Renewable Supply Chains and Manufacturing

GET.transform
Transforming Energy Sectors Globally

Building Bridges Between Africa and Europe

GET.transform is co-funded by

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Norway

Ministry of Foreign Affairs of the Netherlands

Sweden
Sverige

Austrian Development Cooperation

Renewable Supply Chains and Manufacturing

Building Bridges Between Africa and Europe

Published by
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

GET.transform
Friedrich-Ebert-Allee 32+36
53113 Bonn, Germany
T +49 228 44601112
E info@get-transform.eu
I www.get-transform.eu
I www.giz.de

Place and date of publication
Bonn, December 2024

Acknowledgements
We gratefully acknowledge the participation of the interviewees. Without their insights, this report would not have been possible.

Responsible
Gildas Siggini, GET.transform

Authors
Ralf Leutz, Leopil
Toby Couture, E3 Analytics
Edi Assoumou, PSL Mines Paristech
Elvis Shoko, Afrionics Energy
Raquel Garde, CENER
Nis Martensen, Energynautics GmbH

GET.transform is a European programme which offers developing and emerging countries comprehensive advisory services to advance their energy sector transformations. It is hosted on the multi-donor platform GET.pro (Global Energy Transformation Programme), and supported by the European Union, Germany, the Netherlands, Sweden, and Austria.

german cooperation
DEUTSCHE ZUSAMMENARBEIT
Norway
Ministry of Foreign Affairs of the Netherlands
Sweden Sverige
Austrian Development Cooperation

Table of Contents

ES/ Executive Summary

About this study

Manufacturing renewable energy components in Africa can provide products where the markets of electrification and energy transition are, local production can save scarce foreign reserves, it can provide jobs and income, and localised manufacturing ecosystems can be a starting point for industrialization, followed by growth, and a general economic upturn.

This study looks at the value chains of manufacturing solar photovoltaic (PV) modules, wind power turbines, Li-ion batteries, electrolysers, and grid components, such as cables, transformers, and inverters, in Africa. Findings are based on interviews with companies in Africa manufacturing these products. These business cases show a small, just emerging, yet vibrant and innovative sector eager to supply the demands of African niche markets. Products are made in Africa for Africa.

This report examines the smallest, yet most important unit of competitiveness, the company and its product, namely, 'the company lens'. It has looked at the challenges and opportunities facing manufacturing in Africa from the bottom-up. This bottom-up analysis provides a rich tapestry of insights and examples, of lessons and pitfalls, to inform decision-making, and investment priorities.

The central question that has guided this study is: what opportunities exist in the renewable energy, battery storage, green hydrogen and grid-related sectors that present near-term, investable opportunities for Europe, and offer potential avenues for cooperation with European partners, specifically in the context of the Net Zero Industries Act and the Critical Raw Materials Act?

Investment environment and European-African cooperation

A vital asset that the EU brings is access to low-cost, longer tenor capital that can be invested in strategically important partnerships, and projects of common interest. The higher cost of capital combined with short loan tenors (2-5 years is common) in Africa makes local manufacturing virtually impossible. New mechanisms and institutional frameworks for providing such patient capital will be instrumental.

Successful African ventures can create valuable spill-over effects and even contribute to the formation of clusters, enabling positive feedback loops of skills, capital, and innovation to emerge. The future market for renewable energy, storage, and grid infrastructure in Africa is vast. This creates significant opportunities for synergies, and partnerships.

The Net-Zero Industry Act (NZIA), the Critical Raw Material Act (CRMA), and the Inflation Reduction Act (IRA) in the U.S. represent a pivotal shift in the global manufacturing landscape, a shift that is already having major impacts on global supply chains. The EU's NZIA aims to have an aggregate of 40% of annual deployment needs of renewable energy technologies manufactured in the EU by 2030 (European Commission, 2023f): this leaves 60% of the value of renewable energy components that can be manufactured outside the EU. With regard to the CRMA, Africa has tremendous potential in a host of critically important minerals and materials, and is actively seeking partners and companies to extract and help refine and process them safely, and sustainably, in a way that maximises local value added.

Opportunities for deep and lasting partnerships exist, but they need to be nurtured, as they are unlikely to emerge without a clear support, and a coherent strategy.

Summary table on near-term economic viability and Africa-EU synergies

Technology category	Supply chain segment	Assessment of near-term economic viability in Africa	Strategic potential in terms of Africa-EU synergies
Solar	Silica	Low	Low
	Polysilicon	Low	Low
	Ingots	Low	Low
	Wafers	Low	Low
	Cells	Low	Med (markets)
	Module Assembly	High (niche markets)	Med (tech transfer; synergetic markets GH2, electricity)
	Recycling	Med	High
Wind	Towers	High	High (synergies with low carbon steel or concrete)
	Blades	Low (lack of technology transfer and skills)	Med (in North Africa despite unsuccessful experience, niche markets)
	Nacelle/Gearbox	Low (some opportunities for small scale turbines)	Med (tech transfer, opportunities for spare parts and small-scale turbines)
GH2	Electrolyser & Fuel Cell Components	Low	Low
	Electrolyser & Fuel Cell Stacks & Modules	Med (policy driven)	Med (GH2 exports)
	Electrolyser & Fuel Cell Plants	Med (policy driven)	Med (GH2 exports)
Batteries	Mining and processing	High	High
	Refining	High	High
	Precursors	Medium	High
	Cell Manufacturing	Low	Low
	Module/Pack Assembly	High	Medium
	System Integration	High	Medium
	Second Life	High	High
	Recycling	Medium	High
Grid Technologies	Cables/Lines	High	Low
	Transformers	High	Low
	Inverters	Medium	Medium
	Secondary equipment, meters, other	Medium	Medium

As highlighted throughout this study, location decisions rank among the most important decisions that manufacturers make. And manufacturing clusters only emerge where both seeds and suitable soil are present: currently there are only a few regions in Africa where both of these pre-conditions exist. And yet, the history of Africa's role in the Green Industrial Revolution is not yet written. The actions, policies, laws, and investment frameworks established by countries throughout the continent can and will play a major role in writing that history.

While it is impossible to forecast the future, a few aspects are clear: market forces alone are not likely to drive local manufacturing at scale in Africa; solar and wind power manufacturing face particularly strong headwinds, and will need to be closely tied to local markets and local needs; by contrast, the battery storage sector is at an inflection point, and has tremendous potential for greater support and win-win partnerships; while electrolyser production in Africa faces challenges, the potential for greater green hydrogen production and local beneficiation remains enormous; and finally, both grids and related equipment (including insulators, circuit breakers, measurement transformers, data recording and control devices, among others) are underappreciated in terms of their size and potential, and represent major opportunities for growth, investment, and strategic partnerships.

Key insights for solar technologies

Solar products currently are made in Africa for Africa; small panels satisfying the demand of the rural and low-income populations in Sub-Saharan Africa, delivered from South Africa, the logistics and industrial epicentre of the region. Larger panels are procured by the informal markets, in Nigeria. Unique Selling Points (USP) include robustness, affordability, and locally enforceable warranties. Manufacturing is restricted to module assembly, which is the entry stage for PV manufacturing.

Foreign investments have been placed, but start-ups tend to avoid dilution. Opportunities for partnerships between Europe and Africa may focus on future technologies, such as agrivoltaics, floating PV, Concentrating Photovoltaics (CPV), potentially adding benefits to the generation of electricity. The integration of local PV manufacturing in green hydrogen (GH2) projects is a real possibility, as premiums could be afforded. As Plan B for GH2, electricity generation and exchange between the continents is a possibility.

Key insights for wind technologies

Wind manufacturing in Africa is recovering from the pull-out of a blade factory in Morocco. Manufacturing is focussing on concrete and steel industry backlinks for making tower segments in South Africa. Opportunities for EU investments include, like with large-scale solar, holistic projects around the production of green hydrogen.

Key insights for Green Hydrogen (GH2)

Regarding green technology manufacturing in Africa, two potential business cases have been recognised: one in North Africa focusing on electrolyser production, leveraging the established fertiliser market and proximity to Europe for exports, and another in Southern Africa centred around reversible fuel cells to address local energy needs while utilizing its natural and mineral resources. Both strategies could become competitive through supportive policies. In both cases, it is a priority for technology manufacturers to secure a stable market, including financial and policy support, and the necessary human, infrastructure and logistical resources.

To forge lasting and fair partnerships between the EU and Africa, it will be necessary to develop a green hydrogen (GH2) ecosystem in key sectors, aiming for a sustainable and competitive market both locally and internationally. This involves setting up bilateral agreements for GH2 project development with specific goals and plans, encouraging collaboration with local component manufacturers or suppliers to strengthen supply chains, advancing international standards and codes, and supporting educational programs to boost expertise in green technologies.

