.	6 out of 56 bids announced as preferred bidders in December 2022 and early 2023

Beyond the newly signed JETP during COP26 mentioned at the beginning, the Integrated Resource Plan (2019) also sets out a long-term diversification of the power mix by 2030 and moves towards lightening the carbon footprint of the energy sector while meeting growing energy demand and ensuring a socio-economically just transition. With a cleaner energy transition, the local manufacturing of environmental goods will become a driven industry to the country's sustainable development.

Manufacturing Capacity

South Africa is one of the leading nations that host relatively good manufacturing fundamentals. Between 2017 to 2021, its manufacturing sector contributes an average of 12.17 % to its GDP. Compared to peer countries, it also shows good performance regarding connectivity and logistics, making it an ideal position to manufacture and export environmental goods.

Recent data have shown that South Africa has imported US\$2.5 billion worth of solar panels, lithium-ion batteries, and inverters in the 1st half of 2023, rising sharply from US\$0.8 billion in 2021 and US\$1.7 billion in 2022¹⁹⁶. It shows great opportunities for the local markets.

Though South Africa shows ideal resources and infrastructure to be the EG manufacturing hub, it still faces many challenges. Though the energy capacity is huge, the issue of an ageing network infrastructure remains a concern for the distribution network as it compounds the supply and limits South Africa's ability to expand electricity access.

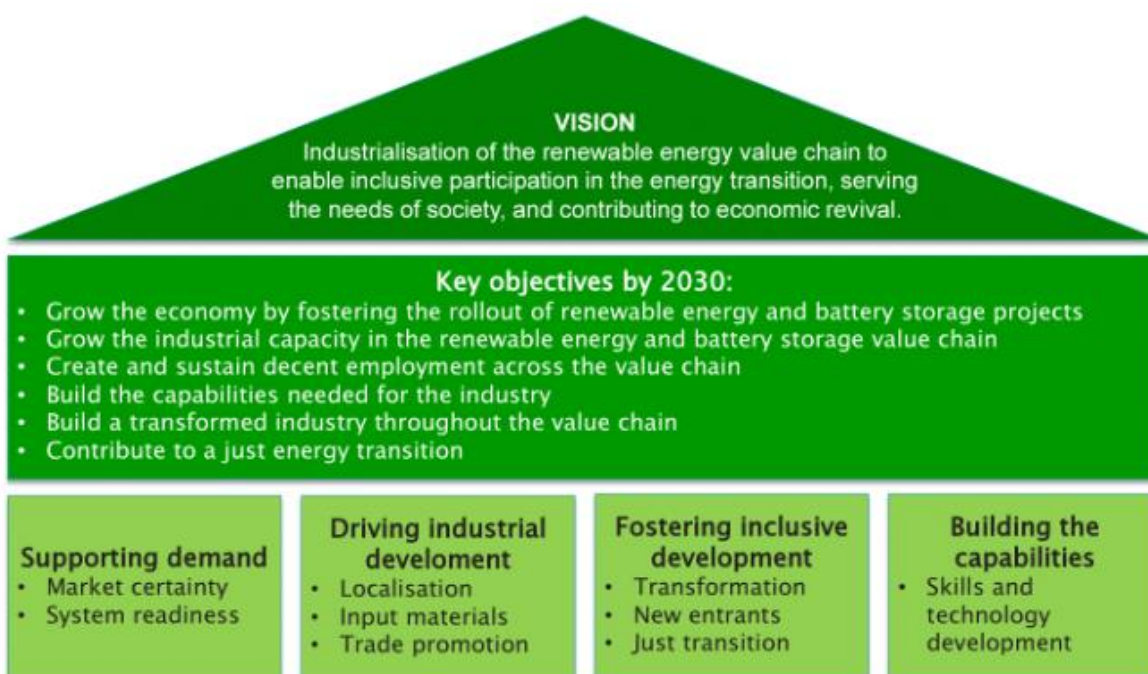
¹⁹⁵ GreenCape. 2023. Large-scale Renewable Energy Market Intelligence Report.

¹⁹⁶ Gaylor Montmasson-Clair, https://www.linkedin.com/posts/gaylor-montmasson-clair-40188023_solarpanels-batteries-renewableenergy-activity-7094269030026350593-ybuT?utm_source=share&utm_medium=member_desktop

Though data shows the labour value added directly contained in exports (that is, the wages paid to produce the exports) has been increasing robustly since 2001—growth over the decade was 7.7 per cent annually in nominal terms. But relative to the value of gross exports, the labour share is in sharp decline. In 2001 each US\$100 of exports generated US\$41 of domestic wages, while by 2011 this figure had fallen to US\$33—of which just US\$14.5 comes directly in the export sectors, with the rest coming through backward links to the domestic economy.¹⁹⁷

Currently, the Department of Mineral Resources and Energy (DMRE) is leading the drafting of the South African Renewable Energy Masterplan (SAREM), as shown in Figure 18 below. The SAREM process was initiated in 2020 to drive the industrialization of the renewable energy value chains and it aims to leverage the rising demand to unlock the industrial and inclusive development of associated renewable energy and battery storage value chains in South Africa.

Figure 18: South African Renewable Energy Masterplan (SAREM) ¹⁹⁸



As one of the four key pillars under SAREM, localizing the renewable energy and storage value chains to boost industry development and trade is majorly highlighted. The local manufacturing of solar PV, Wind energy facilities, Lithium-ion batteries and vanadium-based batteries (VRFB), as well as the local services, surrounding EGs production and use, including the end-of-life management (reuse, remanufacturing and recycling), were all highlighted (see Figure 19).

¹⁹⁷ World Bank, Factory Southern Africa? SACU in Global Value Chains, <https://documents1.worldbank.org/curated/en/973351468195001238/pdf/102850-WP-P149486-Box394847B-PUBLIC-Factory-Southern-Africa-FINAL-PUBLISH-002.pdf>

¹⁹⁸ [https://www.dmr.gov.za/Portals/0/Resources/Renewable%20Energy%20Masterplan%20\(SAREM\)/South%20Africa%20Renewable%20Energy%20Masterplan%20\(SAREM\)%20Draft%20III.pdf?ver=2023-07-17-141604-137×tamp=1689596128318](https://www.dmr.gov.za/Portals/0/Resources/Renewable%20Energy%20Masterplan%20(SAREM)/South%20Africa%20Renewable%20Energy%20Masterplan%20(SAREM)%20Draft%20III.pdf?ver=2023-07-17-141604-137×tamp=1689596128318) (It is still the draft version and currently calling for comments from the public)

Figure 19: Summary of renewable energy and battery storage industrial development opportunities for South Africa

Table 4: Summary of renewable energy and battery storage industrial development opportunities for South Africa

Technology	Past/existing activities	Short- to medium-term opportunities	Frontier
Solar PV	Mounting structures, trackers, modules	Growth of existing industry Cell manufacturing	Production of ingots and wafers
Wind energy	Steel and concrete towers, rotors (including blades)	Growth of existing industry Blade manufacturing	Hub manufacturing Production and assembly of nacelles
Lithium-ion batteries	Mineral beneficiation, casing and assembly and electrical systems (including battery and energy management systems)	Growth of battery manufacturing Growth of mineral beneficiation	Cell manufacturing
VRFB	Vanadium mining and refining, electrolyte production and VRFB assembly	Overall growth (conditional to demand)	Stack manufacturing
Cross-cutting	Manufacturing of (centralised) inverters, civil works, electrical balance of plant (e.g. cables) as well as numerous services	Overall growth	Overall growth

Note: while individual component manufacturing would benefit from domestic value chain integration, most can be developed independently of each other. A few stages, such as wafers to cells, require integration.

With the goal of promoting the development of local industrial capabilities in the production of renewable energy and storage components to ensure the availability of supply for the domestic market as well as shield the local market from excessive price volatility, SAREM highlights different intensives, including the implementation of a targeted incentive will be pursued by re-activating the existing (but currently inactive) 12i tax allowance incentive with a focus on renewable energy and battery value chains (and possibly other “green technologies”), as well as provide financial support to the SMEs from the EG sectors. With the SAREM launching in the future, South Africa is possible to become a leading hub of environment goods manufacturers.

Cost Analysis

For Southern Africa and one of the continent’s largest economies, the pace of growth has lagged global growth between 2019-2022. IMF data forecasts an unchanged trend for 2023 and 2024, with growth forecasts of 0.1% and 1.8% respectively. In terms of sectoral contribution to overall growth, South Africa’s manufacturing sector represents about 11.95%, a significant proportion in nominal and monetary terms.

Inflation as measured by CPI, has increased by 71% between 2019-2022, with a 52.65% spike between 2021-2022. Accordingly, interest rates have grown between 2019-2022, raising the cost of running and funding business in South Africa. 2021 electricity tariffs of about US\$0.076 per kilowatt hour place South Africa slightly below our 10-country median of US\$0.090. Diesel on the other hand, is a significant production cost and is the third highest in our 10-country regional hub group. 2019-2022 data on pump prices notes a 25.24% increase in the period, with an average price of US\$1.05 per litre. According to 2021 IRENA data, solar PV and onshore wind investments in South Africa have globally competitive WACCs of 5.2% and 6.6% respectively.

In terms of labour costs, South Africa’s \$243.10 per month in PPP terms ranks fifth in our 10-country regional hub group and comes 84.59% lower than a global median among the top 20 global exporters of environmental goods.

4.2.9 ZAMBIA

As Africa's second-largest producer of copper, Zambia domain a leading position in critical minerals across the continent, while around 85% of its electricity from hydropower, which all makes it under the spotlight of global investors from both public and private sectors to generate green investment. Since becoming president in 2021, Hakainde Hichilema has sought to pragmatically exploit global interest in his country's mineral wealth under the global green energy transition trends.

Lately, on August 3, 2023, the UK-Zambia Green Growth Compact, aimed at generating US\$3.17 billion of British private sector investment in Zambia's mining, minerals and renewable energy sectors alongside US\$500 million pounds of government-backed investments.¹⁹⁹ Early this year, Zambia and UAE, the next COP28 host, also reached a US\$2 billion agreement for Emirati solar investments across Zambia.²⁰⁰ Last year, the Biden administration also committed to helping Zambia develop a supply chain for electric vehicle batteries to end its dependence on raw minerals export.²⁰¹

However, mining is a particularly energy-intensive activity and mining companies have not escaped electricity rationing following the record-low water levels at Lake Kariba, the world's biggest dam reservoir. Such cuts have come at an inopportune time as global demand for copper is rising, and the climate change impacts are also challenging the process. Zambia submitted its updated NDC in July 2021 but remains the mitigation target to reduce emissions by 25% by 2030, or by 47% with substantial international support. In early 2023, it also launched the NDC Implementation Framework with about US\$17.2 billion cost until 2023 to prioritize the national climate actions, also to meet its "Vision 2030" for a "climate-resilient and low carbon economy".²⁰² The country's active participation in green transition and climate commitments are also the internal drive to be the regional hub.

Finally, while the government walk closely to the West, the country's largest bilateral creditor and the second largest importer and exporter, China also agree to debt relief under the IMF G20 common framework, which gives extra space for future green projects.²⁰³

Natural Endowment

As the world's eighth-largest producer of copper in 2022²⁰⁴, it is also home to small, exploitable deposits of cobalt, nickel, and manganese, Zambia possesses world-class mineral reserves that could boost global energy transitions to defend global climate change.

¹⁹⁹ Britain agrees deals on clean energy, critical minerals with Zambia, <https://www.reuters.com/world/britain-agrees-deals-clean-energy-critical-minerals-with-zambia-2023-08-02/>

²⁰⁰ Zambia and UAE Sign Landmark Agreement for \$2 Billion Renewable Energy Investment, <https://www.lusakatimes.com/2023/01/17/zambia-and-uae-sign-landmark-agreement-for-2-billion-renewable-energy-investment-2/>

²⁰¹ The United States Releases Signed Memorandum of Understanding with the Democratic Republic of Congo and Zambia to Strengthen Electric Vehicle Battery Value Chain, <https://www.state.gov/the-united-states-releases-signed-memorandum-of-understanding-with-the-democratic-republic-of-congo-and-zambia-to-strengthen-electric-vehicle-battery-value-chain/>

²⁰² NDC Partnership, Zambia's NDC Implementation Framework, <https://ndcpartnership.org/news/zambia-launches-integrated-path-climate-action-through-its-ndc-implementation-framework>

²⁰³ IMF Managing Director Welcomes Debt Treatment Agreement Reached by Zambia and Its Official Creditors under the G20 Common Framework, <https://www.imf.org/en/News/Articles/2023/06/22/pr23235-imf-welcomes-debt-treatment-agreement-reached-by-zambia>

²⁰⁴ GlobalData, Global Copper Mining to 2026 report, <https://www.mining-technology.com/data-insights/copper-in-zambia/>

The nation's economy highly depends on mining. **Table 13** below provides a snapshot of main critical minerals productions in Zambia. According to Zambia Extractive Industries Transparency Initiative (ZEITI), the extractive sector contributes to 90% of the country's GDP, accounting for 77% of total export earnings and 39% of government revenues in 2021²⁰⁵, mainly developed by global mining giants such as First Quantum Minerals (FQM), Barrick Gold, and Glencore active in the country.

Table 13: Zambia's critical minerals productions²⁰⁶

Critical minerals	Products	Avg. production (2017-2021)
Copper	Wind turbines and EV motors, power lines	826,484.6
Nickel	Battery, wind turbines and EV motors	2,164.25
Cobalt	Battery	1,895.33
Manganese	Battery	72,992.4

It makes sense that the country is trying to seize the global drive for critical minerals to boost the green transition into capital and already set the ambition to treble the country's copper production to three million tonnes by 2040. After consulting with industry stakeholders, Zambia also implemented policy measures to attract investment, including the removal of "double taxation" whereby mining companies paid corporate tax on top of royalties.

In response to the active changes the new administration brought in, the Canadian-listed FQM, announced a new \$1.35bn dollar investment over 20 years in its Kansanshi Mine. Other top firms also made their steps forward. Anglo American announced the acquisition of a majority stake in a junior exploration firm and Rio Tinto has also stepped-up exploration through joint ventures too.

Renewable Energy Potential and Structure

Zambia is located along a network of rivers at the end of the East Africa great depression, and the hydropower domain is the country's electricity supply for a long time. As **Figure 20** shown below, the renewable energy share of electricity capacity was 97% in 2013, but the share declined to about 82% in 2016. It is also because the increase in generating capacity mainly comes from the coal-fired power plant in Maamba in the past decade.

²⁰⁵ 2021 Zambia Extractive Industries Transparency Initiative (ZEITI) report, <https://zambiaeiti.org/wp-content/uploads/2023/05/2021-ZEITI-Report.pdf>

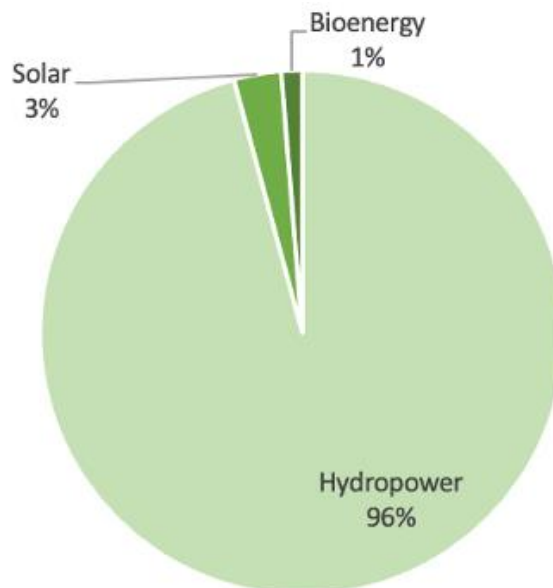
²⁰⁶ Source: British Geological Survey-Critical Mineral Production (2017-2021)

Figure 20: Zambia Renewable energy share of electricity capacity (2022)²⁰⁷



As 95% of the nation's renewable energy generations came from hydropower, climate change is also challenging to the current energy structure (see **Figure 21**). Lake Kariba under the Zambezi River Authority is the world's biggest dam reservoir, but its reservoir has not been at full capacity since 2011 and stopped generating electricity at the Kariba Dam's South Power Station in late 2022, causing a severe electricity crisis.