Key insights for battery storage technologies

Much of the battery value chain startup activity in Africa is observed in the more profitable segment of battery pack assembly, where the global average net margin is 19%. All five featured battery business cases include at least some form of battery pack assembly, predominantly for two-wheeler e-mobility in East and West Africa, and Energy Storage Systems (ESS) in Southern Africa.

There is the need to develop regional battery value chains to enable economies of scale, to reach the critical mass of feedstock for mineral processing, refining, precursor, cell manufacturing, and end-of-life battery recycling plants. The primary market in the short-term is expected to be for export. In battery pack assembly and system integration, the demand side is fundamentally African. By aggregating demand across regional economic communities (RECs), globally competitive regional battery assembly hubs could be established.

As Africa's battery ecosystem is highly fragmented, current operators, particularly in battery pack assembly for e-mobility, reported having to both forward and backward integrate to create the necessary ecosystems for business model viability. The ecosystem-building strategy is also evident in the China-led battery investments occurring in Morocco, although the scale of investment involved in this case is much larger than envisaged for the EU. Opportunities for EU-Africa partnerships to promote local manufacturing are identified across the value chain. Cell manufacturing is the most challenging, more favourable segments of the value chain are discussed as hot spots for further exploration.

Key insights for grid technologies

The International Energy Agency (IEA) has determined a need for annual investment into the African grid of USD 45 billion by 2023 in its Sustainable Africa Scenario, just under the amount required for deployment of renewables (IEA, 2023c). This means that for every Euro spent on renewable energy capacity in the coming decades in Africa, nearly another Euro is expected to be needed in grids and related infrastructure. This points to significant potential for cables, transformers, wires, power electronics, and other related components, many of which are already being produced in certain parts of Africa today (DMRE, 2023). As with solar PV, testing and quality assurance facilities are likely needed to ensure that locally produced products can qualify for larger regional and international tenders on grid-related infrastructure projects.

Selection of products, companies, and locations for manufacturing renewable energy components in Africa

Competitive industries will create jobs, wealth, and manufacturing value added (MVA) for Africa, plus diversified and more resilient global supply chains for Europe. The rationale for Europe to invest and cooperate in renewable energy component manufacturing is the narrative motivating this study:

- **Goal:** Just energy transition in Africa at the nexus of manufacturing, value creation, and electrification

- **Strategic aims**
  - more local value creation in Africa
  - more resilient supply chains for Europe

- **Means:** Manufacturing ecosystems
  - centred on renewable energy parts and products,
  - embedded and supported,
  - answer to demand,
  - strengthen the local value chain upstream (beneficiation of minerals), and downstream (renewable power generation), along with the product segment,

- yield internationally competitive companies,
- sustainably offering competitive products.

- **Benefits for both Africa and Europe**
  - jobs, profits, wealth, economic upturn through manufacturing value added
  - diversified technologically and geographically, hence more resilient global supply chains with access to critical raw materials (CRM) and renewable energy components

An abbreviated summary of countries, products, support activities, instruments, and facilitators enabling the manufacture of renewable energy components in Africa is given in Table 1.

Table 1: Manufacturing renewable energy components in Africa: countries, products, support activities, instruments, and facilitators (abbreviated version)

	Agile start-ups and small enterprises	Mature, competitive medium-sized corporations	Large, high-tech multi-national industry
Manufacturing focus	Assembly, niche products	Established product lines, lateral integration	Vertically integrated anchors for supply chains
Potential country list	Democratic Republic of Congo, Egypt, Ghana, Kenya, Mauritania, Morocco, Namibia, Nigeria, South Africa, Tunisia, Zambia		
Products and processes	PV modules, battery pack assembly, assembly of light electric vehicles (LEV), electrolyser/ FC stacks & modules assembly	Wind towers, transformers/ cables, electrolyser plants	Extraction and refining of CRMs Co, Li, Cu
Support activity **Market**	'No market, no manufacturing': follow and foster local demand Unsexy products may sell best, focus on competitiveness of the company		Explore local and global markets
Support activity **Industrial policy**	Grow clusters based on prioritizing places with basic manufacturing ecosystems already in place, avoiding the pitfalls of Special Economic Zones (SEZ) Learn from existing role model industries involving complexity and automation, and undergoing restructuring, like automotive (Electric Vehicles) Incentivise green products, offering a competitive advantage under Net Zero Industry Act (NZIA) and Carbon Border Adjustment Mechanism (CBAM) Sign win-win, eye-level partnerships for mutually beneficially agreements (example: clear production and offtake clauses), this to strengthen the upstream extraction and beneficiation sector for technologically and geographically diversified and more resilient supply chains, locally and globally Support applies to all segments of the value chain, in particular to the beneficiation of minerals, strengthening the industry as a whole		
Support activity **Financing**	Give access to patient capital and venture debt (>5 years) for Capex, bridging loans in production and project Lower or insure currency risks		
Support activity **Skills**	Skill building and upskilling, on all levels up to C-level R&D partnerships		

Facilitators	Change agents (GET.transform, GET.invest, cluster development agents), consultants Industry associations, unions, companies Export Credit Agencies (ECAs), European Investment Bank (EIB) and other Development Finance Institutions (DFI)		
	Entrepreneurs		

01

Renewable Energy Manufacturing Capacity in Africa

01/ Renewable Energy Manufacturing Capacity in Africa

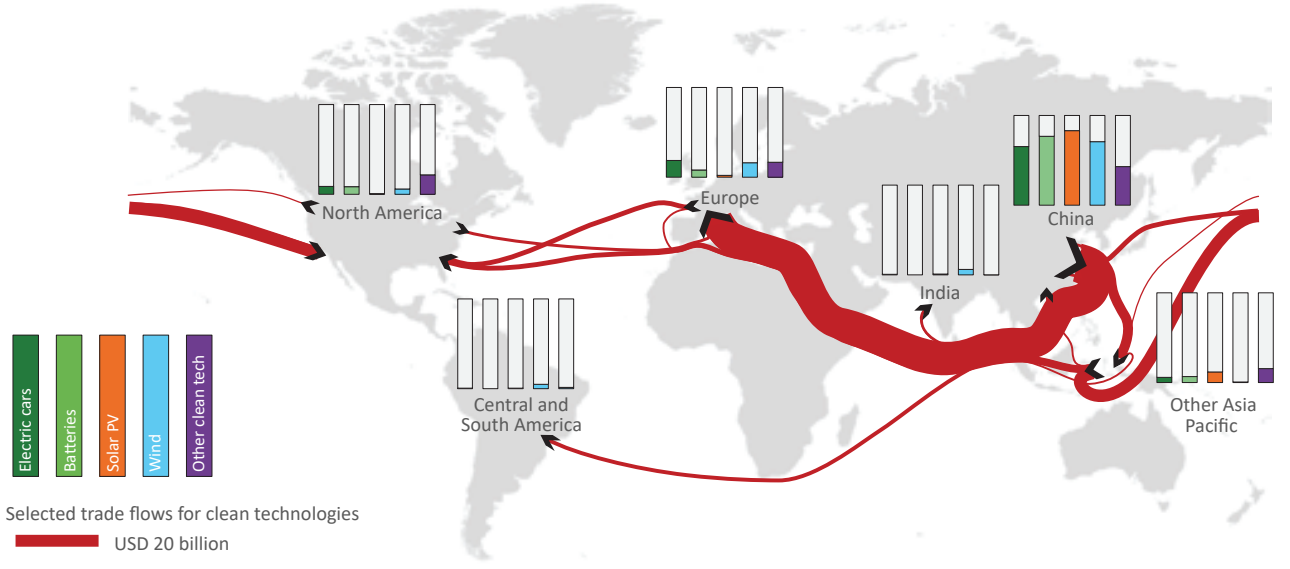
This report is structured into four chapters, this first outlining the present status of manufacturing renewable energy components in Africa, followed by a chapter on investment environment and policy frameworks. The third chapter contains an analysis of business case competitiveness embedded in strengthening the European-African cooperation. The final chapter extends recommendations to the Global Gateway Initiative required to achieve mutually beneficial manufacturing in Africa.

In order to outline the present status of manufacturing renewable energy components in Africa, this first chapter starts with a landscape analysis that defines the various manufacturing value chains considered and shows where segments of these value chains are sited in Africa, giving the necessary background for the subsequent chapters. As one of the objectives of the report is also to help strengthen the European-African cooperation, a brief second subsection provides a collection of existing European-African projects in Renewable Energy (RE) manufacturing.