Figure 21: Zambia installed renewable energy distribution (2022)



²⁰⁷ Source: IRENA, Renewable Energy Capacity Statistics 2023

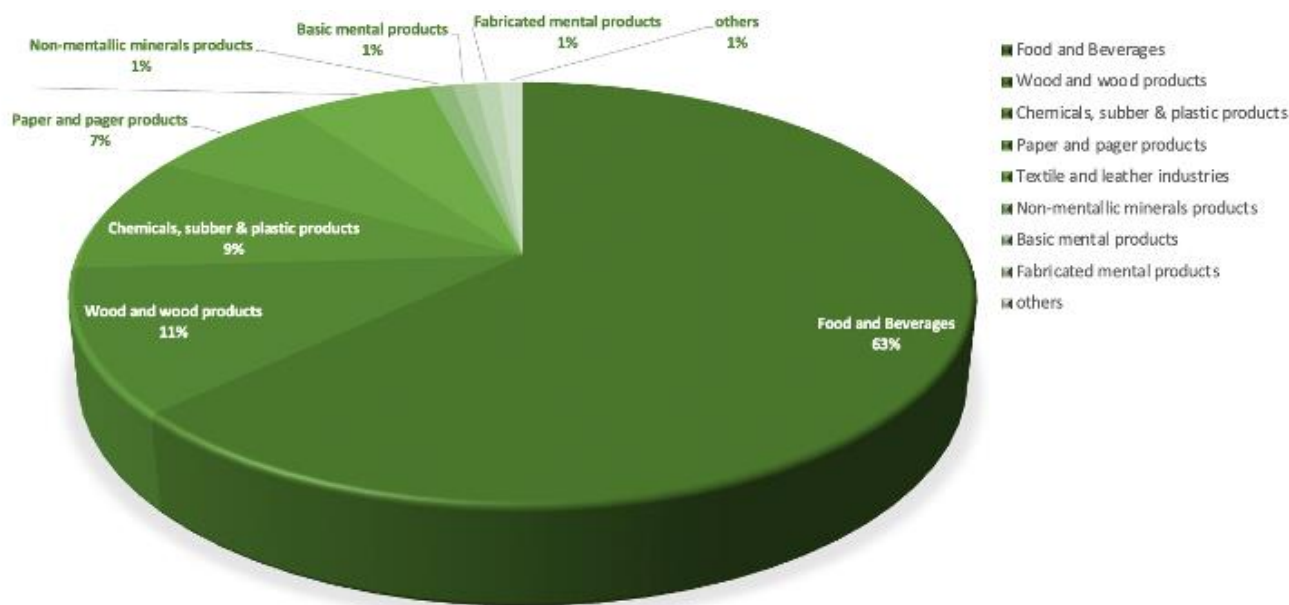
The Sinohydro-constructed Kafue Gorge Lower (KGL) Power Station marks a continued commitment to sustainable generation. The first of its five turbines was commercially commissioned in July 2021²⁰⁸ and the last also started in March 2023, making the renewable contribution to the electricity supply increase again, reaching 84.5% in 2021 and 86.3% in 2022.²⁰⁹ Meanwhile, the mining sector's development also has a vital role to play in supporting the country's green transition. FQM's investment announcement was paralleled by an ambitious solar and wind energy project to power its operations.

Manufacturing Capacity

From 2017 to 2021, the manufacturing sector contributes an average of 7.78% of the country's GDP²¹⁰ and has been consistently growing due to growing investment in the sector.²¹¹ But according to the Zambia Development Agency, as shown in Figure 22 below, the manufacture is largely driven by food & beverages processing (63%), textiles and leather wood products (11%). The process of metals, especially the smelting & refining of copper, leads the secondary processing products manufacturing, but only accounting for about 3% of the total sector.²¹²

Government incentives support new businesses that process copper rather than exporting raw copper, including the manufacture of copper wire and other copper products, such as copper plate and tubing, copper rods and cables, which is also essential for the energy transition.

Figure 22: Composition of Zambia's manufacturing sector²¹³



²⁰⁸ Afrik21, ZAMBIA: Sinohydro commissions Unit I of the Kafue hydroelectric power station, <https://www.afrik21.africa/en/zambia-sinohydro-commissions-unit-i-of-the-kafue-hydroelectric-power-station/>

²⁰⁹ IRENA, Renewable Energy Capacity Statistics 2023

²¹⁰ World Bank-World Development Indicators, Manufacturing Sector, value added (as % of GDP)

²¹¹ Zambia Development Agency, Manufacturing Sector Profile, <https://www.zda.org.zm/manufacturing/>

²¹² Zambia Development Agency, Manufacturing Sector Profile, <https://www.zda.org.zm/manufacturing/>

²¹³ Source: Zambia Development Agency

Historically, with the private ownership to state-led import substitution and subsequent de-industrialization, the contribution of manufacturing to Zambian GDP proliferated from 10% in 1971 to an impressive peak of 37 % in 1992, which is also evidence that the country established good manufacturing foundations. In response to the recent decades' downturn, the government set the goal that manufacturing as a priority sector to be technology-based, export-focused, dynamic and competitive according to the country's "Vision 2030" with effective entities that add value to locally abundant natural resources, to transform Zambia into a prosperous middle-income country. Regionally, the country's membership in regional organizations such as the Common Market for Eastern and Southern Africa (COMESA) and the Southern African Development Community (SADC) provides export markets in the region for value-added manufactured products.

More specifically, to set up the first steps towards economic growth through manufacturing, the government bodies have identified Multi-Facility Economic Zones (MFEZs) and industrial parks, introduced a zero tax for a period of 10 years from the first year of commencement of work in an MFEZ or industrial park, on profits made on exports²¹⁴. As a result, the Lusaka South Multi-Facility Economic Zone had attracted more than 30 companies, with a total pledged investment of US\$230 million and 400 jobs in 2022. It is also revealed that there is an MFEZ in Kalumbila, a mining town to promote mining-linked manufacturing for Zambian and Congolese markets.²¹⁵

Cost Analysis

According to IMF data, between 2019-2022, Zambia either matched or lagged global economic growth rates. Like Congo Republic, a turnaround has been forecast for 2023 and 2024, with growth rates of 4% and 4.1% expected respectively. In terms of contribution to overall economic growth, Zambia's manufacturing adds about 8%, and is on the lower-end of our 10-country regional hub group.

In the period 2019-2023, Zambia's inflation has remained elevated, prompting interest rate hikes from the country's Central Bank and by extension, increasing borrowing costs. While 2021 electricity tariff indicate a competitively low US\$0.056 per kilowatt hour in Zambia, diesel pump price data between 2019-2022 is the highest in our 10-country regional hub group. However, we assess Zambia's labour costs as measured by monthly minimum wage data, as a potential offset to the relatively high energy prices. In PPP terms, wages stand at about \$93.97, making Zambia's labour-intensive manufacturing competitively low.

²¹⁴ ZAMBIA: FISCAL INCENTIVES TO PROMOTE MANUFACTURING IN ECONOMIC ZONES RE-INTRODUCED, <https://bowmanslaw.com/insights/corporate-services/zambia-re-introduces-fiscal-incentives-to-promote-manufacturing-in-economic-zones/>

²¹⁵ 2023 national budget: manufacturing to stimulate growth and value addition, <https://bowmanslaw.com/insights/tax/zambia-2023-national-budget-manufacturing-to-stimulate-growth-and-value-addition/>

4.2.10 NORTHERN AFRICA

Overview

Country	Avg. Manufacturing Sector Value Added (2017-2021, % GDP)	Labor force participation (% of total population ages 15+)	Logistic performance (LPI 2023)	Total Renewable Energy Capacity (MW) 2022	Critical mineral production (2017-2021)	Total EG Trade with China (2021, USD)	Avg. Chinese FDI in the country (2017-2021) in million USD
Algeria	23.83	40.58	2.5	599	-	649,859,178.00	23.57084
Egypt	16.09	41.82	3.1	6322	390,758.80	2,116,898,590.00	109.766
Libya	2.84	47.47	1.9	6	-	208,586,803.00	-43.568
Mauritania	5.99	40.84	2.3	123	26,777.20	64,698,982.00	18.95
Morocco	14.94	45.57		3727	119,127.00	488,456,512.00	43.368
Tunisia	14.23	45.74		508	-	196,939,685.00	4.94

Environmental good manufacturing capacity and potential varies across North African countries. In Algeria, Egypt, Morocco and Tunisia, manufacturing has been a key contributor to economic development in the period 2017-2021. By narrowing down our assessment to focus on the production of environmental goods, trade data in the same period ranks these four countries in Africa's top five environmental good exporters.

The estimated ranges of active working populations in the region are between 40%-48%, highlighting that no individual economy has a clear edge over the other. But when it comes to mineral commodities and considering their importance in the environmental good value chain, our critical mineral production data highlights Egypt and Morocco as clear leaders. Looking at the role of clean energy generation and its significance in North Africa, renewable energy potential data favours the larger economies in the region; namely Egypt and Morocco. In the broader context of Africa's trade and investment engagements with China, we also find that Egypt and Morocco are North Africa's top environmental good exporters to China and lead in securing FDI from China.

Regional hubs

Based on the scoring system introduced in 4.1, this report identifies two regional hubs for environmental goods manufacturing in North Africa - Egypt and Morocco.



4.2.11 EGYPT

Table 14: Egypt's National Climate Change Strategy (NCSS) 2050

Goals	Targets	Key Objectives
Goal 1: Achieving Sustainable Economic Growth and Low-Emission Development in Various Sectors	Renewable and alternative energy	<ul style="list-style-type: none"> -Increase their share in national energy mix -cutting down fossil fuel emissions -improving energy efficiency -adoption of non-energy sector sustainable production and consumption
Goal 2: Enhancing Adaptive Capacity and Resilience to Climate Change and Alleviating the Associated Negative Impacts	Citizens and local environment	<ul style="list-style-type: none"> -shield Egyptian citizens from climate change health impacts -reduce loss and damage impacts -preservation of resources from climate change -improve infrastructure and service delivery climate resilience -disaster risk reduction -creation and growth of green spaces -better positioning women to adapt and respond to climate change impacts
Goal 3: Enhancing Climate Change Action Governance	Systems and stakeholders	<ul style="list-style-type: none"> -allocation of stakeholder roles to achieve set climate goals -attract climate finance -sector-level policy reform to match intended climate change interventions -improving Egypt's "monitoring, reporting and verification system"
Goal 4: Enhancing Climate Finance Infrastructure	Financial system	<ul style="list-style-type: none"> -stimulating climate finance -enhance climate adaption finance and innovative mechanisms -roping-in private sector -multilateral development bank climate finance compliance -continuation of successful climate finance outcomes
Goal 5: Enhancing Scientific Research, Technology Transfer, Knowledge Management and Awareness to Combat Climate Change	Science and technology-led communication	<ul style="list-style-type: none"> -revolving climate change response on scientific research and technology transfer -information sharing within state organisations and among citizens -awareness campaigns

Table 14 above provides a snapshot of Egypt’s National Climate Change Strategy (NCSS). In addition to the strategy above, Egypt has also updated its set of NDCs to cover the period 2015-2030. Key areas touched on are sector level climate change mitigation and adaptation measures, forecast greenhouse gas emission scenarios in relation to planned interventions, and points of clarification concerning Egypt’s new NDCs²¹⁶.

Natural Endowment

Egypt’s US\$130 billion mining and the extractive industry has contributed as much as 30% to GDP between 2017-2021, making it a pillar of economic growth.²¹⁷ More importantly, World Bank mineral rent indicators highlight a series of positive figures. This means that Egypt’s production of minerals has a net financial contribution to Egypt.

Table 15: snapshot of Egypt’s critical mineral production

Mineral	Average Annual Production Volume (tonnes, 2017-2021)
Manganese	111k
Aluminium	280k

Petroleum and natural gas dominate the industry, with about 90% of Egypt’s electricity generated from these sources²¹⁸. However, mining and quarrying of mineral commodities also supports Egypt’s mining sector development. In terms of critical mineral production, the latest British Geological Survey data identifies consistent manganese and aluminium outputs between 2017-2021 (see **Table 15** above). Based on mine production and mineral reserve estimates, Egypt’s Aluminium and Manganese volumes fall outside of the top 10 worldwide²¹⁹.

Renewable Energy Potential and Structure

Table 16: Egypt’s renewable energy structure (2022)

Source of energy	Current capacity (MW)	% of total
Hydropower	14,769	58
Wind	5,269	20.8
Solar	4,973	19.66

²¹⁶ Nationally Determined Contributions, "Egypt’s First Updated Nationally Determined Contributions". 2022. <https://unfccc.int/sites/default/files/NDC/2022-07/Egypt%20Updated%20NDC.pdf.pdf>

²¹⁷ World Bank. 2015. "Local Manufacturing Potential for Solar Technology Components in Egypt." <https://documents1.worldbank.org/curated/en/815821468189556943/pdf/95144-REVISED-WP-P113684-PUBLIC-Box393206B.pdf>

²¹⁸ Egypt’s electricity generation, "Egypt’s electricity generation by source". 2000-2022. <https://ember-climate.org/countries-and-regions/countries/egypt/>

²¹⁹ Mineral commodity production, "U.S Department of the Interior U.S Geological Survey Mineral Commodity Summaries". 2023. <https://pubs.usgs.gov/periodicals/mcs2023/mcs2023.pdf>

Bioenergy	277	0.01
Total	25,288	-

With the advantage of direct access to the Nile, Africa’s longest river, hydropower is a clear comparative advantage for Egypt, accounting for 58% of the country’s renewable energy structure (see **Table 16**). The country’s three plants have a combined capacity of 2,250MW, but only represent about 6.5% of overall electricity production. Wind and solar have a combined contribution of 4.5%. Within this mix is the Benben Solar Park, the world’s largest energy station.²²⁰ Egypt has however committed to expand the contribution of renewables from the current 11% to 42% in line with the country’s NDCs.

Manufacturing Capacity

Egypt’s manufacturing sector is valued at about US\$68 billion and has contributed at least 15% to GDP between 2017-2021. In the same period, Egypt has been Africa’s second biggest exporter of environmental goods, earning an average of US\$1.3 billion annually.²²¹

Egypt’s manufacturing sector is guided by the country’s Ministry of Planning and Economic Development through policy and development plans. In the fiscal year 2022/2023, Egypt plans to reduce its exposure to global shocks by analysing the set of goods typically imported and strengthening domestic manufacturing of such goods.²²² The goal that informs this strategy is reduction of Egypt’s exposure to global shocks, where price and supply fluctuations may have a negative impact on Egypt’s capacity to manufacture goods locally. With an industrial sector growth target of 7.7% in the 2022/2023 fiscal year, overall contribution to GDP would leap to 21%.

Through Egypt’s export support programme, a goal of US\$30 billion worth of industrial exports has been set in the 2022/2023 year. This will be achieved by the development of production standards compliant with international benchmarks, and by training local labour to meet new quality requirements. Additionally, the country’s 2020 Customs Law injects an additional layer of manufacturing sector support.²²³ Export expansion is incentivised by easing customs clearance processes and exempting custom fee payments by importers in the manufacturing sector, harmonizing the administration of tax refunds and accelerating the release of goods held at Egypt’s borders.

Production Focus

The largely fossil-fuel state of Egypt’s energy sector is a massive opportunity for the scaling-up of clean energy alternatives. Egypt has the geographical advantage of being within the global solar belt, a position that makes solar energy an ideal source of sustainable power generation.

²²⁰ The Arab Republic of Egypt Presidency, "Benban", the Largest Solar Power Plant in Aswan".

²²¹ Environmental goods exports, "IMF Climate Change Indicators Dashboard", 2021.

<https://climatedata.imf.org/pages/bp-indicators#cb1>

²²² Egypt Ministry of Planning and Economic Development news, "Egypt aims to boost local manufacturing in FY 22/2023". 2022. <https://mped.gov.eg/singlenews?id=1159&type=previous&lang=en>

²²³ International Trade Administration (ITA), Egypt – Country Commercial Guide. <https://www.trade.gov/country-commercial-guides/egypt-customs-regulations>

Additionally, Egypt can boost regional energy security in the EuroAfrica Interconnector by increasing its renewable energy output, particularly through solar energy.²²⁴

Product focus: Solar PV

However, high infrastructure costs have been a barrier to household solar uptake.²²⁵ From a private sector and commercial perspective, incentive schemes such as feed-in tariffs have had a mixed set of results.²²⁶ Concerning finance terms, businesses argued that the state-regulated tariff rates made the feed in tariff system commercially unviable. Going forward, an upward adjustment of tariffs would be the foundation of restructuring feed in tariffs or creating a new approach altogether. For tariff currencies, the rigidity of terms meant that businesses could lose out through foreign exchange fluctuations and their impact on the Egyptian Pound. Here too, lies an opportunity to correct this flaw by making an accommodative tariff system that anticipates shifts in macroeconomic conditions.

Ultimately, the tariff system failed and has since been abandoned as a solar energy investment incentive. Going forward, there is an opportunity for Egypt's energy regulators and the country's Ministry of Finance to work more closely with stakeholders in the energy sector by developing renewable energy policies and creating an attractive, sustainable investment environment. Manufacturing solar energy generation products in Egypt stands out as an investment opportunity. As Egypt works towards achieving its 2030 NDCs and expanding supplies of renewable energy in the national electricity grid, policy support should complement the clear market potential that exists.

Cost Analysis

According to IMF data, Egypt has almost consistently been in Africa's top 20 fastest growing economies between 2019-2021. For 2023 and 2024, growth forecasts of 3.7% and 5% respectively are both ahead of anticipated global growth rates of 2.8% and 3%. In terms of growth contribution and using pre-COVID 19 as a comparison benchmark, Egypt Ministry of Planning data indicates that manufacturing added an average annual contribution of 13.5% to overall GDP between 2019-2022.

Within the same period, real interest rates, a representation of borrowing costs for an investor, have ranged between 0.14% in 2022 and peaked at 4.89% in 2020. The latest data from Egypt's Central Agency for Public Mobilization and Statistics notes that industrial inflation has been relatively stable. Using Egypt's producer price index (PPI) as a measure of industrial inflation, PPI has been about 1.2% between January 2019 and March 2023.

In terms of energy, 2021 data highlights a competitively low average kilowatt hour price of US\$0.0411. Diesel, another key component in the manufacturing process, costs about US\$0.52 per litre but has seen significant fluctuations between 2019-2022. As a result, Egypt's consumer price inflation (CPI) data reveals that transport costs have regularly increased monthly (albeit at

²²⁴ EnergyPress news, "EuroAsia project moving again, Egypt present with EuroAfrica". 2020. <https://energypress.eu/tag/euroafrica-interconnector/>

²²⁵ The Economist, "Why Egypt's plans for solar power are left in the shade". 2022. <https://www.economist.com/middle-east-and-africa/2022/09/01/why-egypts-plans-for-solar-power-are-left-in-the-shade>

²²⁶ American Chamber of Commerce in Egypt Business Monthly, "IN DEPTH - Egypt pulls the plug on the feed-in tariff". 2017. <https://www.amcham.org.eg/publications/business-monthly/issues/261/September-2017/3638/egypt-pulls-the-plug-on-the-feed-in-tariff>

a modest pace), relative to prices in the same periods a year earlier. According to 2021 IRENA data, solar PV and onshore wind investments in Egypt have WACCs of 8.8%.

Lastly, labour costs, as measured by minimum wage data, stood at \$243.62 per month from an international purchasing power parity (PPP) point of comparison. By international standards and when compared with the world's leading environmental good exporters, Egypt's labour costs are about 23.60% cheaper. Accordingly, we identify Egypt's labour costs as a potential investment attraction, and one bolstered by the country's consistent energy costs.

4.2.12 MOROCCO

In June 2021, Morocco unveiled its Nationally Determined Contribution (NDC) plan, striving for a substantial 45.5% reduction in greenhouse gas emissions by 2030²²⁷. Notably, 18.3% of this target is unconditional, while the remaining 27.2% relies on international funding. The updated NDC encompasses a comprehensive 61 mitigation actions, blending unconditional and conditional measures, all contributing to the overarching goal of emission reduction. Through this, Morocco ambitiously addresses emissions from the cement and phosphate industries, leveraging innovative strategies like carbon storage in the phosphate sector. This is particularly significant as Morocco possesses 75% of global phosphate reserves. Climate Action Tracker notes that Morocco's 2016 NDC was one of the few which was "1.5°C Paris Agreement Compatible," reflecting the government's commitment. Complementing these efforts, Morocco's National Adaptation Plan (NAP) outlines a resilient framework spanning 2020-2030, prioritizing adaptation in critical sectors, notably water, agriculture, fisheries, forestry, and vulnerable ecosystems. The associated adaptation endeavors, including safeguarding oases, coastlines, and mountains, necessitate an estimated investment of US\$40 billion²²⁸.

The National Climate Plan 2030 of Morocco was introduced in 2019, with a key emphasis on accelerating the transition to a low-carbon economy.²²⁹ This plan unveiled a series of impactful actions, including the implementation of six unconditional greenhouse gas (GHG) mitigation projects. These projects encompassed diverse areas such as wind and solar power expansion, photovoltaic promotion, hydroelectric power station development, and the establishment of private wind farms. In addition, Morocco laid out four conditional GHG emissions mitigation projects, demonstrating its readiness to further enhance its efforts. These commitments were reinforced by measures aimed at accelerating GHG emission reduction within the housing sector and driving innovation in housing mitigation strategies.

Further, the 2018 National Climate Change Profile plan of Morocco prioritizes the energy sector. Ambitious targets emerged, including exceeding 50% of installed electricity production capacity from renewable sources by 2025 and achieving a 15% reduction in energy consumption by 2030. Also, the project launched plans to significantly curtail fossil fuel subsidies, bolster natural gas utilization through advanced infrastructure, and deliver a substantial portion of electrical power from renewable sources. This commitment has been supported with comprehensive reductions

²²⁷ Kingdom of Morocco National Determined Contributions (NDS). 2021.

https://unfccc.int/sites/default/files/NDC/2022-06/Moroccan%20updated%20NDC%202021%20_Fr.pdf

²²⁸United Nations Development Programme (UNDP) Project Brief/Fact Sheet, "National Adaptation Plans in focus: Lessons from Morocco". https://www.adaptation-undp.org/sites/default/files/resources/morocco_nap_country_briefing_final.pdf

²²⁹ Climate Change Competence Center of Morocco, "National Climate Plan 2030".

https://www.4c.ma/files/uqd/3c9136_b08a13993f714dfb93cdaa1f12a8b319.pdf?index=true

in energy consumption across key sectors like buildings, industry, and transport, underlining Morocco's pursuit of a green economy.

Natural Endowment

Overall, Morocco's mining contributes 10% of the country's GDP and 26% of exports,²³⁰ though about 90% of extraction is phosphates²³¹. Regarding the critical minerals for green development, Morocco was the 11th-ranked and 17th-ranked producer of cobalt and silver, respectively, and accounted for 1.8% and 1.4% of world output, respectively. Morocco also accounted for 1.4% of the world's copper production. The **Table 17** below shows a snapshot of Morocco's critical minerals production, all of which are all important for the manufacture of environmental goods.

Table 17: A snapshot of Morocco's critical mineral production²³²

Mineral	Products	Average Annual Production Volume (tonnes, 2017-2021)
Manganese	Battery	83,568
Copper	Wind turbines and EV motors, power lines	33,360
Cobalt	Battery	2,067
Nickle	Battery, wind turbines and EV motors	130

As for mining export, eight critical minerals²³³ account for 97% of its value export. Lithium is the first critical mineral in terms of export value and accounts for 21% of the total, followed by iron ore (18%), nickel (17%), phosphate rock (15%), and PGM (15%).²³⁴

Morocco announced that they discovered a lithium deposit near the border with Mauritania in 2022, showing the county's potential for lithium to be explored.²³⁵ Moreover, the newly launched report of the country's Economic and Social Council (EESC) also revealed that its tropic seamount, located between the Atlantic coasts of Western Sahara and the Canary Islands, also holds great potential for critical minerals such as iron, magnesium, cobalt and tellurium.

For now, the 95% state-owned OCP (Office Cherifien des Phosphates) and Managem are the major market players in Morocco's critical minerals production. OCP is the main company responsible for phosphate rock mining while Managem works more broadly in cobalt, copper, and

²³⁰ <https://www.atalayar.com/en/articulo/economy-and-business/exploring-moroccos-strategic-and-critical-minerals/20230330104943182382.html>

²³¹ Morocco seeks to extract and process a wider variety of mineral resources, <https://oxfordbusinessgroup.com/reports/morocco/2020-report/economy/below-ground-mineral-producers-are-digging-for-more-than-phosphates>

²³² Source: British Geological Survey-Critical Mineral Production (2017-2021)

²³³ Eight critical minerals include: lithium, iron ore, nickel, phosphate rock, platinum group metals, diamond, tungsten, mix metal products. https://unctad.org/system/files/non-official-document/edar2023_BP2_en.pdf

²³⁴ UNCTAD, Critical Minerals and Routes to Diversification in Africa: Opportunities for Diversification into Renewable Energy Technologies - The Case of Morocco https://unctad.org/system/files/non-official-document/edar2023_BP2_en.pdf

²³⁵ <https://www.atalayar.com/en/articulo/economy-and-business/major-lithium-deposit-discovered-morocco/20220519161714156503.html>

silver and is also developing mining operations in Sudan, Guinea, DRC, Gabon Ethiopia, Guinea and Sudan.

The government reformed the mining sector regulation and policy framework in 2015 to attract foreign investments and increase domestic value addition, including tax exemptions on imported equipment for investments, and reduced tax rates for companies that supply ores to domestic mineral-processing. For example, Mining companies that sell their output to processing companies for subsequent export can benefit from a reduced corporate tax rate of 17.5%.²³⁶

Renewable Energy Potential and Structure

According to IRENA data, renewable energy output accounted for 10% of Morocco's power supply. Among the country's clean energy mix, hydropower has the greatest potential, while wind and solar follow closely (see **Table 18**).

Table 18: Morocco's renewable energy structure (2022)

Source of energy	Current capacity (MW)
Hydropower	1,770
Wind	1,558
Solar	854
Bioenergy	7
Pure Pumped Storage	464

Guiding Morocco's renewable energy production are the Morocco Agency for Sustainable Energy (MASEN), a public-private enterprise that implements national renewable energy initiatives such as the 2009-2030 National Energy Strategy.^{237 238}

Additionally, Morocco's energy ambitions are delivered within the context of Renewable Energy Law 58-15, a legal mechanism that regulates both public and private sector renewable energy developments²³⁹. A third pillar that supports Morocco's renewable energy ambitions is the 2022 Investment Charter which decentralizes and incentivizes investment prospects by regions with the support of Export Processing Zones (EPZs).²⁴⁰ Additionally, firms operating within such zones stand to benefit from five-year corporate tax exemptions. For renewable energy investments,

²³⁶ Australian Trade and Investment Commission, Export markets – Morocco, <https://www.austrade.gov.au/export/export-markets/countries/morocco/industries>

²³⁷ Morocco Agency for Sustainable Energy (MASEN). <https://www.masen.ma/en>

²³⁸ World Bank research, "Morocco Energy Policy MRV- Emission Reductions from Energy Subsidies Reform and Renewable Energy Policy". 2018. <https://documents1.worldbank.org/curated/en/964331541085444404/pdf/Morocco-Energy-Policy-MRV.pdf>

²³⁹ Kingdom of Morocco Ministry of Energy, Mines, Water and the Environment, "Renewable Energy Law". 2010. https://cdn.climatepolicyradar.org/navigator/MAR/2010/law-on-renewable-energies_042c524bd467633a3efdb9ca2e800d4b.pdf

²⁴⁰ Kingdom of Morocco Official Bulletin, Morocco Investment Charter. 2022. http://www.sgg.gov.ma/BO/FR/2873/2022/BO_7152_Fr.pdf

benefits are direct where electricity export plans exist, as well as through an assurance of electricity offtake partners in the form of industrial firms.

Two key segments in Morocco's renewable energy portfolio are solar and wind power. Like Egypt, Morocco is within an ideal geographic position that optimises solar power generation. For wind as a power source, the country's vast coastline is a highly beneficial resource for wind energy production. In addition to the world's largest concentrated solar power plant at Noor Ouarzazate (580MW), Morocco is also developing the Noor Midelt, an 800MW power plant.²⁴¹²⁴² For wind, a notable example is the Taza Wind Farm and its 87MW capacity, while five wind farms with a combined output of 850MW will fall under Morocco's Integrated Wind Programme.²⁴³

In terms of renewable energy, Morocco's combination of a favorable investment policy framework as well as its attractive geographical traits present the country's renewable energy sector as priority investment cases.

Manufacturing Capacity

On average, Morocco's manufacturing sector contributed just under 14.94% to GDP in the period 2017-2021. As of 2021, this valued the sector at about US\$22 billion, making it the third largest in monetary terms within North Africa after Egypt and Algeria. Five sub-sectors of manufacturing have been growth drivers in the period 2017-2021, including Processing petroleum coking; Production of chemicals and chemical products; Manufacture of computers, communication equipment; electronics and magnetic as well as optical media; Electrical equipment, and Transport equipment.

Contracted growth was recorded across most of these sub-sectors in 2020 on account of the COVID 19 pandemic. However, significant recovery followed on a quarterly basis from January 2021. Looking ahead and judging by the latest Bank Al-Maghrib Business Outlook Survey, Morocco's production capacity utilisation of 70% is high.²⁴⁴ However, the economy foregoes additional manufacturing sector and broader economic growth by not maximising production potential.

Production Focus

According to OCP, Morocco has over 70% of the world's phosphate reserves. Although nickel-manganese-cobalt have been core components in electric vehicle and rechargeable battery technology, lithium-ion phosphate (LFP) batteries have the advantage of superior energy density, are more ideal for high energy consuming technologies, such as transportation, and have long shelf lives²⁴⁵. Additionally, they are considered a lower cost and more durable alternative. As a result, leading electric vehicle and battery cell technology manufacturing companies such as Tesla, Ford and LG Energy Solution, have committed to investing in LFP-based battery technology. Having reserves of phosphate as large as Morocco gives the country a comparative

²⁴¹ African Development Bank (AfDB) project completion report, "Morocco - NOOR Ouarzazate Solar Complex Project – Phase III (NOOR Ouarzazate III Power Plant). 2021. <https://www.afdb.org/en/documents/morocco-noor-ouarzazate-solar-complex-project-phase-iii-noor-ouarzazate-iii-power-plant-project-completion-report>

²⁴² Masdar Noor Midelt overview. <https://masdar.ae/Masdar-Clean-Energy/Projects/Noor-Midelt>

²⁴³ CMS expert guide to renewable law and regulation in Morocco. <https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/morocco>

²⁴⁴ Bank Al-Maghrib, "Business Outlook Survey 2023". 2023. <https://www.bkam.ma/en/Statistics/Surveys/Business-outlook-survey2/Business-outlook-survey>

²⁴⁵ University of Washington Clean Energy Institute research, "What is a lithium-ion battery and how does it work?". <https://www.cei.washington.edu/research/energy-storage/lithium-ion-battery/>

advantage in phosphate-based manufacturing, making Morocco a potential electric vehicle battery manufacturing hub.

On the downside, the International Travel Air Travel Association (IATA) classifies lithium batteries as dangerous goods²⁴⁶. Regulatory compliance barriers may therefore hinder smooth distribution of manufactured batteries from Morocco to neighbouring markets in Africa, and to the rest of the world. IATA does however still allow air shipments of lithium-ion batteries on condition that packaging requirements and standards have been met, and that all relevant administrative procedures have been followed.

Cost Analysis

IMF data highlights 2021 as the most recent standout year of economic growth in Morocco, where an estimated 7.9% growth rate was achieved. The country's manufacturing sector has contributed an average of 15% to growth since 2019, marking its importance to overall economic development.

Morocco's real interest rates have ranged from -4.16% in 2022, to 1.95% in 2019 because of local inflation developments. The implication on borrowers has therefore been positive in recent years. 2021 electricity costs were approximately US\$0.131 per kilowatt hour. Still looking at energy and using January 2019 to June 2023 monthly transport sector CPI as a proxy for fuel cost trends, the rate of price changes has largely been negative, meaning that prices have been declining. Based on 2021 IRENA data, solar PV and onshore wind investments in Morocco have WACCs of 6.7% and 6.1% respectively.

In PPP terms, Morocco's minimum wages stand at \$698.89, a comparatively high costs relative to our 10 other regional hubs. Compared to Mexico and China, two leading environmental good exporters with the lowest wage costs of \$319 and \$390 in PPP terms, Morocco's labour costs are more expensive. However, they are still 55.71% lower than the 2022 median wage of the world's top 20 environmental good exporters, making Morocco's labour market competitive by global standards.