1.1 Landscape analysis

Source: IEA 2024; Energy Technology Perspectives (ETP), https://prod.iea.org/reports/energy-technology-perspectives-2024, License: CC BY 4.0

Share of global clean technology manufacturing output by technology, 2023



The manufacturing of clean technologies is highly concentrated geographically, with China accounting for around 70% of the global manufacturing output value for the six key clean technologies.

When we look at the volume of trade in clean energy technologies, Africa's share is very small, if not insignificant. Most of the trade takes place between Europe and China and represents several billion dollars annually. In comparison, the most significant flows represented in the figure above between Africa, mainly South Africa, and China are less than 5 billion dollars. The flows mainly concern solar modules, which are enjoying greater momentum on the continent than other clean technologies. These flows underline the relatively low level of industrial activity in clean energy technologies on the continent today.

Investment in manufacturing is significantly influenced by pre-existing parts of the value chains. The identification and assessment of investment opportunities therefore starts with the collection of analysis of information on the

existing RE manufacturing landscape in Africa. The first steps in this process are the definition of the value chain concept and the description of the core value chains to be considered within the scope of this work.

The manufacturing value chain is a concept describing subsequent steps taken in manufacturing a product. The value chain is a simplification of reality and it is product centred. The value chains assessed include raw materials upstream, recycling downstream, and exclude steps such as product design, distribution, and service. The value chain concept is descriptive, heuristic (a model), but is also a tool for profitability and competitiveness of the processes described leading to the product to be manufactured. With the help of the value chain, the value added in the manufacturing steps, their complexity, jobs created, Capex required, and costs generated can be assessed.

Technologies, products, and value chain steps considered in this work are collected in Table 2.

Figure 1 shows manufacturing value chain steps sited in Africa. Steps not listed are not present on the continent (such as battery cell manufacturing). The map gives an overview of mining and manufacturing sites covered by the manufacturing supply chains outlined above. Most sites are operating, some have been closed temporarily or permanently, and some have been credibly announced or are under construction.

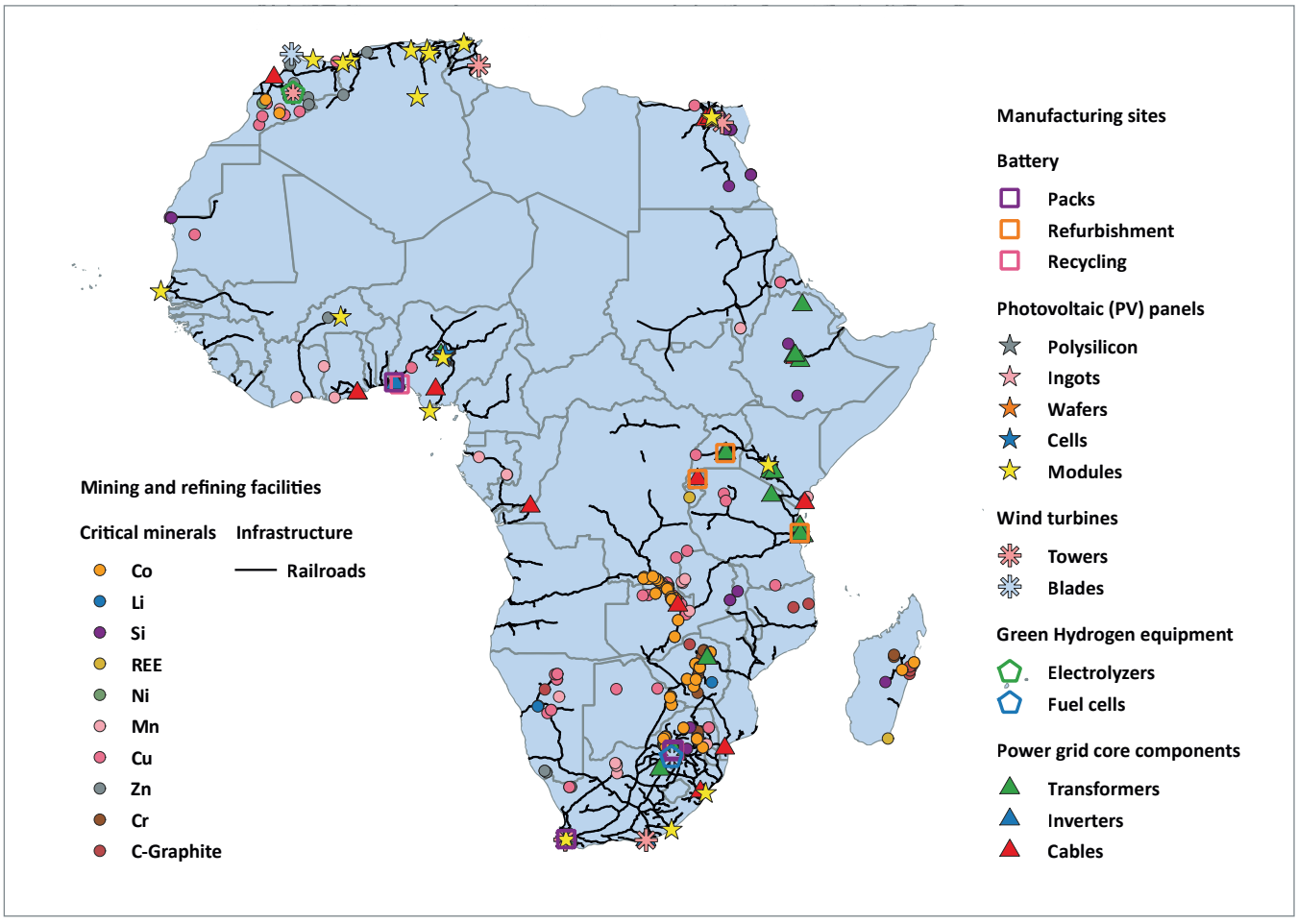
Table 2: Value chains of renewable energy components: products, critical minerals, process steps, and links. Sources: Critical minerals (IEA, 2021), critical minerals for batteries (Carreon, 2023), authors' compilation

Technology and product	Critical minerals	Upstream processes	Links (parts input)	Product step (Midstream Processes)[1]	Downstream processes
Solar photovoltaic (PV) Module	Al Cu Si Zn	Silica mining Ingot refining Wafer cutting and wiring Cell diffusion and coating	Glass Backsheets Frames Junction boxes	Module assembly	Module recycling
Wind Wind turbine	Al Cr Cu Mn Mo Ni REE Zn	Nacelle: carrier, gearbox, brakes, electric generator manufacturing Rotor: adapter, hub, low and high-speed shafts making	Blades Tower Electrical equipment and controls	Wind turbine assembly	Wind turbine recycling
Lithium-ion Batteries (based on nickel manganese cobalt oxides (NMC) Chemistry only) Battery module and pack	Co Li Mn Ni Graphite Cu Al	Mining Processing	Binders Tabs Cans Cases Lids Electrolyte separators	Refining Precursor, and Active Material manufacturing Electrolyte production Electrode Manufacturing Cell assembly and finishing	BMS manufacturing Battery modules and packs assembly Second Life Repurposing Recycling
Green Hydrogen Electrolyser	Ni Zr Pt Pd Ir	Mining Refining Electrode and sub-component manufacturing	Electrolyte Separator Frames	(Alkaline & PEM) Electrolyser stack and module assembly	Stack recycling

[1] For batteries, the processes listed are classified as the midstream of the value chain by industry convention.

Power systems Cables	Al Cu	Mining Cathode smelting and refining Wire drawing, annealing, twisting, and stranding	PVC/PE sheath	Cable, line assembly	Cable scrapping
Power systems Transformers	Cu	Iron mining Steel coil purification Silicon steel sheet rolling Core bending, notching, heating, and stacking Windings drying and shrinking	Clamps Oil ducts and oil Bolts Wood beams Paper Fiberglass Cooling system Insulation Tanks	Transformer assembly	Transformer drainage, disassembly, and refurbishing
Power systems Inverters	Cu Si	Mining Semiconductor processes Insulated-Gate Bipolar Transistor (IGBT) module packaging	Chemicals Case, heat sink Transformer Display	Inverter assembly	Inverter recycling

Figure 1: Manufacturing value chains of renewable energy components in Africa. Sources: Mining and refining (USGS, 2023), authors' research



There are two aspects completing the landscape analysis. Firstly, the capacity of manufacturing renewable energy components in Africa, compared to the capacity in other parts of the world. Secondly, the consequences immediately

following the volumes produced, such as cost and learning curve, and skill base.
To identify competitive advantages of Africa-based production, it is necessary to identify niches, and unique selling points (USP) to demonstrate sustainable long-term visions as well as investment opportunities in the short term. These opportunities will be presented within the framework of business cases in chapter 3 of this report. The next section gives an overview of existing manufacturing partnerships between EU and Africa.