²⁴⁶ International Travel Air Travel Association (IATA) Knowledge Hub, "What to Know About How to Ship Lithium Batteries?". 2021. <https://www.iata.org/en/publications/newsletters/iata-knowledge-hub/what-to-know-about-how-to-ship-lithium-batteries/>

4.2.13 CENTRAL AFRICA

Overview

Country	Avg. Manufacturing Sector Value Added (2017-2021, % GDP)	Labor force participation (% of total population ages 15+)	Logistic performance (LPI 2023)	Total Renewable Energy Capacity (MW) 2022	Critical mineral production (2017-2021)	Total EG Trade with China (2021, USD)	Avg. Chinese FDI in the country (2017-2021) in million USD
Angola	6.17	76.87	2.1	4078	-	167,996,682.00	307.996
Burundi		79.73		80	212.00	7,147,530.00	3.282
Cameroon	13.30	71.77	2.1	827	57,440.00	140,356,231.00	43.472
Cent Africa Rep	17.91	70.58	2.5	19	-	10,145,322.00	9.308
Chad	2.96	59.56		4	-	29,198,919.00	57.284
Congo DR	18.78	66.23	2.5	2742	1,435,407.75	383,771,176.00	714.294
Congo Rep	8.88	67.59	2.6	227	-	35,130,885.00	99.944
Equatorial Guinea	23.00	55.03		127	-	9,584,682.00	-3.718
Gabon	19.48	47.65	2.4	333	7,239,000.00	24,274,978.00	-1.574
São Tomé and Príncipe	6.23	53.77		3	-	668,083.00	0.322

Regional hubs

Based on the scoring system introduced in 4.1, this report identifies 2 regional hubs for environmental goods manufacturing in Central Africa – Angola and Congo Republic²⁴⁷.

²⁴⁷ While the Democratic Republic of Congo (DRC) ranks at the top of the presented table, it is essential to note that it did not initially qualify in our filtering for the top 20 environmental goods exporters in Africa. As a result, it is not designated as a priority regional hub in this specific context. However, we acknowledge the substantial opportunities for environmental goods manufacturing in the DRC and in fostering regional collaborations, and these prospects merit thorough exploration and consideration for future initiatives.



4.2.14 CONGO

Congo's economic structure is heavily shaped by its reliance on rain-dependent agriculture, oil production, and extractive minerals. These industries account for about 98% of extractive revenue and underscore Congo's acute susceptibility to global price volatility, economic shocks, and climatic shifts²⁴⁸. Natural Gas, forming 59% of the current electricity mix, is pivotal to energy needs, and the government is vested in exploring further gas reserves for electricity generation.

As one of the top five African oil producers, Congo's economic and social fabric is intertwined with oil revenue. However, the nation has unequivocally committed to a progressive reduction in GHG emissions, pledging to an unconditional reduction of 17.09% by 2025 and further extending this commitment to 21.46% by 2030. The environmental threats from large-scale extractive industries, deforestation, pollution, and unsustainable resource management remain significant. With an estimated loss of 500,000 hectares of forests by 2020, Congo's conscious effort to integrate development with environmental preservation is evident in its climate policies and Nationally Determined Contributions (NDC) Frameworks. Prioritising both adaptation and mitigation, these policies focus on critical areas such as agriculture, energy, industrial processes and waste management, forestry, along with other land uses waste.²⁴⁹²⁵⁰

While oil and gas remain a significant portion of Congo's economy, Congo's National Development Plan (2022-2026) focuses on building resilience by fostering industrialization and positioning Congo as a prime destination for manufacturing. Initiatives include investing in liquid and gaseous hydrocarbons for energy generation, improving energy infrastructure, promoting in-country mineral processing, and adopting policies for economic self-reliance.

²⁴⁸ EITI. (2022). Understanding State Oil Revenues and Sales through Financial Modelling: Republic of Congo. <https://eiti.org/documents/understanding-state-oil-revenues-and-sales-through-financial-modelling-republic-congo>

²⁴⁹ NDC Partnership. (2021). Republic of Congo. <https://ndcpartnership.org/countries-map/country?iso=COG#:~:text=In%20August%202021%2C%20the%20Republic.business%2Das%2Dusual%20scenario>.

²⁵⁰ Climate Watch. (2023). Republic of Congo Country Profile. https://www.climatewatchdata.org/countries/COG?database=wb&end_year=2020&start_year=1990

Congo's strategic location with the central African region with established trade route, such as Pointe-Noire-Brazzaville-Bangui-Ndjamena multimodal transport corridor within the region and membership in organizations like CEMAC, CEEAC, and WTO make it a key hub for supply chain activities and preferential tax benefits²⁵¹. Additionally, the government's focus on creating a national market for private enterprises make it a potentially viable regional hub for production and distribution of environmental goods. The country also plans to develop skilled labour in line with the green economy.

The Country also has a number of Special Economic Zones (SEZs), designed to be competitive business environments. Support mechanisms include single-window export-import facilitation, preferential tax regimes, and other fiscal incentives.

Congo' broader regulatory measures further contribute to a friendly investment climate. This includes incentives for export, reinvestment, operations in remote areas, and even contributions to social and cultural growth. The preferential tax treatments are especially strategic, such as the tax exemptions for firms with 25% local ownership, reduction in registration fees, minimized exposure to dividend taxes, and reduced rents.²⁵² These incentives aim to promote local content development and a nurturing business environment. Complementing these economic measures are important legal instruments focused on environmental responsibility, environmental protection, and sustainable natural resource management.²⁵³²⁵⁴²⁵⁵

Furthermore, the emphasis on local ownership and incentives for social and cultural investment reflects a balanced and sustainable growth model which leverages international investment to foster local development, ensuring that economic growth translates into societal advancement.

National Endowment

The mining sector in Congo offers an overview of the opportunity and challenges for investment. While the absence of detailed critical mineral production data presents a challenge, the known existence of resources such as potash, cobalt, iron ore, magnesium, phosphate, copper, lead, zinc, gold, chromium, niobium, tantalum, uranium and tin provide prospects for exploration and industrialization (see **Table 19**). Despite its potential, much of the territory is unexplored. Research permits have been issued to explore industrial ores (iron, potash, phosphate and polymetals), gold, diamonds, coltan, but also on uranium and lithium.

Many reserves are unexploited due to lack of transport infrastructure and difficulty in raising funds since the drop in mineral prices in 2014. The underdevelopment of the sector is attributed to the focus on the oil industry. The mining industry's major challenges include energy needs, transport problems for evacuation to the coast, development of an ore port, and constraints in raising large capital required for mining projects. Currently, only a few companies are in the production phase,

²⁵¹ African Development Bank. (2023). Multinational - Pointe-Noire-Brazzaville-Bangui-Ndjamena Multimodal Transport Corridor Development Project, Phase I. <https://projectsportal.afdb.org/dataportal/VProject/show/P-Z1-D00-047>

²⁵² PwC. "Congo, Republic of. Corporate, tax credit and incentive." <https://taxsummaries.pwc.com/republic-of-congo/corporate/tax-credits-and-incentives>

²⁵³ International Energy Agency (IEA). (2020). Hydrocarbons Law (Law n°15/012). <https://www.iea.org/policies/11935-hydrocarbons-law-law-n015012>

²⁵⁴ International Energy Agency (IEA). (2022). Law No. 11/009 of 09 July 2011 on fundamental principles relating to the protection of the environment. <https://www.iea.org/policies/11937-law-no-11009-of-09-july-2011-on-fundamental-principles-relating-to-the-protection-of-the-environment>

²⁵⁵ International Energy Agency (IEA). (2020). Decree n°16/010 - Hydrocarbons Regulations 2020. <https://www.iea.org/policies/11936-decree-n016010-hydrocarbons-regulations>

including SOREMI, Lulu, and Sapro-Mayoko. Most others have completed geological research and feasibility studies.

There are opportunities related to the construction of industries for local mineral transformation, with potential annual production amounting to large quantities of various ores. The potential of these minerals, combined with proper investment and overcoming existing challenges, could lead to stand as key prerequisites to unlocking the full spectrum of Congo's mineral wealth.

Table 19: Mineral Potential in Congo Republic ²⁵⁶

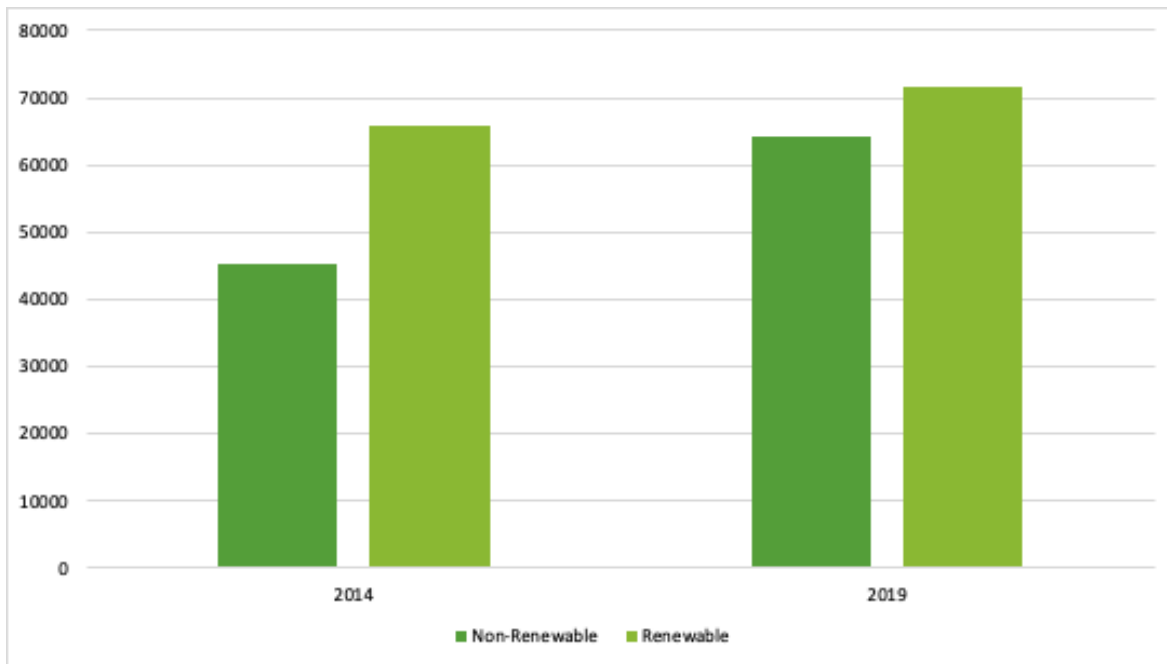
Minerals	Potential
Iron	100 million tons annually
Copper	50,000 tons annually
Potash	3 to 5 million tons annually
Phosphate	4 million tons annually
Zinc	Several thousand tons annually
Limestone	1.5 million tonnes of cement

Renewable Energy Potential and Structure

With a total of 227MW, the country's renewable energy potential is relatively modest. However, there is vast opportunity for growth and diversification in Congo's energy landscape where only 48.3% of the population have access to electricity and majority of source of energy is natural gas, biofuels, oil, with limited renewable energy (see Figure 23).

²⁵⁶ "Les potentialités naturelles du Congo 2021." (2021). Congo ECO le journal d'unicongo. <https://www.unicongo.cg/wp-content/uploads/2021/11/J-ECO-17.pdf>

Figure 23: Republic of Congo Renewable energy share of total energy supply (2014 – 2019)



Among the renewable sources, as shown in Figure 24 below, hydroelectric power emerges as a key area of focus, reflecting both the nation's geographical features and policy orientation. Hydroelectric projects form part of a government strategy to establish an “energy highway” carrying electricity between the south and north. Coupled with other projects, they aim to install more than 2,000 MW to make Congo Republic the second biggest power producer in central Africa, after the Democratic Republic of Congo (DRC) with its giant Inga facility²⁵⁷.

Beyond hydropower, there lies untapped potential for solar and wind energy development, and with the newly launched Oyo center for renewable energy and energy efficiency, exploring research and capacity building projects on renewable energy solutions.²⁵⁸

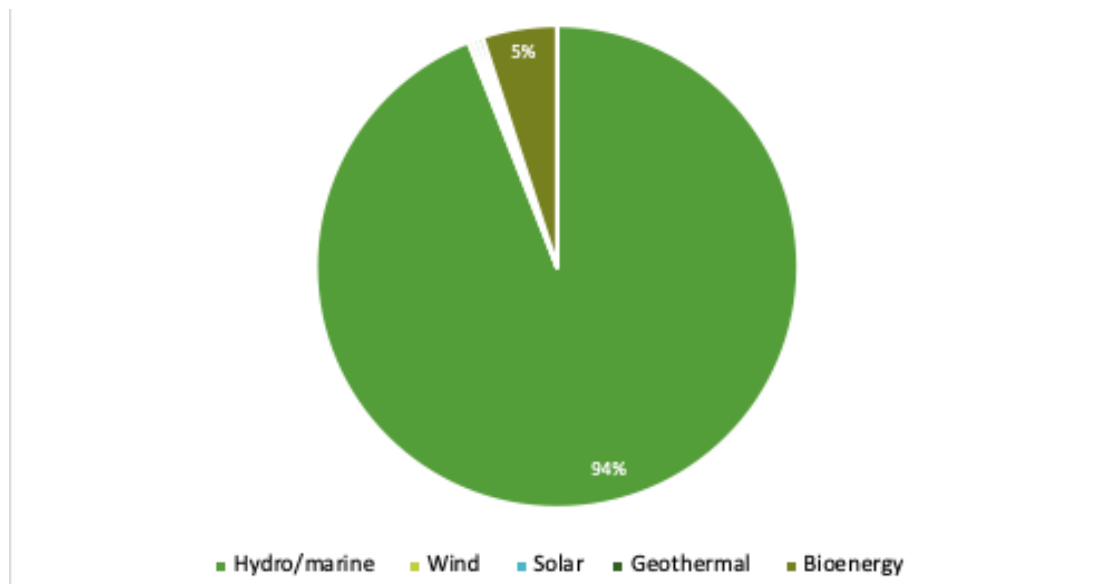
²⁵⁷ Hydro Review. (2006). Congo Republic Awards Four Hydro Project Contracts.

<https://www.hydroreview.com/world-regions/africa/congo-republic-awards-four-hydro-project-contracts/>

²⁵⁸ ESI Africa. (2023). Republic of Congo Inaugurates Centre for Renewable Energy, Energy Efficiency.

<https://www.esi-africa.com/central-africa/republic-of-congo-inaugurates-centre-for-renewable-energy-energy-efficiency/>

Figure 24: Republic of Congo Renewable energy supply in 2019²⁵⁹



Manufacturing Capacity

The Republic of Congo's manufacturing capacity, though promising, faces multifaceted challenges. Between 2017 to 2021, its manufacturing sector contributed an average of 8.88 % to its GDP, relatively lower compared to the agricultural and services sectors. Most factories are concentrated in key urban areas and products span a diverse array, including processed foods, beverages, textiles, footwear, wood and paper products, chemicals, cement, handicrafts, and metal goods.²⁶⁰

Due to the untapped manufacturing and agricultural landscape, Congo's manufacturing landscape is emergent with about 75% of food products are imported.²⁶¹

Compared to countries within the region, it also shows the highest performance regarding connectivity and logistics, making it an ideal position with the supply chain for the manufacture, transportation, and export environmental goods, especially within the central African region.

The labour force participation is about 67.59% and presents opportunities for skill development and technological transfer. Similar to most commodity-based economies, there are limited job created and insufficiency of job creation in the formal sector, attributed to the low diversification of the economy. However, this provides an untapped labour force for potential manufacturing at competitive labour costs and the opportunity to diversify the economy.

The sector is constrained by small domestic markets, which reduce the scale of opportunities for local producers. Additionally, there is a tangible dependence upon foreign investment, which introduces both possibilities and vulnerabilities into the equation.

²⁵⁹ ibid

²⁶⁰ Ministère de l'Économie, de l'Industrie et du Portefeuille Public (République du Congo). (2023). Activités Industrielles par Filière. <https://economie.gouv.cg/fr/activit%C3%A9s-industrielles-par-fili%C3%A8re>

²⁶¹ Nzololo, M. (2023). Déterminants de consommation des aliments à Brazzaville. La Revue des Sciences de Gestion, 319, 71-80. <https://www.cairn.info/revue--2023-1-page-71.html>

Production Focus

Congo's strategic geographical location, coupled with its abundance of natural resources and fertile agricultural landscape, lends itself to a distinct competitive edge for EG manufacturing. The country's largely untapped renewable energy resources further amplify its advantage in this sector. Solar panels manufacturing, recycling and waste management, component manufacturing for wind turbines and hydropower systems, biomass and bioenergy equipment, and water purification and filtration technologies offer potential for Congo. These sectors not only align with global sustainability goals but also offer immense potential for job creation, economic diversification, and enhanced global competitiveness. By embracing these opportunities, Congo has the opportunity to stimulate economic growth, cultivate a diversified economy, and make strides in reducing carbon emissions.

Cost Analysis

Unlike the majority of its regional hub peers, Congo's annual economic growth has lagged behind global benchmarks between 2019-2022. However, IMF data anticipates a turnaround in 2023 and 2024, with forecasted growth rates of 4.1% and 4.6% respectively – both ahead of global growth. Looking at national contribution to overall economic growth, Congo's manufacturing sector has on average represented 8% between 2019-2021, placing it at the lower-end of our regional hub group.

Except for a 77% spike between 2021 and 2022, annual CPI has been steady. Accordingly, real interest rates and domestic borrowing costs have been negative between 2019-2022, ranging between -1.72% and -3.04% as of 2022. Looking at manufacturing costs, 2021 data places Congo's US\$0.093 per kilowatt hour slightly above the median electricity costs in our regional hubs. Congo's labour costs on the other hand, are the third highest at \$273.06 per month in PPP terms, but are still 14.37% lower than a global benchmark of \$319 set by Mexico, a leading environmental good exporter with the lowest labour costs.

4.2.15 ANGOLA

Angola, a nation renowned primarily for its vast oil reserves, also possesses immense potential in the domain of environmental goods manufacturing. "Angola Energia 2025" national policy^{262,263}, spanning from 2015 to 2025, outlines Angola's roadmap for a sustainable energy transition, with a goal to increase its electrification rate from 46% to approximately 60% by the end of the policy's term²⁶⁴. The policy also envisions diversifying Angola's energy portfolio, with 66% from water sources, 19% from natural gas, 8% from innovative renewable sources, and 7% from thermal energy^{265,266}. Additionally, Angola's commitment to combating climate change is underscored by its Nationally Determined Contribution (NDC), in which the country has set a conditional target of reducing its 0.26% global emissions share by 24%, contingent upon receiving adequate

²⁶² United Nations Framework Convention on Climate Change (UNFCCC). (2021). Nationally Determined Contribution of Angola. <https://unfccc.int/sites/default/files/NDC/2022-06/NDC%20Angola.pdf>

²⁶³ Angola Energia 2025. (2023). Angola Power Sector Long Term Vision. <https://angolaenergia2025.gestoenergy.com/en/conteudo/documents>

²⁶⁴ ibid

²⁶⁵ ibid

²⁶⁶ International Energy Agency (IEA). (2015). 2025 Angola Long-Term Strategy. <https://www.iea.org/policies/5849-2025-angola-long-term-strategy>

support²⁶⁷. As part of this NDC framework, key sectors targeted for significant adaptation and resilience measures include agriculture, energy, water, land use, land-use change, forestry, and water management²⁶⁸.

Angola's wealth extends beyond its oil reserves, as the country also has significant deposits of vital minerals essential for renewable energy technologies. Endowed with crucial minerals and a variety of renewable energy sources such as hydropower, solar, hydrogen, wind, and geothermal energy, Angola has the potential to harness these resources not only for domestic use but also for the export of environmental goods. This capability aligns with the vision of sustainable, eco-friendly, and economically viable manufacturing.

Geographically, Angola's strategic location in Africa enhances its trade prospects in both the central and southern regions of the continent. Beyond this regional scope, Angola's extensive coastline provides a portal to maritime commerce. By leveraging its robust port infrastructure and clear access to the Atlantic, Angola could potentially provide cost-efficient transportation solutions, particularly for internationally bound goods. Existing trade relationships with nations like Brazil and members of two African regional economic communities (SADC and ECCAS) further strengthen this position, potentially establishing Angola as an influential player in the environmental goods manufacturing sector and facilitating efficient trade flows.

Natural Endowment

The economy of Angola is heavily reliant on its commodity exports, with the oil sector being the predominant contributor, accounting for 95% of the nation's export revenue. This dependency on oil forms the backbone of Angola's economic activity and employment. However, it simultaneously leaves the country susceptible to the capricious nature of global oil prices, posing a significant threat to its fiscal stability.

Angola is reported to house substantial deposits of 36 out of the 51 key minerals, a list that includes lithium, copper, cobalt, zinc, graphite, and nickel (see **Table 20**).²⁶⁹ These minerals play pivotal roles in the production of cutting-edge environmental goods. For instance, lithium serves as the backbone of electric vehicle batteries and renewable energy storage systems. Similarly, rare earth elements, which are abundant in Angola, are the linchpins in the manufacture of products ranging from wind turbines to a variety of sophisticated electronics.

²⁶⁷ UNDP Climate Promise. (2022). Angola. <https://climatepromise.undp.org/what-we-do/where-we-work/angola>

²⁶⁸ *ibid*

²⁶⁹ Energy Capital & Power. (2023). Angola Targets Critical Mineral Investment. <https://energycapitalpower.com/angola-targets-critical-mineral-investment/>

Table 20: Top critical minerals used in clean transition²⁷⁰²⁷¹

Critical minerals	Products	Found in Angola
Lithium	Battery	Yes
Nickel	Battery, wind turbines and EV motors	Yes
Cobalt	Battery	Yes
Graphite	Battery	Yes
Rare earth elements	Wind turbines and EV motors	Yes
Copper	Wind turbines and EVs and battery storage, Solar PV	Yes
Potassium/Phosphate/Limestone		Yes

Although Angola is rich in mineral resources, much of the country's mineral wealth lies untouched, thereby limiting its ability to establish a strong position in the environmental goods manufacturing sector. At present, several strategic developments are underway to ensure that Angola emerges as a global producer of energy transition minerals²⁷². Prospective sites are being identified and prepared for the extraction of rare earth materials²⁷³.

The historical over-reliance on oil, insufficient investment in alternative industries, lack of funding and infrastructure for exploring and mining critical minerals and fluctuating regulatory frameworks have hampered the nation's ability to reap the benefits of its rich resource base. Despite these challenges, with a growing young workforce and valuable insights from the established oil sector, ample opportunities lie ahead for Angola to carve out a new economic trajectory.

In an effort to stimulate investment and boost local manufacturing, Angola has implemented several initiatives, including the Angola Special Economic Zone (ZEE). Local manufacturers and exporters can take advantage of significant fiscal incentives such as reduced corporate income tax rates, exemptions from import duties, potential deductions in Value Added Tax, and an easier process for obtaining export licenses²⁷⁴. These incentives are supplemented with comprehensive infrastructure support, including ready-to-use industrial plots and an extensive transport network. The government has also streamlined administrative procedures through a 'One-Stop Shop' system, significantly reducing the bureaucracy faced by businesses. Furthermore, initiatives have been launched to encourage technology transfer and the development of the local workforce.

²⁷⁰ Ministério dos Recursos Minerais, Petróleo e Gás (MIREMPET). (2022, November 1). Minerais Críticos Apontados Para Transição Energética.

²⁷¹ Pedro, J. (2022, December 31). Critical minerals for the energy transition among MIREMPET's priorities. Forbes África Lusófona.

²⁷² Rare earth element mines, deposits, and occurrences," Mineral Resources OnLine Spatial Data, United States Geological Survey. <https://mrddata.usgs.gov/mineralresources/ree.html>.

²⁷³ Parker, D. (2023, April 3). Pensana Close to Finalising \$550m Financing for Saltend, Longonjo. Mining Weekly. <https://www.miningweekly.com/article/pensana-close-to-finalising-550m-financing-for-saltend-longonjo-2023-04-03>

²⁷⁴ Presidente da República, 'Decreto legislativo presidencial no. 6/15', 27 October 2015.

These measures provide a glimpse into Angola's strategy to diversify its economy and stake a claim in the global environmental goods manufacturing sector. However, for these efforts to be fruitful, concerted actions and sustained commitment will be needed to overcome the country's historic dependence on oil and address the challenges associated with exploring its untapped mineral wealth.

Renewable Energy Potential and Structure

The nation is a prominent hydropower electricity producer in Africa, with renewable sources, particularly hydropower, accounting for 74% of its electricity generation. However, the country has only tapped into a small fraction (5%) of its hydropower potential, even though it possesses 47 watersheds. Additionally, the Ministry of Energy and Water estimates that Angola possesses potential for 16.3 GW of solar power, 3.9 GW of wind power, and a whopping 18 GW of hydropower²⁷⁵. The nation's potential solar photovoltaic power output averages 5.4 kWh/m²/day—higher than in other countries within the region, showing a high potential for solar energy²⁷⁶.

To realize this untapped energy potential, Angola is actively championing the establishment of public-private partnerships. This approach serves as a catalyst for facilitating project financing, encouraging private sector involvement, and elevating solar and wind generation capacity to a targeted 800MW, aligning seamlessly with the "Angola 2025" plan's aspirations²⁷⁷. However, the nation's energy sector has encountered setbacks in recent times, posing challenges to private sector growth. Factors such as the volatile nature of crude oil prices, insufficient capital for energy projects, and a lack of a robust regulatory framework have collectively contributed to this decline. These obstacles, coupled with limitations in infrastructure, investment opportunities, policy frameworks, and capacity enhancement initiatives, have hindered the realization of Angola's renewable energy potential.

In response to these challenges and with the aim of enhancing energy provision, Angola has devised a comprehensive strategy to secure significant investments. The nation is striving to attract a total of US\$23 billion in investments, with US\$12 billion allocated for generation, US\$4 billion for transmission, and US\$7.5 billion for distribution²⁷⁸.

Manufacturing Capacity

Angola has been making concerted efforts to diversify its economy, with manufacturing playing a central role. Between 2018 and 2022, Angola's manufacturing sector experienced a steady growth of 7.7%, significantly contributing to its GDP. Current focus lies on basic goods such as food processing, beverages, textiles, and cement, along with opportunities in refining crude oil domestically for value-added products.

Despite no recorded current local production of environmental goods and technologies, the government is keen on projects that can provide comprehensive solutions, especially in regions inaccessible by the national transmission network. The nation's manufacturing capacity is also linked to mining and resource extraction activities, with recent rapid growth in manufacturing seen

²⁷⁵ "Identifying Opportunities in Angola's Renewable Energy Sector." (2022). Energy Capital & Power. <https://energycapitalpower.com/angola-opportunities-renewable-energy/>

²⁷⁶ Global Solar Atlas. (2023). Solar Energy Potential Map for Coordinates 19.145168, 9.228516. <https://globalsolaratlas.info/map?c=19.145168,9.228516,3&s=-13.752725,16.699219&m=site>

²⁷⁷ International Energy Agency (IEA). (2015, December 4). 2025 Angola Long Term Strategy. <https://www.iea.org/policies/5849-2025-angola-long-term-strategy>

²⁷⁸ Enerdata. (2023). Angola Energy Report. <https://www.enerdata.net/estore/country-profiles/angola.html>

(18.3% per year). The government, recognizing the potential for growth via diversification and import substitution, included this as part of its National Development Plan.²⁷⁹

To foster industrial growth across renewable energy and energy storage value chains, Angola's energy department is developing the Angolan Renewable Energy Strategy (ARES)²⁸⁰. The plan emphasizes localizing renewable energy and storage value chains, manufacturing solar PV, wind energy infrastructure, and potential energy storage solutions domestically, and developing local services associated with environmental goods production. ARES also proposes rejuvenating existing tax allowances for renewable energy and green technologies and providing financial assistance to SMEs in the environmental goods domain.

Production Focus

Angola could leverage its competitive advantage in natural and human resources on these core sectors to maximizing its resource potential while effectively tackling urgent economic and environmental challenges. By focusing on sectors such as engineered wood industry, waste management, solar panel manufacturing, and electric mobility, Angola not only lays the foundation for sustainable development but also generates substantial employment opportunities, overarching goals of promoting sustainability and achieving economic diversification, establishing a clear roadmap towards climate mitigation efforts and reduction of emissions.

Cost Analysis

Angola's GDP is about 15% that of Nigeria in monetary terms, but the IMF forecasts that these two economies will achieve similar growth rates between 3%-3.8% in 2023 and 2024 respectively. Looking at contribution to overall economic growth, Angola's manufacturing sector has averaged about 6% between 2019-2021, placing this sector at the bottom of our group of 10 regional hubs.

At about 20% year-on-year, Angola's inflation has been stubbornly high between 2019-2021. For Angola's Central Bank, intervention has been made through interest rate increases. Accordingly, borrowing costs have gone up in the period by 35% as measured by real interest rates. However, national energy costs have been contained, with competitive electricity and diesel costs relative to our other regional hubs. For electricity, average tariffs in 2021 were US\$0.013 per kilowatt hour, the cheapest in our 10 regional hubs.

Using transport sector CPI as a proxy for fuel cost movement, we assess Angola's fuel cost to be competitively low. On average, this sub-set of CPI has only shifted by 0.98% in terms of year-on-year changes between January 2019 and June 2023. Similarly, and gauging by international PPP, Angola's minimum monthly wage rate of \$91.66 is the second lowest in our 10 regional hubs. Angola's labour is also 71.26% more affordable than the world's cheapest, leading environmental good export market- Mexico.

²⁷⁹ Ministério das Finanças - República de Angola. (2007). Angola 2025: Angola Um País Com Futuro. <http://www.ucm.minfin.gov.ao/cs/groups/public/documents/document/zmlu/mdmz/~edisp/minfin033817.pdf>

²⁸⁰ Ministério da Energia e Águas - República de Angola. (2023). New Renewables Strategy. <https://angolaenergia2025.gestoenergy.com/en/conteudo/new-renewables-strategy>

CHAPTER 5

INVESTMENT OPPORTUNITIES



Chapter summary

Following the 8th FOCAC in 2021 and the announcement of the China-Africa Declaration on Combating Climate Change, China-Africa climate change cooperation has increased, including new private and public sector investment to drive Africa's clean energy transition and green development.

Out of the 54 Chinese climate action projects across renewable energy, clean technology, infrastructure, and electric vehicles in Africa since late 2021, Western Africa (19), Eastern Africa (16), and Southern Africa (13) have the most project numbers.

Among the 10 identified regional hubs, Nigeria and Kenya have been the top host countries of new Chinese climate action projects. Within these projects, China's involvement is prominently driven by energy-focused state-owned entities, with PowerChina at the forefront.

Drawing from the distinct strengths of the identified regional hubs, the most favorable investment prospects lie within renewable energy components and systems, with a specific focus on wind turbines, solar panels, and battery components. Moreover, Electric Vehicles and waste management emerge as equally promising sectors for potential environmental goods investment.

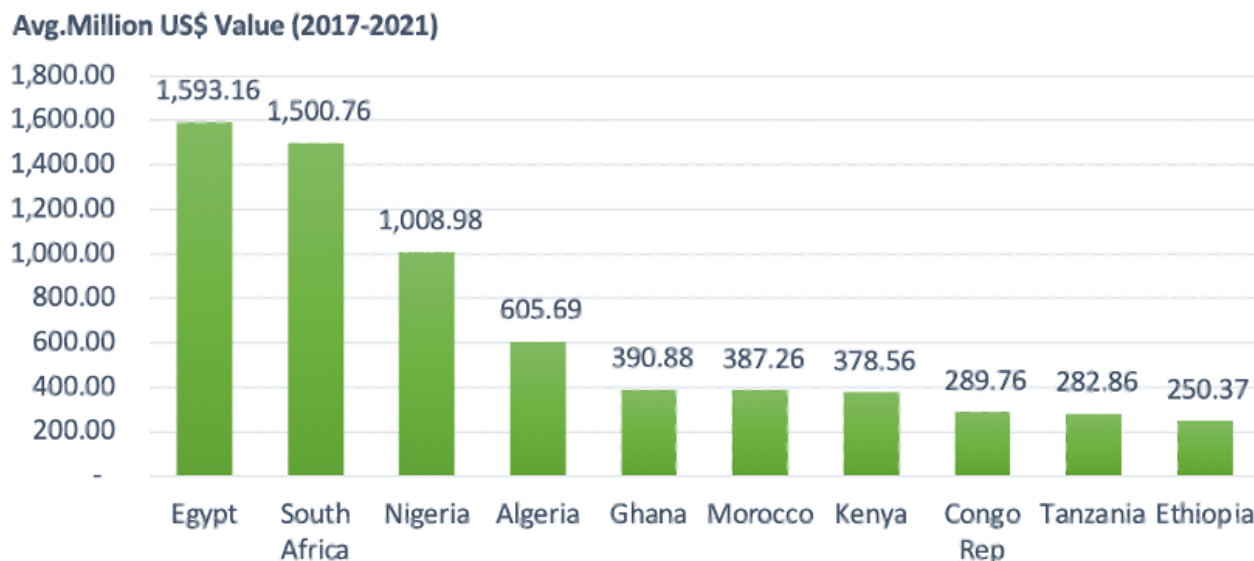
In Chapter 4, we identified 20 countries in Africa based on 11 criteria and 10 countries were picked up as the regional hubs (2 high-ranked countries from each region) with the most optimistic potential to develop the local manufacturing capacity of environmental goods. The closer economic ties with China and the good connections to generation the regional collaborations are also valued as assets.