1.2 European-African projects in RE manufacturing

In recent years, notably following the unveiling of the REpowerEU strategy (IEA, 2023f), which outlines Europe's goal of importing 10 million tons of green hydrogen per year by 2030, numerous African countries have collaborated with various international and European entities to evaluate their potential as exporters of green molecules. This transformative initiative is illustrated by Namibia's commitment through the HYPHEN project (Hyphen Hydrogen Energy, 2023) and Kenya's strategic collaboration with the European Investment Bank (EIB, 2023), among other noteworthy partnerships.

The ESECA project (ESECA, 2023), funded by the European Commission under the COSME Clusters GO International programme, aims to support the internationalisation of European Small and Medium-sized Enterprises (SME) in the renewable energy and smart grids sectors in Sub-Saharan Africa. Solarge, an EU-based solar module manufacturer, has tapped into funding from the Infrastructure Corporation of Nigeria and the African Green Infrastructure Investment Bank to develop local solar manufacturing in Nigeria (ESI Africa, 2023). Another manufacturer having benefitted from EU funding is Husk Power Systems (Husk, 2023; Peterschmidt, Mattson, & Kidenda, 2023), a company rolling out renewable mini-grids in Africa, which has in 2022 benefited from a 749 thousand US Dollar (DEG Invest, 2023) financial commitment of the German KfW DEG in its Up-Scaling section of the AfricaConnect programme. European manufacturer Ecoprogetti (Ecoprogetti srl, 2023) has delivered turn-key PV module assembly lines, e.g., to Morocco in 2018 (Bellini, 2018). Spanish Mondragon Corporation has installed PV module assembly lines in Burkina Faso (Spaes, 2020), Algeria (Mondragon, 2021), and Egypt (Takouleu, 2020).

As these select examples indicate, EU-based manufacturers are actively looking to establish partnerships that can provide mutually beneficial opportunities for growth, investment, and job creation. In some cases, such as in the case of green hydrogen and green ammonia, the business case may be oriented more toward exports to the EU (due to the EU's larger demand), while in other cases, the businesses cases will only thrive if they specifically serve local, bottom-up demand. The latter is the approach taken in Nigeria (see above) as well as in many of the cleantech manufacturing ventures taking root in South Africa (DMRE, 2023; LSF, 2023).

Identification and analysis of RE manufacturing opportunities in Africa has been carried out as recently as 2022 by Sustainable Energy for All (SEforALL, 2023). However, the SEforALL report looks at opportunities for China-based manufacturers. While there is a number of manufacturers with major production facilities in China that have decided to add manufacturing capacity in Africa (e.g., Seraphim in South Africa (Green Building Africa, 2019)), most of the interviewed companies based in China remained focused on their production facilities in China, and were more interested in Africa as a potential export market. This is particularly the case in the solar sector, where significant excess capacity in China already exists. In batteries, the story is different, with many large Chinese manufacturers actively scouting the continent for opportunities (Rhodium Group, MERICS, 2023).

02

Investment Environment and Policy Frameworks

02/ Investment Environment and Policy Frameworks

The investment environment is at the heart of the success or failure of manufacturing ventures. The investment environment refers to the whole ecosystem of policies, rules, regulations, market, infrastructure, political, and macro-economic factors that influence the success or failure of a manufacturing project. The current global and regional competition for green manufacturing investment is fierce. And with only 2% of global manufacturing output, despite being home to a sixth of the world's population, Africa has not fared well so far (McKinsey, 2023c). The realisation has dawned that more needs to be done to scale-up Africa's manufacturing sector and to increase the level of economic value-added in the resources and materials produced locally.

Countries across Africa need support in their efforts to self-produce a greater share of the products and finished goods they currently need. In fact, reducing reliance on imports of finished goods is becoming a major priority for economic policy throughout the continent. Making a greater share of products, or parts, locally adds value, creates greater economic activity and local opportunities, and increases independence. This is precisely the kind of synergy and support that many countries in Africa are looking for.

For a growing number of countries across the continent, the question is converging on the underlying dilemma: to make or to buy (i.e. to manufacture one's own goods or to import them)? For many goods, the decision to import may remain for years if not decades to come; yet, there is a growing chorus of voices from Egypt, from South Africa, from Morocco, and from Nigeria among others, that Africa can do more to manufacture a greater share of products, and increase the value-added of its raw materials through local processing and refining, than it has in the past. The realisation is dawning that countries across Africa not only can do more, but rather, that they must do more. To achieve this, countries across Africa need partners, which is to say, there is an urgent need to establish and nurture mutually beneficial partnerships.

Since countries across Africa are unlikely to be able to compete with the U.S., the EU, or China in terms of "fiscal firepower," Africa will need to compete differently.

There are win-win opportunities for the EU and Africa – the challenge is to identify them, and act. This will be covered in greater detail in the section on business cases below.

This chapter adopts the country lens, while much of the rest of the report adopts a company/sectoral lens. It highlights the various success factors for mobilizing manufacturing investment (2.1), drawing on specific examples, and provides a set of key benchmarking metrics that countries can work to improve (2.2) before turning to an analysis of the main barriers (2.3). Following the barriers, the analysis looks at the vast array of policy measures that governments can take to support manufacturing investment (2.4) before looking at the specific case of Special Economic Zones (2.5), and what role they can play in supporting African countries' journey to become more important players in the global clean energy (wind, solar, batteries, electrolysers) manufacturing landscape.

2.1 Key criteria for mobilising investment in manufacturing

At the firm level, manufacturing never exists in isolation: it is always embedded within a broader supply chain of the components, materials, raw inputs, and skills that are either available locally or imported. On the other hand, the regulatory, legal, and tax context of a particular jurisdiction directly impacts the economics and viability of these

supply chains and capital flows. For example, sudden changes to the tax, legal, or regulatory environment such as the introduction of new import tariffs, the increase in taxes or fees, or adjustments a country makes to its currency peg, can jeopardise the viability of manufacturing business cases.

Given this complex interplay of political, legal, regulatory, and commercial factors, combined with an ever-shifting demand landscape, manufacturing is a perilous business. Thus, location decisions rank among the most important decisions that manufacturers make. Countries that have scaled-up domestic manufacturing such as China, India, and Bangladesh have used a combination of elements (location, labor force, access to raw materials, etc.) to develop their manufacturing sector.

The five following elements represent the foundations of the investment environment:

- ***Stable tax, legal, and regulatory regime (including good governance);***
- ***Presence of supporting infrastructure (quality ports, roads, bridges, rail lines, reliable electricity supply, water supply);***
- ***Raw materials, precursors, and supply chains;***
- ***Skilled workforce;***
- ***Viable market.***

For manufacturers, these elements can be converted into a set of key questions:

- ***How stable is the country?***
- ***How does the country rank in terms of key indicators such as governance, or corruption?***
- ***How reliable is key infrastructure such as roads, rail, and the port?***
- ***Can I readily access the key inputs I need?***
- ***What are the wait times for obtaining goods or raw materials from the port?***
- ***How reliable is the electricity supply?***
- ***How easy is it to find people locally to fill key positions at the company?***
- ***Is there a viable market for the products I produce?***

Furthermore, some location-specific aspects such as work culture can have a profound impact on manufacturing performance, hence siting decisions for new production facilities (Porter, 1990; Swahn, Semini, & Strandhagen, 2016). However, central to manufacturing is the presence of **demand** - demand can either be local, regional (neighbouring countries), or global (export markets).

Accordingly, an assessment of manufacturing business cases must undertake a thorough due diligence on the existence of a viable market. Ideally, such a market would be local or regional, but markets further afield can also be viable.

Currently, renewable energy markets are relatively small or nascent in most African countries; still this must be balanced with the expected rapid growth of these markets underpinned by several factors including population

growth, energy access programmes (UN SDG 7) such as green mini-grid rollouts, the energy transition frameworks such as South Africa's USD 8.5 billion Just Energy Transition Partnership (JETP), and the regional consolidation of these markets, e.g., the African Single Electricity Market (AfSEM). For example, while current capacities are 12 GW for wind, 15 GW for solar, and nascent for green hydrogen, growth is projected to be 35x (wind), 100x (solar), and potentially as much as 700 megatons of green hydrogen by 2050 (McKinsey, 2023a).