China as a leading player in the global energy transition, with its own huge capacity for environmental goods manufacturing and trade, could play a vital role in Africa's manufacturing-driven green growth. The identified regional hubs could be promising for Chinese investors to expand their overseas value chains and enhance development collaboration.

5.1 CURRENT CHINESE INVESTMENT IN ENVIRONMENTAL GOODS MANUFACTURING IN AFRICA

As we have discussed in previous chapters, China is the world's top environmental goods trader accounting for 17.3% of global volume with \$487.76 billion in 2020 while Africa only covered 1%. Currently, 8 of our 10 identified regional hubs are among the top bilateral trade partners in environmental goods with China (Angola ranked 15, Zambia ranked 22), proving the existing market and logistics linkages, and providing a good foundation for future value chain establishment (see Figure 25).

Figure 24: Top 10 African countries in environmental goods trade with China²⁸¹



Since the 8th FOCAC host in 2021, China-Africa cooperation on climate change has increased - from both private and public sectors to generate Africa's clean energy transition and green development.

Based on the public announcements, we have collected **54 projects** in climate action²⁸² in collaboration between China and African entities from the launch of the climate declarations in late 2021 until June 2023.

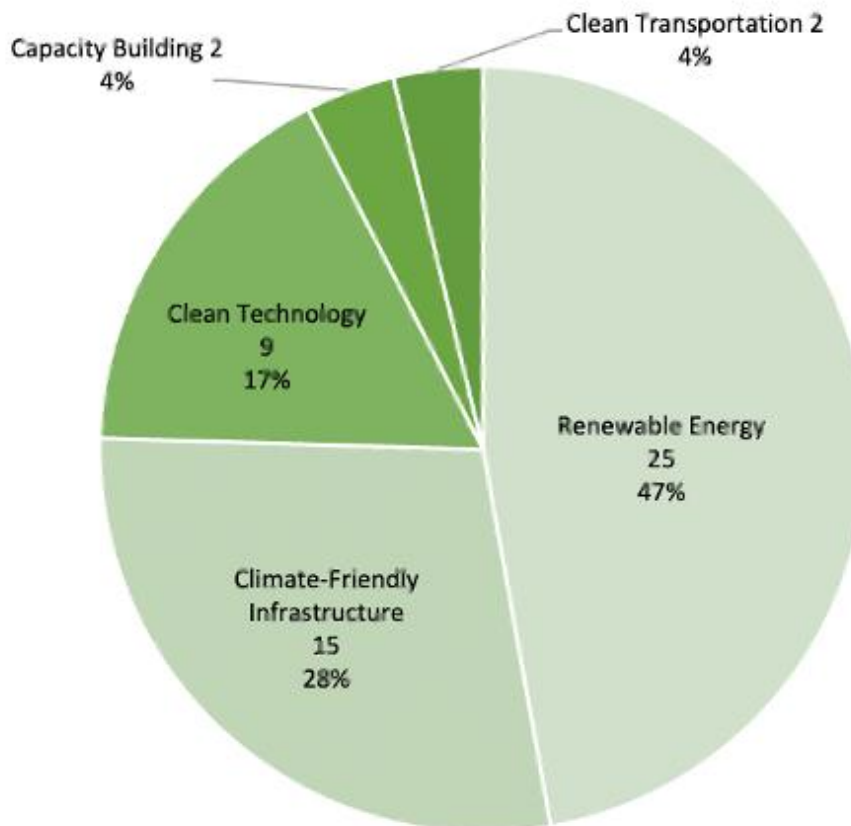
Those projects are divided into five different categories. As shown in Figure 26, the **renewable energy** projects lead the activities with almost half of the total. The **clean technology** projects to reduce negative environmental impacts through energy efficiency improvements, including energy storage, grid management, and sustainable materials make up 17% of the total. Significantly, as the leading player in the infrastructure sector, Chinese entities are also participating actively in **climate-friendly infrastructure**, accounting for 28%, including water use projects, environmentally friendly agriculture projects, and climate-friendly city infrastructure. Chinese entities are also involved in establishing buildings for local government to implement clean technology M&D and public education.

²⁸¹ Source: IMF, Trade in Environmental Goods, Climate Change Dashboard

²⁸² Climate Action involves any investments and loans from Chinese stakeholders to address and respond to climate changes in Africa, we focus on FIVE categories of climate actions: renewable energy, clean technology, clean transportation, climate-friendly infrastructure and capacity building.

Finally, as the world's leading EV manufacturer and best practitioner in **clean transportation**, there are also rising activities from Chinese companies, including the BYD²⁸³ and Yutong Bus²⁸⁴.

Figure 24: Categories divide of China's climate action projects in Africa (2021-2023)

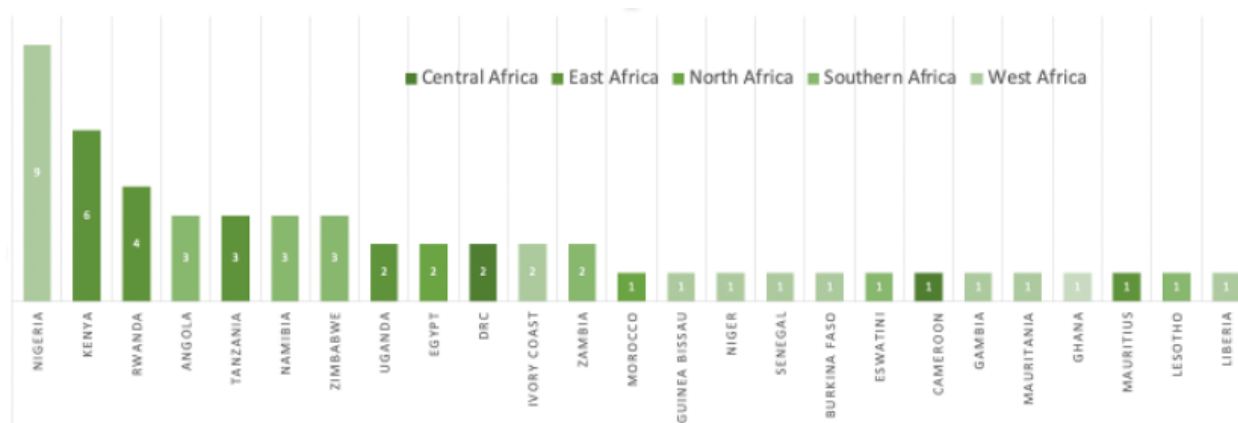


Among the 54 projects, **Figure 27** shows that over 30 are in the West Africa (19) and East Africa (16) region, and the Southern Africa region followed with 13 projects. And of the identified 10 regional hubs – Nigeria and Kenya are the top 2 host country, which have 9 projects and 7 projects respectively. Other than that, except for Tanzania, Egypt and Zambia, other regional hubs only have one or less.

²⁸³ World's biggest electric carmaker launches in South Africa, <https://www.iol.co.za/motoring/industry-news/worlds-biggest-electric-carmaker-launches-in-south-africa-byd-atto-3-price-announced-4bf214a9-5773-4115-a142-22abbeac9e2d>

²⁸⁴ Chinese bus maker Yutong launches first electric buses in Nigeria, <https://english.news.cn/africa/20230524/a8eb49cbfd7a40e3b2b45177060ac7bb/c.html>

Figure 25: China's climate action projects in Africa by Country and Region (2021-2023)



	West Africa	East Africa	Southern Africa	Central Africa	North Africa	Total
Projects	19	16	13	3	3	54

It is also worth to notice the top five Chinese entities that invest or participate in climate actions related projects are also listed (see Figure 28 below). Among them, The energy-focus state-owned companies led the participation: PowerChina captured 14 projects in total, China Energy Engineering (CEEC) had 6 projects and Sinohydro Group was involved in 4 projects. The most exciting player is Huawei, which is not a typical climate or energy focus private company but trying to implement digital solutions to accelerate the clean energy transition and green development in Africa.

Table 21: Major Chinese entities engaged in the projects (2021-2023)

Chinese Entities Engaged	Project number
PowerChina	14
China Energy Engineering (CEEC)	6
Sinohydro Group	4
Huawei	3
China Railway Engineering	2

5.2 INVESTMENT OPPORTUNITIES OVERVIEW OF THE IDENTIFIED REGIONAL HUBS

The competitive edges of each regional hub have been analyzed mainly based on the **natural resources endowments** which promised the country access to the products and essential materials, the major **renewable energy potential & structure** that would ensure the economy's

manufacturing sector is green, sustainable and stable; lastly, the **manufacturing capacity** showing the nation's potential for deeper industrialization including labour costs, logistics conditions and related policy incentives.

Table 22: Identified 10 regional hubs' competitive edge & potential sector

Region	Country	Over all Rank	Competitive edge (Based on Chapter 4)	Recommend EGs manufacture
Southern Africa	South Africa	1	cost and availability of labour and materials, local market attractiveness, energy cost and policies, economic, trade, financial and tax system, physical infrastructure, supplier network	renewable energy components and systems (wind, solar PV, and battery components and systems), Electric Vehicles,
	Zambia	3	low labour cost, clean energy driven electricity system, copper resource and processing manufacture	renewable energy components and systems, especially the copper related products manufacture (cables)
North Africa	Egypt	2	Leading economic growth, good manufacturing foundations and performance, competitive energy price, low labour cost	renewable energy components and systems (wind, solar PV), Electric Vehicles
	Morocco	6	Increasing economic growth, high manufacturing contribution to GDP, good investment return	renewable energy components and systems (wind, solar PV), Electric Vehicles
West Africa	Nigeria	4	Good manufacture foundations, low labour cost, transitioning energy policy	renewable energy components and systems (wind, solar PV), E-mobility two-wheelers assembly
	Ghana	5	Strong economic growth, high return on renewable investment, low labour cost	renewable energy components and systems (wind, solar PV), e-mobility components (batteries, charging infrastructure, electric motor systems)
East Africa	Kenya	12	Leading economic scale in the region, good economic growth, renewable energy driven electricity	renewable energy components and systems (wind, solar PV)
	Tanzania	13	Low electricity cost, Low labour cost, stable finance system, renewable energy driven electricity	renewable energy components and systems (wind, solar PV)
Central Africa	Angola	6	critical mineral reserve, renewable energy resources, good logistics location, tax intensives to EGs investors	renewable energy components and systems (wind, solar PV)
	Congo Rep	19	strategic location connecting the region, transitioning energy supply (hydrogen)	Solar Panels Manufacturing and Recycling and Waste Management Equipment

Table 21 above shows each country’s competitive edge and more importantly, the recommendations on its focus to manufacture the environmental goods. Under the global trends of energy transition and the fact that Africa still facing low energy access, the most promising investment field is to invest in **renewable energy components and systems**, including wind turbines, solar panels, and battery components for some countries with related materials. Related to the renewable energy components and systems, **maintenance, recycling and related waste management** will also follow behind when more and more products are to be maintained and re-produced.

It is also significant to see that the transportation sector will be another driver for environmental goods manufacturing, especially in many countries including South Africa, Zambia, and Kenya, the private sector has already started the investment into electricity Vehicles while the government is looking for public investment and plans to deliver intensives policies to boost the localization of the EVs value chain, making it good timing to join in.

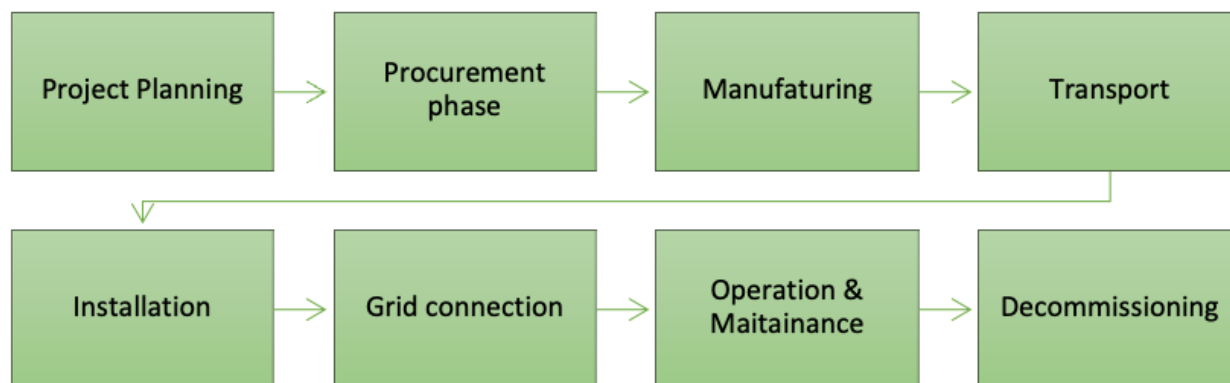
5.3 LOCAL MANUFACTURING OPPORTUNITIES IN THE ENVIRONMENT GOODS IN AFRICA

As we defined in Chapter 2, the major manufactured environmental goods categories include Renewable Energy (RE), Environmentally Preferable Products (EPP) and Environmental Protection (EP). Based on the current Chinese investment preferences and the potential of the identified regional hubs, RE will be the most competitive investment sector. Meanwhile, electrical vehicles as the leading EPP and waste management as an EP solution could be also the choices for some hubs to develop.

5.3.1 RENEWABLE ENERGY

Under the recent global trend of the energy transition, there has been considerable consolidation in the global market. From the energy companies, each function of the value train is under vertical consolidations, including procurement and contracting (EPC) to operation and maintenance (O&M), especially in the case of solar PV, making it a good time to restructuring (see **Figure 27**).

Figure 26: Renewable Energy Value Chain



The localisation in solar PV was in the balance of plant, mounting structures and trackers. For wind, it was the balance of plants and towers. The bulk of the imports in solar PV was in the photovoltaic module with its associated inputs such as frames, glass, and cells. In the wind value

chain, the collection of components that constitute the rotor, nacelle and drivetrain are largely untapped from a local manufacturing perspective. **Table 22** below gives a breakdown of the local manufacturing opportunities in the solar and wind value chain mainly based on the past and key input materials' availability, quality and cost.

Solar PV components	Potential for localization in region hubs
Module manufacturing	Additional module manufacturing presents a short-term opportunity in the South African, Kenya, Nigeria market that could be driven by the high local demand and the established module manufacturing capacity
Aluminum module frame and junction box	Expansion of aluminum module frame and junction box manufacturing facilities provided the cost of aluminums can be reduced to be cost-competitive with imports. Mozambique and Egypt are leading aluminum producers of the continent while Camaron & Ghana are as well the producers though smaller. Egypt and Ghana are the identified regional hubs and Mozambique is the neighbor and port to South Africa , making it also business-wise to invest in the regional value chain.
System assembly of inverters	System assembly of inverters with core imported products and some local components and manufacturing under license would require support from local producers to meet quality standards and access to testing and certification locally . Expanding magnetics production would be possible with additional milling capacity, and enclosure and packaging production could be expanded.
Transformers	Expanding transformer production through reductions in input material costs (especially steel) and improved efficiencies to meet the standards expected by international inverter manufacturers.
Mounting structures	Mounting structures are more readily localized due to the high cost of transport but are relatively lower-value components of a solar PV system. Expansion of production of steel and aluminum mounting structures could be done, provided steel production and aluminum extrusion production capacity can be expanded, and the support provided for tooling and cost of these inputs can be reduced to be cost-competitive with imports. It makes South Africa and Egypt good destinations to try with relatively good manufacture foundations.
Cable production (AC & DC)	Expanding cable production could be enabled by expanding local conductors, insulation, and armour provided input material costs (steel, aluminum, and polymers) are addressed. Local aluminum rod production could boost local cable production. Except for the four aluminum producers, Zambia , as a major copper producer with good processing manufacture base, will also play a role in this part, especially to connect with South Africa market and materials from Mozambique.
Wind components	Potential for localisation in region hubs
Wind tower	Steel and cement towers are normally manufactured locally, however additional tower and tower internals manufacturing are possible. Kenya, Tanzania as the leading country with renewable energy capacity and wills, and the whole East Africa (like Ethiopia) region as well, brings more potential to invest in this function.

Nacelle assembly	Though initially largely imported components, Local nacelle assembly is an important enabler of higher value local turbine component manufacturing. Local nacelle assembly could also expand existing casting, forging and transformer production if capacitated for renewable energy component production. But it required relatively high on local capacity to manufacture high-quality steel.
Blades	Blades could be manufactured by steel and aluminum alloys, but nowadays, the blades are made of carbon fiber with higher strength and the composite materials (for the edge) as it should be very light and strong, so it required relatively high on the materials manufacture capacity.
Cable production	Expanding cable production could be enabled by expanding local conductors, insulation, and armor, provided input material costs (steel, aluminum, and polymers) are addressed. Local aluminum rod production could boost local cable production. It again makes it possible to develop supply chains in Southern Africa (South Africa, Mozambique, Zambia) North Africa (Egypt, Morocco, Algeria).

It is also worth noting significant current interest in off-grid solar products in Africa. The assembly or some parts of the manufacture could be implemented locally in the future.

Case box: Power Solution

Power Solution is a Shenzhen-based off-grid solar equipment manufacturer, targeting on the Africa and India market. As of the end of 2022, Power Solution has sold more than one million sets of solar lights to Africa, covering over 4 million families under poverty line. Power Solution specializes in offering off-grid solar energy solutions, which provide flexible and cheap energy for the vast rural area. Their product warranty period ranges from one year to three years, and the defective rate is controlled within 3%. It is critical for their operations and maintenance that the products keep in good condition under extreme scenarios, so the product normally under one kilowatt-hour with simpler systems.

After years of growth in Africa market, Power Solution is launching the very first joint venture factory in Africa, located in Ethiopia by the end of 2023. According to LI Xia, the CEO & Founder of the Power Solution, **when deciding the investment destinations, they value three factors**: the first is whether the market is big enough with coming new orders as setting up production must be market-oriented; the second is to consider the sustainability of the development, as the market is big now, but how big the potential is for growth; the third is to consider the stability of the country's economy, especially the monetary policy, but it only accounts for less than 30% as she believes the political uncertainty should not drive the business explorations, especially in Africa market where they plan for the long-term. Choosing Ethiopia as the first destination goes with the three principles above while it's also valued that the local partner's government relationship and financial instruments, especially the capability to manage US dollars.

LI Xia also gives the strong reason why Chinese manufactures should plan for manufacturing localization: the most critical impetus is the factories could adjust productions based on the local market demand, the advantages of the first are fast response, and the second is to speed up the turnover of the product. Meanwhile, the policy to boost localized manufacturing in Africa will booming soon and it's always better to laid out in advance. In addition, the rise of China's labour prices is also the pushing strengths and the risk for global trader under the current geopolitics' tensions.

5.3.2 ELECTRIC VEHICLES

Globally, the EV market is growing fast - with China EV manufacturers leading in capacity and the Chinese market adapting fast to the new trends, there are also plenty of opportunities for the major players to go to Africa. For instance, the world's biggest EV maker, BYD officially launched their sales in South Africa in early 2023.

Electric vehicles now include cars, transit buses, trucks of all sizes, and even big-rig tractor-trailers that are at least partially powered by electricity. All e-mobility solutions could contribute to Africa's transportation sector to promote the current connectivity status. The EVs value chain encompasses from raw materials to dealerships, charging stations, EV component recycling and more. EV has simpler mechanics and few parts but is more challenging to mass-produce.

The most valuable component of the EV is its battery, which represents about 40% of the total value. China is the leading producer of EV batteries while South Africa and DRC contribute to the major productions of cobalt, the important lithium-ion batteries (see **Table 23** below). For Chinese

stakeholders, as raw materials normally are produced and sent to China, there are possibilities to relocate some parts of the supply chain to closer destinations, like South Africa.

Meanwhile, though the batteries recycling is not yet profitable, the fast growth of EV consumption will lead to recycling to boom soon in the future. Take China as an example, according to the government guide, once an EV battery's capacity drops to 80%, it should be taken out of the EV and reclassified, once a battery drops below 40% capacity, it is designated for recycling. Only in China, there are 7 million new EV batteries in circulation in 2022, meaning the next peak of recycling stating in 2027 after a five to eight years life cycle.²⁸⁵

What is happening in China's market, could be learned in Africa scenario. Starting from battery manufacturing, the major critical minerals producers and the economy with good manufacturing profiles, are trying to be involved. During the visit to China in July 2023, Algerian President Abdelmadjid Tebboune discussed a potential \$36 billion investment from China, including a major lithium battery factory, while it's neighbour Morocco also reserve cobalt.²⁸⁶

Table 23: lithium battery's key material reserve in identified hubs

Key Materials for Lithium Battery	Regional hubs or neighbour country with available reserve
Lithium	Zimbabwe, Nigeria
Nickel	Morocco, South Africa, Zambia
Cobalt	Morocco, South Africa, Zambia, DRC

For now, the adoption of EVs in Africa is still in the early stage. South Africa is the leading market for EVs in Africa but only accounting for less than 0.2% of new sales including hybrid models in 2022, with about 6000 EVs on the road. Kenya, another rising star in the EVs field, has estimated 350 EVs on the road among the 2.2 million cars registered.²⁸⁷

The political will in some African countries to boost this field is high. Taking Kenya as an example, in 2020, the government stated that it could require real estate developers to incorporate car charging stations between 2020 and 2020. Kenya Power, the country's sole power supplier also plans to convert two thousand gasoline and diesel-powered cars and trucks to electric power cars.

²⁸⁵ Wyk, Barry van. July 2023. "China's official electric vehicle battery recyclers fight wildcat workshops." https://thechinaproject.com/2023/07/11/chinas-official-electric-vehicle-battery-recyclers-fight-wildcat-workshops/?utm_campaign=Fri,%20Jul%2014,%202023%20%3A04%20PM%20-%20Germany%E2%80%99s%20new%20China%20strategy&utm_medium=email&utm_source=Mailjet

²⁸⁶ https://www.theafricareport.com/318662/morocco-algeria-who-will-win-the-battle-for-chinese-electric-batteries/?mc_cid=6f7b213d80&mc_eid=84a5195815

²⁸⁷ ESI Africa. February 2023. "Kenya making great strides to become Africa's electric vehicle hub." <https://www.esi-africa.com/east-africa/kenya-making-great-strides-to-become-africas-electric-vehicle-hub/>

From the private sector, Roam, a local-based EV OEM company, has begun the local production of electric buses which will enter service in Nairobi by the end of 2023. ²⁸⁸

Case box: ROAM

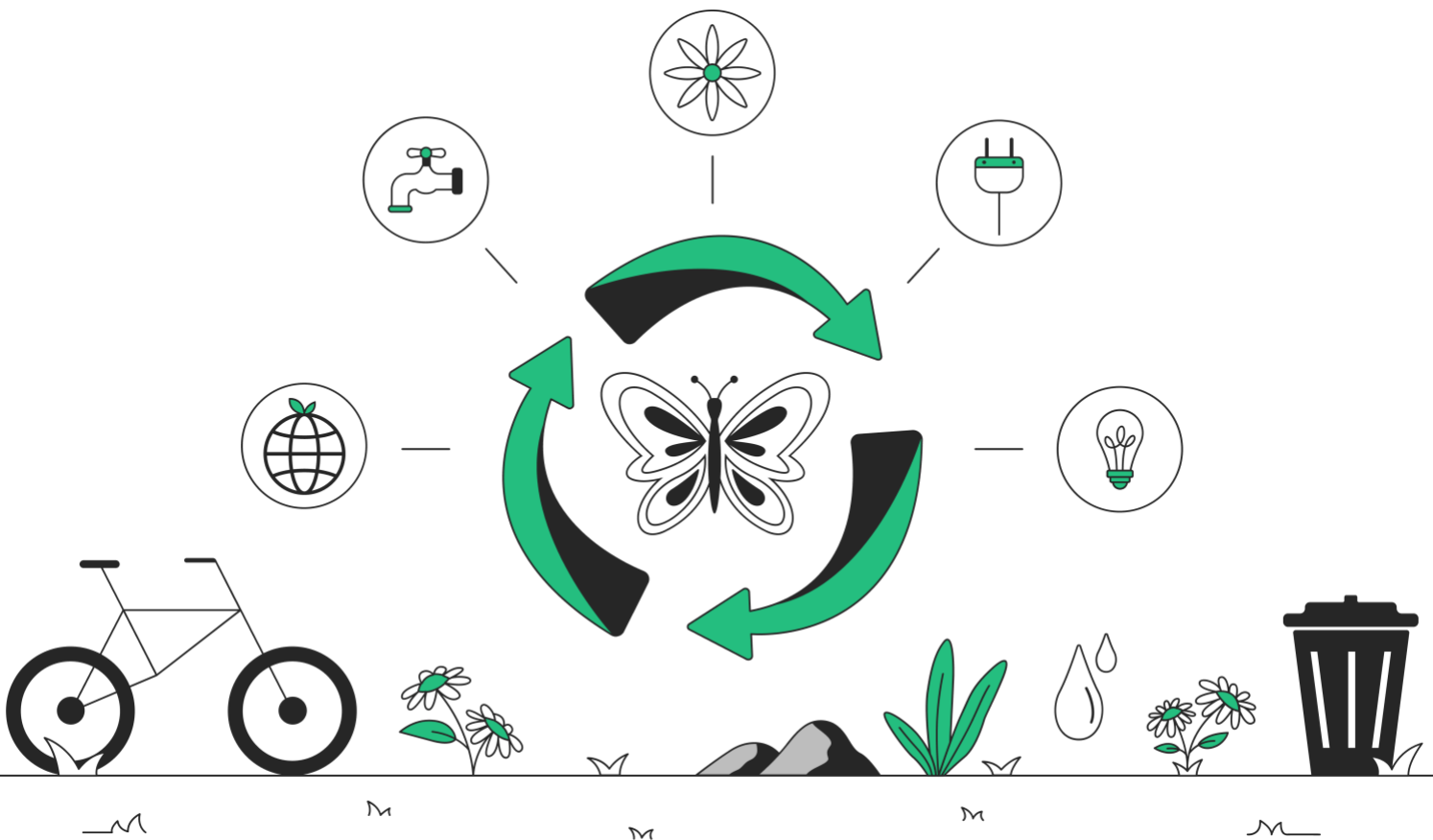
ROAM was founded in 2017, as a research project out of the University in Sweden, the project was basically based to find the best place to implement electric vehicles for carbon reduction. They start by converting old four-by-four vehicles to electric, and now addressing larger segments - mass transportation, including electric motorcycles, taxis, and buses. They aim to make and develop and manufacture all the transportation solutions and the related infrastructure (charging system) locally and already started motorcycle and bus manufacturing in Kenya.

Roam gather a supply chain that is pre-existing in Kenya by providing the original design of the car and manufacturing the frame in India, and the screen, and rims from China, together with the car components existing in Kenya, to establish a network of contractors to maintain the value train.

²⁸⁸ BusinessDay. "Kenya starts production of Africa's first all electric bus."
<https://businessday.ng/energy/article/kenya-starts-production-of-africas-first-all-electric-bus/>

CHAPTER 6

CHALLENGES



CHAPTER SUMMARY

Political environments and economic environments are intertwined. To date, many economists have suggested that supportive policies, regulations, incentives, and stable governance are essential for manufacturing sector growth, attracting investments, and ensuring sustainable development.

However, the opposite can apply as well. When investing in sectors like critical minerals, prioritizing value-addition can itself improve local community impacts and therefore security and political stability.

Structural challenges for the African continent to localize environmental goods manufacturing include inadequate infrastructure, limited technical capabilities, underdeveloped local supply chains, limited access to finance, and trade barriers.

While the potential for local manufacturing of environmental goods in Africa is promising, it's important to recognize the risks and obstacles that need to be overcome for their success. Drawing insights from our desk research and interviews with key stakeholders across Africa, this chapter delves into the key challenges hindering the development of environmental goods manufacturing on the continent and offers comprehensive recommendations to navigate these hurdles.

Many economists refer to the absence of a robust institutional framework, along with limited financial capabilities that lead to a “natural resource dilemma” or a “resource curse”. Research has shown that rent-seeking institutions cause an impediment to growth.²⁸⁹ As critical minerals have become more prominent in the natural resources field, there have been also extra risks from investing in these sectors, especially at a primary, extractive level. In particular, government and foreign investors often focus on business benefits but ignore the impacts on the local communities.²⁹⁰ Take mining as an example, Mozambique’s Cabo Delgado region is suffering from violence partly driven by grievances over the development of mineral resources²⁹¹. Similarly, in early 2022 in Cameroon, hundreds of civilians took to the streets protesting against a recent deal between a Chinese investor and the local government for iron ore export. These protests stemmed from concerns about the agreement's lack of clarity regarding the interests of the host community²⁹². Such concerns can lead to political instability and even military coups. For example, a coup in Niger in 2023 has been attributed to the country’s previous leaders inability to extract more benefits from its export of uranium to France, its former colonial power²⁹³.

²⁸⁹ Elvis D. Achuo, Resource wealth and the development dilemma in Africa: The role of policy syndromes, Resources Policy, <https://doi.org/10.1016/j.resourpol.2023.103644>.

²⁹⁰ Doodoo, Lennart. (February 19, 2020). “Poor in the Midst of Plenty: The Natural Resource Dilemma in West Africa.” Front Page Africa. <https://frontpageafricaonline.com/opinion/commentary/poor-in-the-midst-of-plenty-the-natural-resource-dilemma-in-west-africa/>

²⁹¹ Burrier, Edward A. and Thomas P. Sheehy. (June 7, 2023). “Challenging China’s Grip on Critical Minerals can be a Boon for Africa’s Future.” *United States Institute of Peace*. <https://www.usip.org/publications/2023/06/challenging-chinas-grip-critical-minerals-can-be-boon-africas-future>

²⁹² Kindzeka, Moki Edwin. (May 23, 2022). “Cameroonian Villagers Pretest China Iron Ore Mining Deal.” *Voice of America*. <https://www.voanews.com/a/cameroonian-villagers-protest-china-iron-ore-mining-deal-6585546.html>

²⁹³ E.g. see <https://politicsofpoverty.oxfamamerica.org/david-vs-goliath-in-the-worlds-poorest-country/>

That said, there has been insufficient examination by economists and governance experts as to whether investment in value-chains in resource-rich countries itself can improve prospects for security and political stability. For instance, Botswana has long been held up as a prominent example of strong political and economic progress on the continent, but it has also been able to gradually extract more added value and returns to its own economy from its main resource – diamonds²⁹⁴. While this theory therefore requires more analysis and testing, it may well be helpful for Chinese and other foreign investors to bear in mind as a direct means to protect their investments. Investing in environmental goods manufacturing, especially goods that make the most of the natural resources of the host countries may well be the best way to protect existing or other types of investments.

Beyond the question of management of security and political instability, addressing structural constraints is equally vital to overcome manufacturing challenges. These constraints include inadequate infrastructure, limited access to financing, skill gaps in the labour market, and a lack of technological capabilities. Recognizing and addressing these constraints can create an environment supportive of local manufacturing initiatives and maximize their transformative potential.

Inadequate infrastructure: The inadequate infrastructure across Africa poses a significant obstacle to the local manufacturing of environmental goods. Deficient transportation networks, unreliable power supply, and restricted access to technology and innovation hubs impede the establishment and expansion of manufacturing facilities. Tackling these infrastructure shortcomings is essential to ensure the efficient production and distribution of environmental goods.

Insufficient technical capabilities: A skilled workforce is vital for the successful development and operation of manufacturing facilities. An interviewee highlighted the challenge of finding individuals capable of operating advanced machinery. Furthermore, there is a shortage of educational programs focusing on advanced engineering, environmental conservation, renewable energy, circular economy, and related disciplines.

Underdeveloped Local Supply Chains: The majority of African nations currently lack fully integrated supply chains for environmental goods manufacturing. An example lies in the realm of solar energy products, where the absence of a comprehensive local supply chain for vital components like PV cells, as well as auxiliary materials such as back sheets, remains a significant challenge. Consequently, manufacturers often resort to importing these components from abroad, leading to increased costs and dependency on foreign sources.