To be sustainable, any envisaged manufacturing in Africa must be cost- and quality-competitive on the global market. Scale effects, partly determined by market size, are among the key drivers for cost-competitiveness. Consider solar: in 2022, countries across Sub-Saharan Africa collectively installed 949 MW of solar PV (Hutchins, 2023). While this number is expected to be significantly higher in 2023, it represents a mere 0.3% of global PV deployment, despite the region representing over 15% of the global population. Without the projected growth, this small market of 0.1% of global supply (Molina, 2023), spread across 50 countries is simply not enough to justify new large-scale investments in local manufacturing. Furthermore, the competition at the margin for additional manufacturing capacity in the solar sector is already extremely high.

Figure 2: PV manufacturing capacity by component (IEA, 2023e), authors

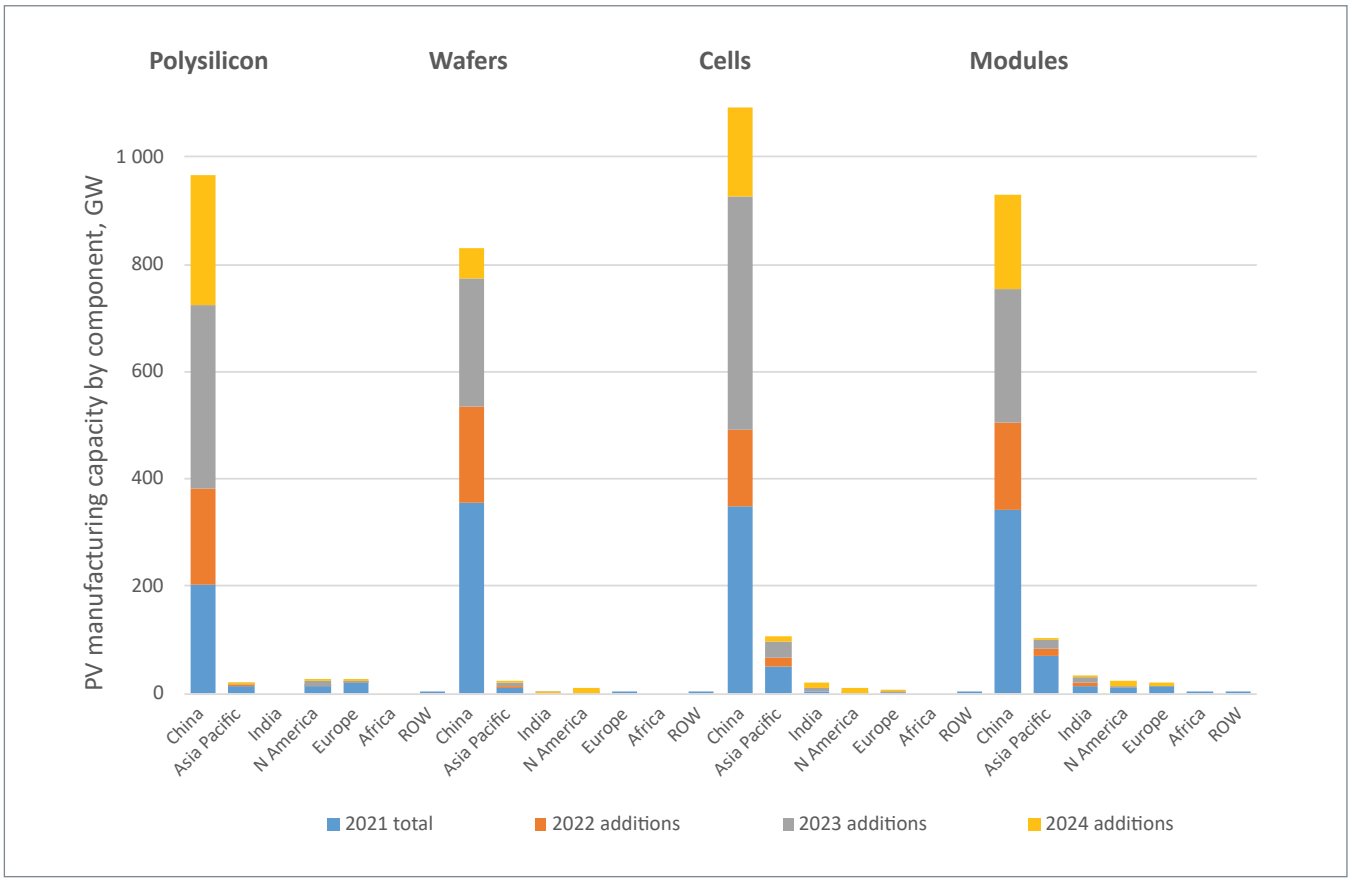
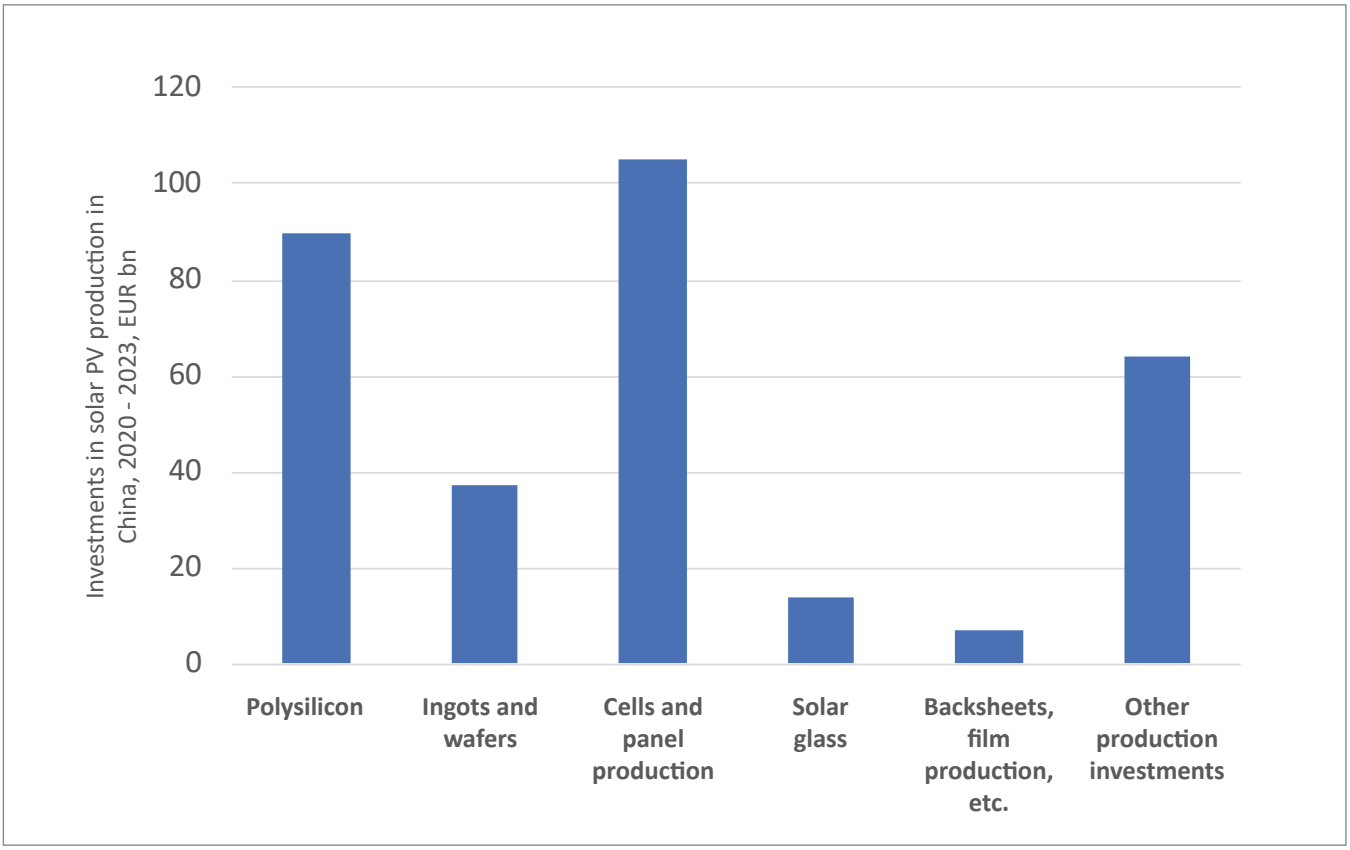


Figure 3: Investment in solar PV production in China 2020-2023 (Shaw, 2023)



In fact, China's current solar PV manufacturing capacity is already estimated at over 800 GW, versus global demand in 2023 of 400 GW, backed by a massive scale-up in investment in solar supply chains in recent years (Figure 2). In total, between 2020 and 2023, China alone invested over EUR 317 billion in new solar PV production (CNY 2.5 trillion), as shown on Figure 3. While manufacturing capacity always exceeds actual demand, building new solar PV supply in the current environment without financial support from governments or donors is extremely challenging.