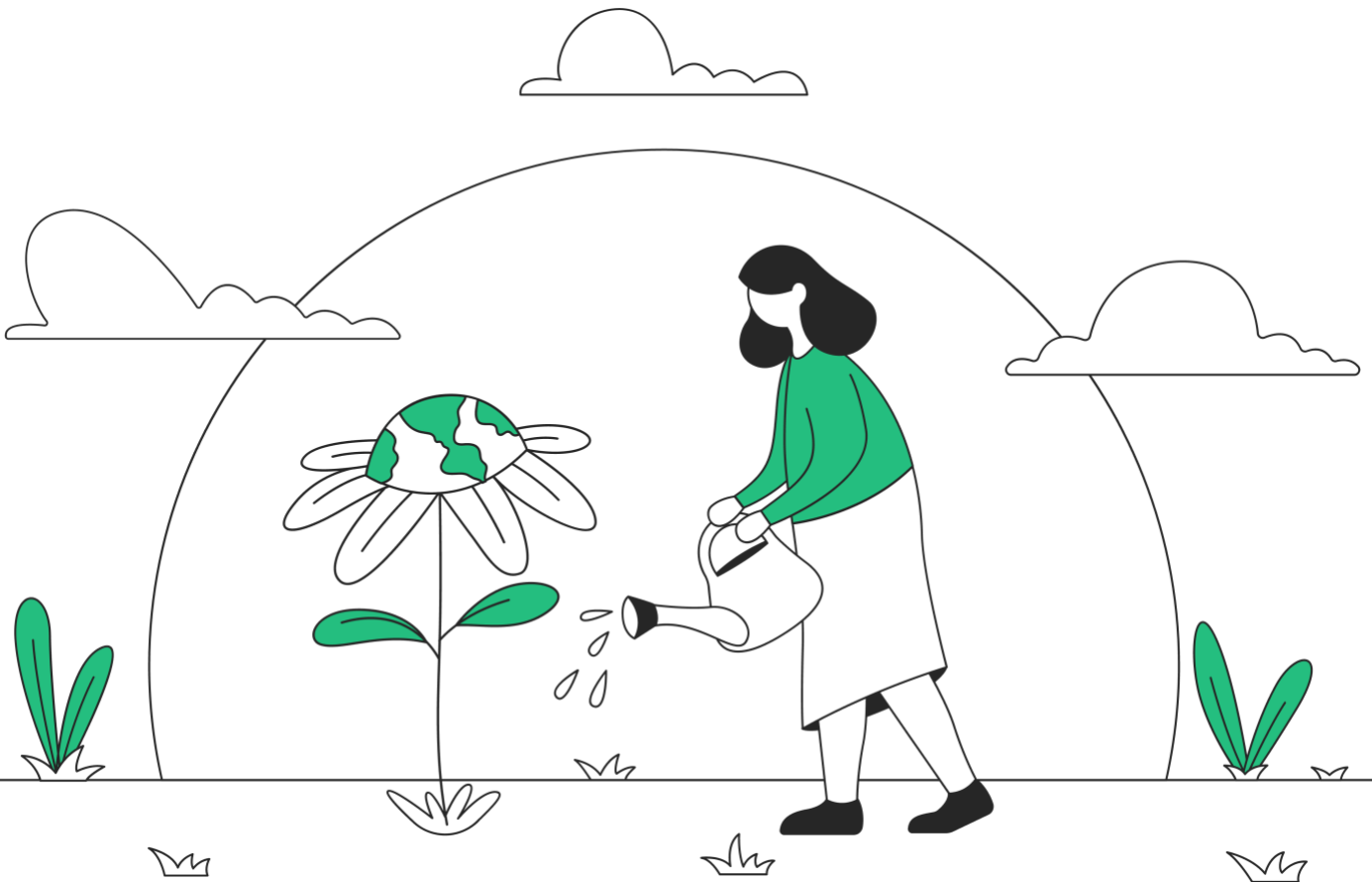
Limited Access to Finance: The challenge of accessing sufficient financial resources continues to hinder local manufacturers in Africa, particularly small and medium-sized enterprises (SMEs). This financial constraint obstructs firms' ability to invest in modern equipment, engage in research and development, and expand their operations, thereby discouraging their establishment and growth in the sector.

Trade Barriers and Regulatory Hurdles: Within Africa, obstacles like intra-African trade barriers, intricate regulatory landscapes, and bureaucratic procedures hinder smooth cross-border trade and investment in the environmental goods sector. Given that different countries possess distinct comparative advantages, fostering cooperation and facilitating trade becomes pivotal for nurturing comprehensive value chains across Africa. A UNCTAD report addressing these barriers can benefit AfCFTA members US\$20 billion.²⁸⁵

²⁹⁴ <https://www.theafricareport.com/110525/botswana-south-africa-the-secret-behind-the-diamond-wedding/>

CHAPTER 7

**CONCLUSIONS AND
RECOMMENDATIONS**



CONCLUSIONS

In the pursuit of sustainable development and environmental resilience, Africa stands at a pivotal crossroads. The urgency to address climate change and promote responsible industrialization has never been more pronounced. This report has delved into the multifaceted realm of local manufacturing of environmental goods in Africa, unraveling a narrative of opportunity, challenge, and transformation.

Amidst the undeniable impacts of climate change, the call for resolute action reverberates louder than ever across Africa. While contributing just a fraction of global greenhouse gas emissions, the continent bears the brunt of climate-related hazards, underscoring the necessity for a sustainable developmental trajectory. The vision of a green manufacturing pathway beckons—one that integrates economic growth, employment generation, and environmental stewardship.

The prospects of environmental goods manufacturing on the African continent are vast and inspiring. With abundant resources, a vast labour pool, and strategic geographic positioning, Africa possesses the raw ingredients to rise as a global powerhouse in the environmental goods sector. As the world pivots towards a future of net-zero emissions, Africa is poised not only to partake but to pioneer, steering its course towards prosperity and sustainability.

Yet, the path is not without its hurdles. The absence of explicit environmental goods manufacturing strategies, political instability, inadequate infrastructure, limited technical capabilities, and limited access to finance are among the obstacles that demand concerted efforts to overcome. The call for policy alignment, skill enhancement, and robust supply chains underscores the need for systemic transformation. These challenges are, in fact, opportunities—opportunities to reshape Africa's manufacturing landscape, unleash its untapped potential, and chart a course towards a more resilient and sustainable future.

The analysis in this report encapsulates both promise and nuance. From the identification of priority African countries to the exploration of challenges and recommendations, the report has endeavored to scrutinize every dimension of EG manufacturing. Nevertheless, it's essential to acknowledge the report's limitations in fully delving into certain aspects of local EG manufacturing in Africa. The complexity of cost analysis across diverse manufacturing scenarios, coupled with the scarcity of comprehensive cost data, has restrained us from providing exhaustive cost assessments. Additionally, the ever-evolving economic and geopolitical landscape underscores the dynamic nature of our predictions.

Despite the limitations, this report underscores the significance of local EG manufacturing as a transformative force in Africa's sustainable development journey, as well as future political and economic stability. This report resonates as a clarion call—a call for collaboration, action, and transformation. It beckons African governments, investors, industries, and communities to unite in the pursuit of a shared vision. It calls for policy reforms that nurture green infrastructure, skill development, and robust supply chains. It urges potential investors to recognize the untapped potential within African markets and to foster partnerships that elevate both profitability and sustainability.

The transformative potential of local EG manufacturing in Africa is unequivocal. It has the power to reshape economies, uplift societies, and contribute to a globally sustainable future. Our choices today will reverberate across generations, charting a course towards a greener, more prosperous, and resilient Africa—a beacon of hope amidst global trials. In the face of global challenges, the cultivation of global solutions is paramount.

RECOMMENDATIONS

To unleash the potential of environmental goods manufacturing and foster the creation of regional EG manufacturing hubs to drive Africa's sustainable development, this report implies six recommendations for African nations:

1. **Focus on value addition:** Many African governments are taking steps to create policies that provide both carrots and sticks in the direction of environmental goods manufacturing. This should both continue and accelerate, and ideally, the African Union, the AfCFTA Secretariat and other regional institutions should plan, publicise and support environmental goods manufacturing strategies.
2. **Regional Supply Chain Integration:** Within each region, a champion or first leader for environmental goods manufacturing should be identified, as we have done in this report, because it will lead to spillover benefits for the region. Competition within regions should be avoided. This country should take the lead in, for example, allocating special economic zones dedicated to environmental goods to attract foreign investment, streamline business operations, and utilise local content and labour from the region. Collaboration within the region from raw material production to manufacturing to marketing is critical.
3. **Prioritise Beneficial Trade agreements:** To strengthen regional hubs, streamlining trade processes and reinforcing regional trade agreements is essential. Regional trade agreements and the AfCFTA should be operationalised to increase regional trade of produced environmental goods, and development partners such as China encouraged to align with the AfCFTA to enable preferential access of African-made environmental goods in their markets. In turn, preferential export of non-African made environmental products to Africa should be discouraged, as it will crowd out local producers.
4. **Infrastructure Development:** To establish regional environmental goods manufacturing hubs, African countries should prioritize investments in green infrastructure. This includes creating comprehensive EV-charging networks, bioethanol-petrol blending facilities, and urban waste collection and recycling centers. Moreover, enhancing electricity infrastructure to accommodate higher levels of renewable energy generation is essential for the clean energy transformation.
5. **Financial Support Mechanisms:** Encouraging financial institutions in Africa, China and other development partner countries to create specialized financial products and incentives tailored to the needs of environmental goods manufacturers is vital. These financial solutions should stimulate investment, foster growth, and support SMEs and other manufacturing ventures operating within the EG manufacturing production network.
6. **Skill Development Initiatives:** Building a skilled workforce requires strategic investments in capacity-building initiatives and vocational training programs at all levels. Collaboration between educational institutions and industry players should focus on developing professionals proficient in environmental goods manufacturing, renewable energy, and sustainable practices.

ANNEX 1 - ASSESSMENT CRITERIA AND ANALYSIS METHODOLOGY

We have adopted a three-step framework to analyze the 12 criteria and to get the list of regional hubs with the greatest potential for environmental goods manufacturing in Africa.

Step 1: Use “Environmental good exports” to filter countries down from a continental assessment to a group of 20 countries.

Our initial assessment criteria are African countries’ environmental good exports, a variable we adopt as a proxy for environmental good production in a country. By virtue of producing goods, and to the extent that a portion of these goods are traded internationally, a country positively indicates the existence of a domestic environment that supports manufacturing of environmental goods. This includes but is not limited to policies and incentives that not only attract investment in local environmental good production, but also enable such businesses to survive long enough to become profitable and export oriented.

Using the International Monetary Fund’s (IMF) Climate Change Indicators Dashboard, we make take the average US\$ value of each African country’s environmental good exports in the period 2017-2021 (last stretch of five-year data).

Step 2: Use the following 11 criteria to get top two African countries from each of five regions by applying a weighted scoring framework:

Criteria	Metric	Description	Scoring system	Total Score ²⁹⁵
Gross domestic product ²⁹⁶	US\$	GDP is a significant measure of recent economic activity. Base 20 countries are ranked based on a five-average of GDP from 2018-2022.	Top 20%: 5 points 20%-40% range: 4 points 40%-60% range: 3 points 60%-80% range: 2 points Bottom 20%: 1 point	5
Manufacturing sector’s contribution to GDP ²⁹⁷	%	It assesses the countries’ manufacturing capacity. Having identified the 25%-30% range as the peak in terms of manufacturing sector contribution to GDP in our set of 20 African countries, we take this range as a benchmark and basis for scoring countries.	25%-30%: 5 points 20%-25%: 4 points 15%-20%: 3 points 10%-15%: 2 points Below 10%: 1 point	5

²⁹⁵ Note: Overall score total is 55; countries ranked according to overall score achieved

²⁹⁶ World Bank. “GDP.” <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD>

²⁹⁷ World Bank. “Manufacturing, value added (% of GDP)”. <https://data.worldbank.org/indicator/NV.IND.MANF.ZS>

Energy interconnectivity and transmission	Numbers 1-5	The foundation of energy generation and its transmission is infrastructure. These variables are critical pillars for downstream economic activities such as environmental good manufacturing. At a continental level, Africa's infrastructure development blueprint is the African Union's Programme for Infrastructure Development in Africa (PIDA). ²⁹⁸ As of July 2023, this blueprint was a group of 409 infrastructure projects with priority development status for the countries and regions the projects are constructed in. In our analysis of environmental good manufacturing, we filter down the 409 projects to only include the following criteria. Each criteria represents 1 point, and countries in our group of 20 countries, are allocated points if they have one of the PIDA project	Hydropower plants: 1 point Power Interconnectors: 1 point Multi-purpose reservoirs: 1 point River basin management: 1 point Water aquifer management: 1 point	5
Renewable energy potential ²⁹⁹	Gigawatts (GW)	In line with clean energy development on the continent, we use 5 gigawatts (GW) as a benchmark in terms of clean energy generation in our set of 20 African countries.	5GW or more: 5 points 2.5 - 5GW: 4 points 1 - 2.5GW: 3 points 0.5 - 1GW: 2 points Less than 0.5GW: 1 point	5
Number of critical minerals produced ³⁰⁰	Numbers 1-5	Critical minerals we focus include lithium, cobalt, nickel, manganese, graphite, rare earth elements, copper and aluminium, which are key component to manufacture environmental goods. ³⁰¹	0 (no critical mineral) – 5	5

²⁹⁸ AU PIDA Projects Dashboard. <https://www.au-pida.org/pida-projects/>

²⁹⁹ IRENA. March 2023. "Renewable Capacity statistics 2023." <https://www.irena.org/Publications/2023/Mar/Renewable-capacity-statistics-2023>

³⁰⁰ British Geological Survey. 2023. "World Mineral Production 2017-21." https://nora.nerc.ac.uk/id/eprint/534316/1/WMP_2017_2021_FINAL.pdf

³⁰¹ International Energy Agency. November 2022. "Critical Minerals Policy Tracker". <https://www.iea.org/data-and-statistics/data-tools/critical-minerals-policy-tracker>

Volume of critical mineral production ³⁰²	Tonnes	Five-year average of critical mineral production volumes in a country is measured. The tonnages produced become the framework used in scoring countries' critical mineral production volumes.	10m tonnes or more: 5 points 5m tonnes - 10m tonnes: 4 points 1m tonnes – 5m tonnes: 3 points 0.5m tonnes – 1m tonnes: 2 points Less than 1m tonnes: 1 point No record: 0 point	5
Environmental goods exported to China ³⁰³	US\$	A five-year average between 2017-2021 from countries' environmental good exports to China is measured.	US\$2 billion or more: 5 points US\$1.5 billion – US\$2 billion: 4 points US\$1 billion – US\$ 1.5 billion: 3 points US\$0.5 billion – US\$ 1 billion: 2 points Less than US\$500 million: 1 point	5
Labour force participation ³⁰⁴	%	Labour is an essential component in the production of environmental goods. More importantly, the proportion of an economy's population in the working-age that is either employed or actively seeking employment provides insights about conditions in a labour market. For planning purposes, an environmental good investment into a country with a high labour force participation rate is a firm foundation for manufacturing sector decisions.	60%-70%: 5 points 50%-60%: 4 points 40%-50%: 3 points 30%-40%: 2 points Less than 30%: 1 point	5
Logistic performance index	Numbers 1-139	The 2023 World Bank logistic performance index (LPI) is a useful tool for environmental good manufacturing stakeholders in their market evaluation- both from the perspectives of ease and	Top 20% (of global rankings): 5 points Between top 20%-40%: 4 points Between top 40%-60%: 3 points	

³⁰² British Geological Survey. 2023. "World Mineral Production 2017-21." https://nora.nerc.ac.uk/id/eprint/534316/1/WMP_2017_2021_FINAL.pdf

³⁰³ IMF Climate Data Dashboard. "Bilateral Trade in Environmental Goods." <https://climatedata.imf.org/pages/bp-indicators#cb1>

³⁰⁴ World Bank. "Labor force participation rate, total." <https://data.worldbank.org/indicator/SL.TLF.CACT.ZS>

		costs of importing production components as well as for external trade of value-added goods.	Between top 60%-80%: 2 points Bottom 80%: 1 point	
National determined contributions (NDCs) ³⁰⁵		A core component of the 2015 Paris Agreement was the set of climate action commitments countries undertook. We use this five-year, renewal-based form of climate action pledges as a scoring mechanism in our analysis of environmental good manufacturing.	Country has NDCs: 5 points Country has no NDCs: 0 points	5
Foreign direct investment from China ³⁰⁶	US\$	The base 20 countries are ranked by on five-year average of foreign direct investment flows from China between 2017 - 2021.	Top 20%: 5 points Between top 20%-40%: 4 points Between top 40%-60%: 3 points Between top 60%-80%: 2 points Bottom 20%: 1 point	5

Step 3: A regional level

At regional level, we make a supplementary, national-level analysis that includes and compares comparative advantages, challenges and opportunities countries have in the context of current and potential environmental good manufacturing.



³⁰⁵ DR's own tracking.

³⁰⁶ China's MOFCOM. 2022 Statistical Bulletin of China's Outward Foreign Direct Investment.