A similar dynamic exists in the wind power sector, where the current installed capacity in Africa is only about 1% of the global capacity (GWEC, 2023b). Higher interest rates, competition from China and others, combined with a stagnant market for wind power on the African continent make it extremely difficult to sustain a wind power manufacturing business in Africa, as the recent closure of a joint venture between Siemens and Gamesa in Morocco indicates (Eljechtimi, 2022).

Lack of global cost-competitiveness is already plaguing domestic solar producers in South Africa: locally produced or assembled solar modules are not cost-competitive with imports from China, even after shipping costs are factored in.[1] Additionally, remaining competitive in a global manufacturing landscape requires that firms innovate and adapt to changing markets and to shifts in consumer preferences. Being closer to the market and to the end-users of manufactured products can provide more direct feedback on user preferences (Gill-Wiehl, Price, & Kammen, 2021).

Product quality-competitiveness is particularly relevant in some market segments where stringent international standards (such as IEC standards) must be met for bankability by international lenders. For instance, simply manufacturing solar modules or wind turbines locally at a cost-competitive price does not ensure that such locally produced modules will be used in the utility-scale market segment, due to the higher standards and track record required to participate in this market segment.[2] In addition, in many countries, norms and testing facilities do not exist, effectively barring locally produced modules from participating in such large-scale projects.

[1] Interview with Gaylor Montmasson-Clair, 2023-08-22

[2] Interview with Benjamin Clarke at Solar Power Europe, 2023-11-09

As a result, African manufacturers of wind and solar technologies may, in the early stages, need to focus on smaller, lower complexity market segments such as the off-grid, water pumping, irrigation, or solar home system markets before other market segments such as the utility-scale market become viable. Corporate and industrial (C&I) and agrivoltaics are novel segments offering potential early mover advantages for Africa. For wind power, local value-added may be more likely in providing the components required for foundations, or for wind turbine towers rather than starting with blades or nacelles (for more on the competitiveness of different market segments, see chapter 3 below).

2.2 Investment environment benchmarking

Increasing the value-added in Africa is at the heart of the continent's future prosperity. Countries throughout Africa continue to rely heavily on the export of raw materials, with too little value-added (beneficiation) occurring domestically. While this has already started to change in the agriculture sector, it has scarcely begun in the manufacturing sector (AfDB, 2017a).

Countries across Africa differ widely on parameters determining the investment environment for manufacturing. Analysing a selection of parameters is illustrative for benchmarking African countries among each other (Figure 4), and in comparison to China (Figure 5). Our choice of parameters relevant to the manufacturing financing environment (Table 3) includes the manufacturing value added (MVA), and the contribution of mid-to-high technology industry to the MVA. The logistics performance index, the time required to get an electricity connection for businesses, and the political stability are example parameters from the World Development Index. As we are describing manufacturing value chains, upstream of the renewable energy components (our 'products'), we plot the number of facilities for mining and refining critical minerals. Downstream, describing the market, we use the installed capacity of PV and wind power combined, for each country in Africa, plus China for benchmarking. All parameters are equally weighted.

Figure 4: Benchmarking African countries for manufacturing (see Table 3 for parameters and sources)

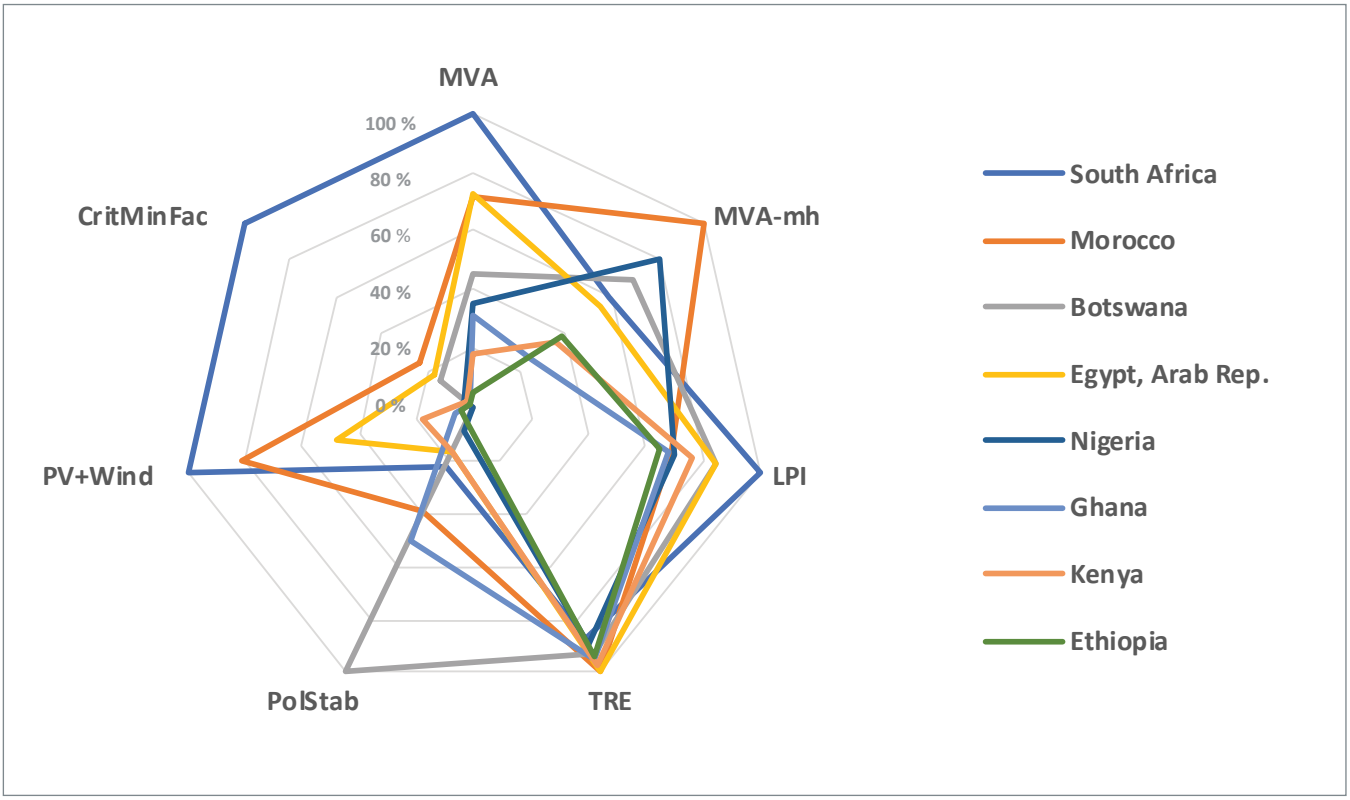


Figure 5: Benchmarking African countries against China (see Table 3 for parameters and sources)

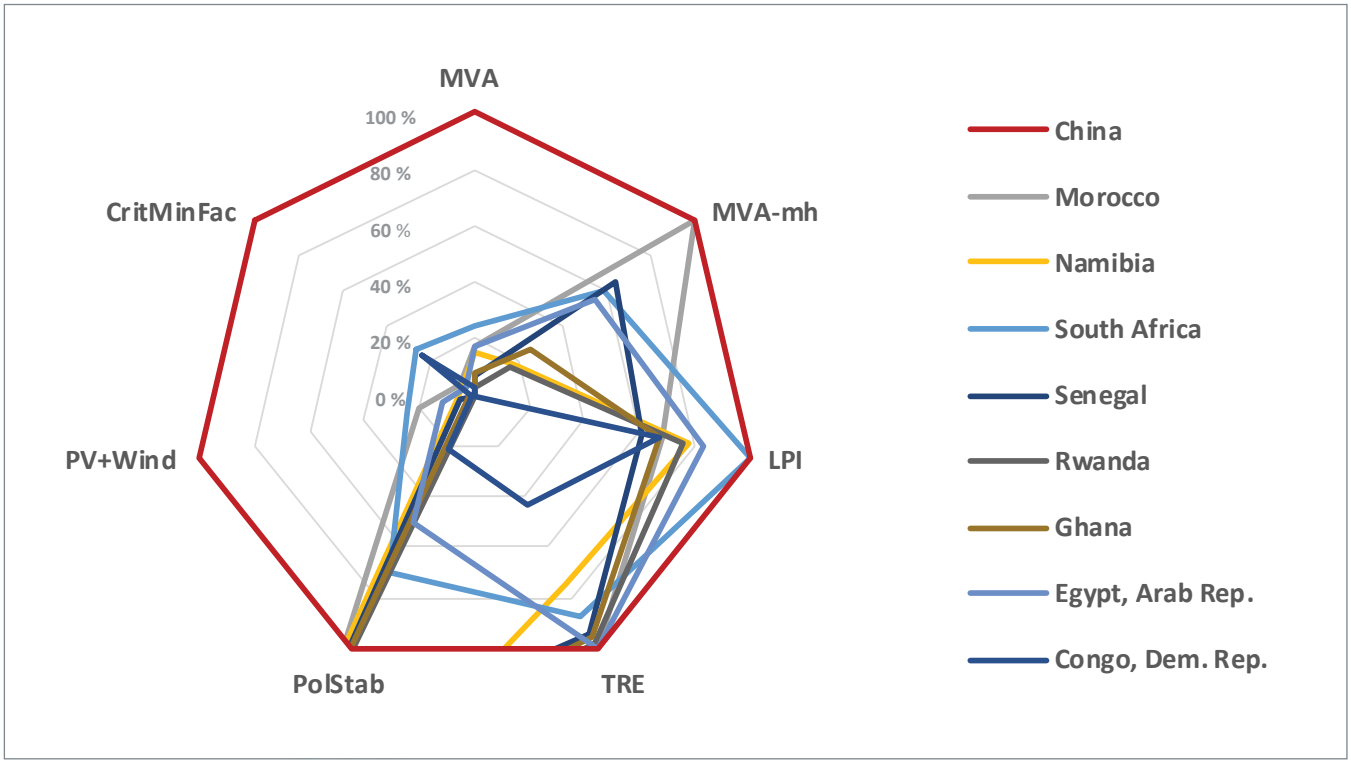


Table 3: Benchmarking parameters relevant for the manufacturing investment environment

Indicator	Original unit	Year	Source
MVA: Manufacturing Value Added	USD/capita	2021	(UNIDO, 2021)
MVA-mh: Medium and high-tech industry value added	%	2021	SDG Indicator 9.b.1, and (UNIDO, 2021)
LPI: Logistic Performance Index	Index (1=low to 5=high)	2022	World Development Index (World Bank, 2022b)
TRE: Time required to get electricity (days)	days	2022	World Development Index (World Bank, 2022b)
PolStab: Political Stability and Absence of Violence/Terrorism: Percentile Rank	%	2022	World Development Index (World Bank, 2022b)
PV+Wind: Installed capacity of solar photovoltaic and wind power plants combined	kW/capita installed	2023	(Global Energy Monitor, 2023, 2024)
CritMinFac: Number of facilities in mining and refining for critical minerals	number of facilities	2019	(IEA, 2021) and (USGS, 2022)

Some countries in Africa are performing on par with China in many aspects of the World Development Index. In manufacturing proper, and in the upstream and downstream (market) parameters, China leads the pack (though still distant from technology leaders, e.g., Germany). Countries in Africa tend to perform weakly in several parameters; only South Africa and Morocco, though far behind China, appear 'rounded'3 in the spider chart. It is possible to group countries broadly into three categories:

[3] Spider charts are made to compare countries for any one parameter. How "round" a country appears, is a matter of parameter selection, and relative benchmarking. China has its weaknesses, but all parameters have been set to unity in Figure 5, not implying more than relative comparisons per parameter.

- Early movers with advantageous conditions: good infrastructure, a major port, governance, and a history of manufacturing. Includes countries like Morocco, South Africa, and Egypt.
- A “middle” group of countries with some attractive fundamentals but less history of manufacturing (Kenya, Nigeria, Namibia, Botswana, Rwanda, DRC, etc.),
- Weaker or more fragile states with less attractive fundamentals and who are landlocked, and currently have little more than artisanal manufacturing (Central African Republic, Chad, etc.)

It should be noted that there is no guarantee that the current early movers will necessarily emerge on top. Government policy in all its facets from regulations and laws to macroeconomic factors such as currency can and will play a decisive role.

Figure 6: Custom value of PV panels and cells imported into South Africa, originating in China and the rest of the world (ROW), (SARS, 2023)

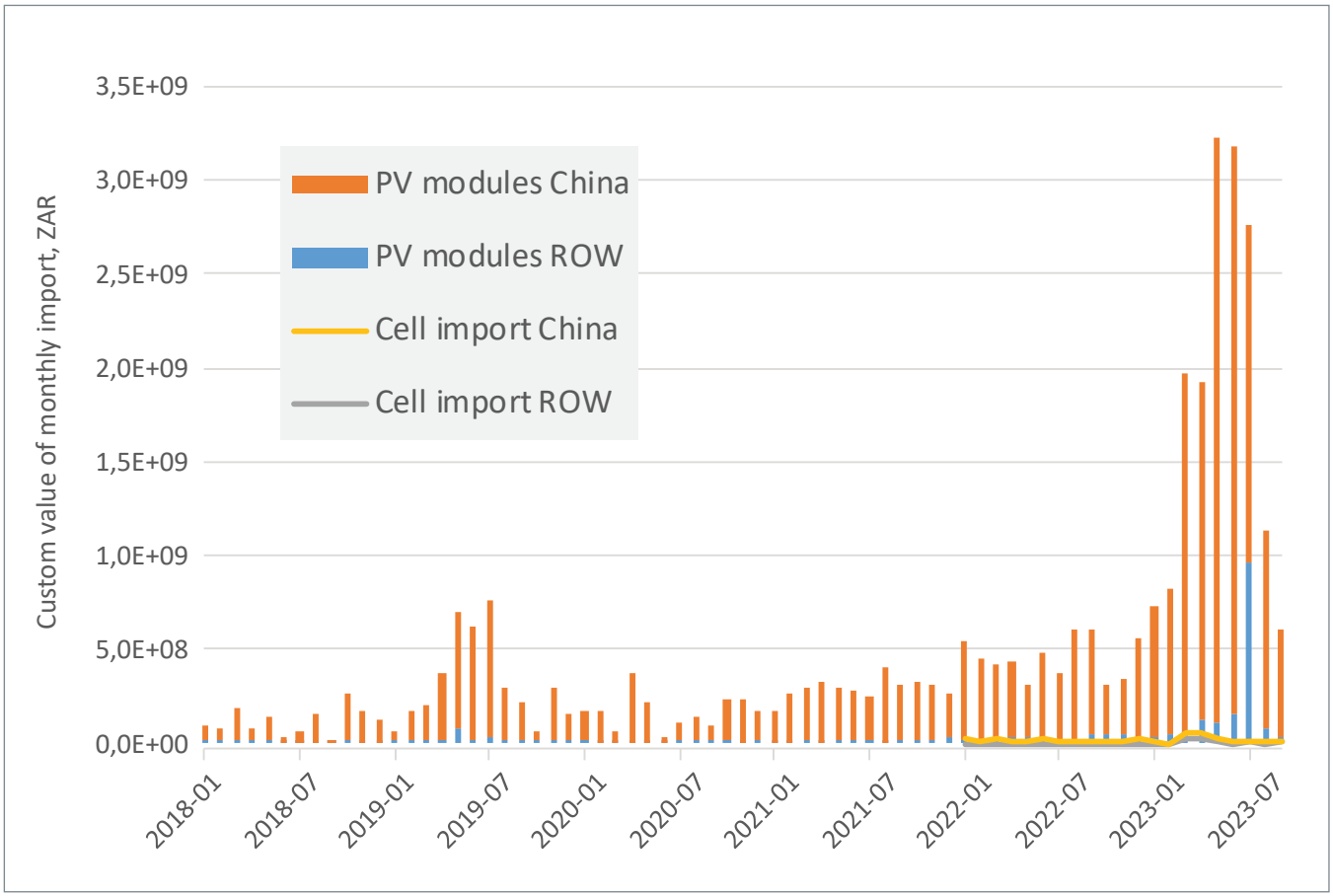
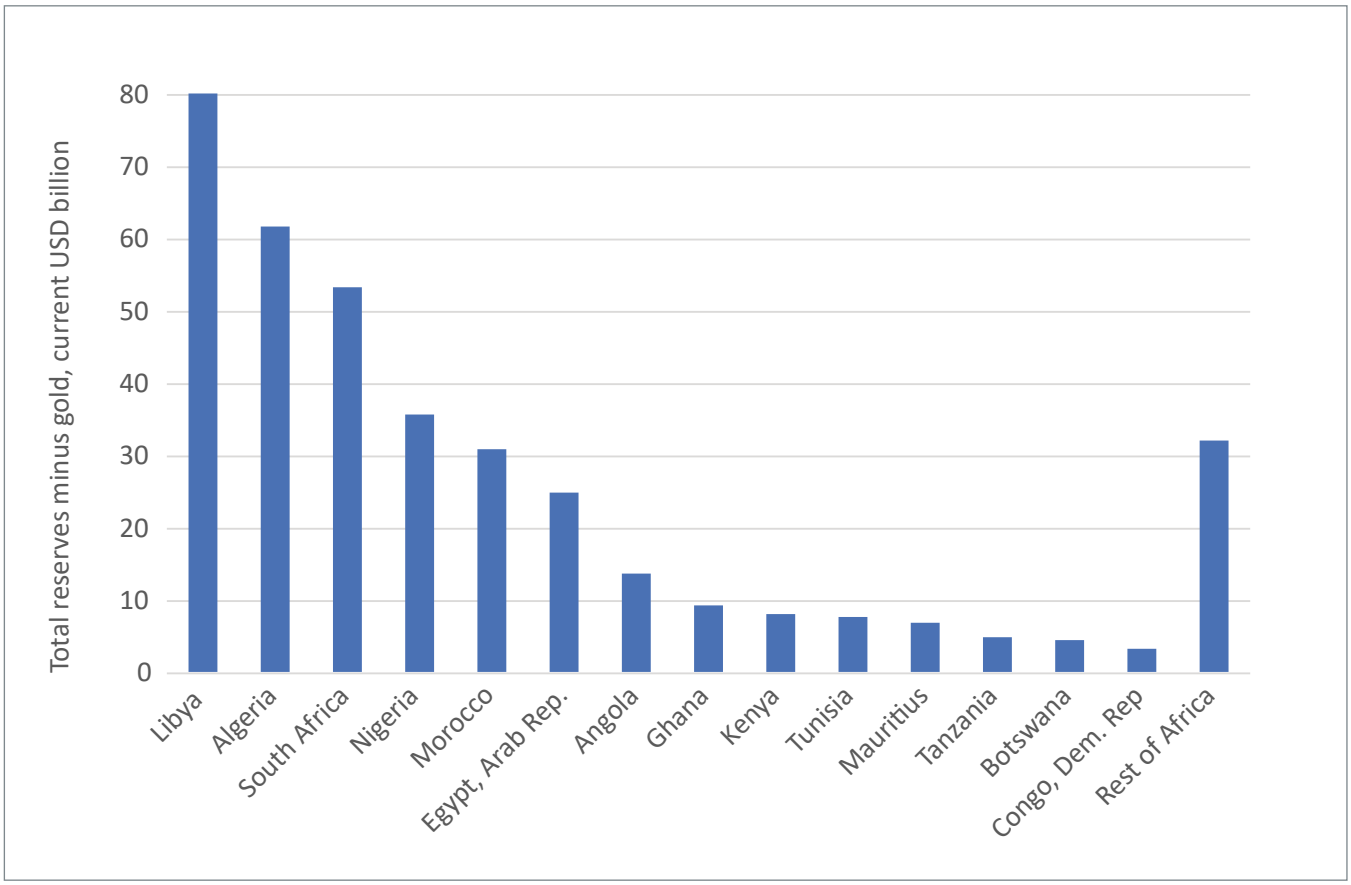


Figure 7: Foreign reserves of African countries (World Bank, 2022a)



Currency and the role of foreign currency reserves

Reducing reliance on imports of finished goods is becoming a major pillar of economic policy in Africa. In the first half of 2023, South Africa imported over USD $2.5 billion worth of solar panels (Figure 6)[4], lithium-ion cells, battery packs, and inverters (Kuhudzai, 2023). While such a surge in solar power deployment is a positive sign for the energy transition, and might save customers money, importing technology on such a scale results in a significant outflow of hard currency, as most renewable energy components worldwide are purchased in USD. For countries with limited foreign currency reserves (Figure 7), hard currency outflows can generate a host of economic challenges.[5]

The role of trade interconnectedness

Central to market access and size is the intra-African trade (i.e., trade among countries within Africa). Currently far too little of the continent's products and resources are traded within Africa. In fact, the share of Africa's own exports to other countries within Africa stands at 17% (McKinsey, 2023b); for members of the European Union, the share is 60%. Much more needs to be done to boost inter-regional trade links.

The role of ports

Maritime shipping is a vital component to the successful scale-up of manufacturing efforts, particularly in terms of EU-Africa cooperation. However, many ports suffer from underinvestment, inefficiencies, and weak governance and oversight, meaning port expansions are failing to keep up with trade growth thereby reducing their global competitiveness (PWC, 2018; Garcia, Taniparti, & Barrios, 2023). A list of ports in Africa and the world and their operational performance is accessible in The Container Port Performance Index (World Bank, 2023).

[4] The peak in PV module import for July 2023 is an import from the Russian Federation. Since Russia does not manufacture PV modules, it can safely be assumed that these panels were made in China.

[5] For comparison, China's reserves are 8.5 times higher than the sum of reserves of African countries.

The role of rail

Rail is often critical to move goods from the site of production, or the location of resource extraction, to where the products or materials are processed, or shipped. Given the relative weakness and scarcity of road infrastructure in many parts of Africa (Figure 1), and the distances involved, moving products and materials by rail is likely to grow in importance as Africa industrialises and different parts of the continent become better interconnected with one another.

The role of power supply

A further aspect is the reliability, availability, and cost of electricity supply. Many countries across Africa experience problems (some periodic, some chronic and recurring) providing secure, reliable access to electricity for industries, including to small and medium-sized enterprises and manufacturers (Trace, 2020; Gopolang Moloko, 2022). In 2019, 78% of companies throughout the continent grappled with disruptive power outages, with 41% of these enterprises identifying electricity supply as a critical impediment to their success. On average, these power interruptions lasted for over fifty hours each month, culminating in a substantial 25-day loss of economic productivity annually for African businesses (Oseni, 2019).

In some countries, power grids do not reach 75% (Burkina Faso, Uganda, Liberia, and Madagascar) or even 90% (DRC) of the households. In contrast, other countries have near 100% electricity access, including Mauritius, Morocco, and Tunisia. However, mini-grids and C&I grids are increasingly addressing the electricity access challenge (IEA, 2023a).

Electricity costs for manufacturing industries vary widely across African nations. The Africa Infrastructure Database (World Bank, 2022b) states effective tariffs in a range of 3-36 US cents/kWh for consumers of 500 kWh/month and higher, influencing cost-competitiveness.

2.3 Barriers analysis

Africa is home to more than USD 82 trillion in discovered natural resources, with the potential to contribute USD 30 billion a year in government revenues over the next 20 years (AfDB, 2016), enough to power its industrialization. However, the following key barriers need to be overcome.

Regional fragmentation

Although initiatives such as the African Continental Free Trade Area (ACFTA) are working to remedy the fragmentation, it remains a major barrier to the emergence of major manufacturing hubs on the continent, in contrast to what is happening in China, the EU, and the US (IMF, 2023b).

Africa is being outcompeted on subsidies and support

Subsidies and supports offered by other countries to manufacturers (e.g., China, the EU, and the US) are vast, and more generous than many countries in Africa can afford to offer. Beyond the additional advantages of creating broad and deep supply chains within a jurisdiction, e.g., China, these subsidies make it a very comfortable environment for manufacturers.[6]

Macro-economic challenges

Macroeconomic instability often underpinned by excessive sovereign debts, combined with overwhelming currency fluctuations, all make manufacturing extremely challenging in many countries throughout Africa today. Interviews with manufacturers confirm that having to deal with rapid or unexpected fluctuations in local currencies is a major headache and consumes valuable time and money that could be more productively invested in the company's growth, in improving its production lines, or in innovation.

[6] Interview with an employee from Maxwell Technologies, China, September 2023

A substantially higher cost of capital

The cost of commercial loans in many countries across Africa is over 15%, and in some cases, over 35%. For instance, in Nigeria the overnight bank lending rates stand at roughly 14% (CEIC, 2023b) and the loans issues to companies often come at a 4-10% premium above that benchmark lending rate; in Egypt, the overnight lending rate stands at 19% (Sept 2023) (CEIC, 2023a). In Ghana, commercial lending rates in 2023 were just over 35% (Bank of Ghana, 2023).

Africa also lacks affordable credit opportunities, particularly for long-term financing. Around 60% of loans in the continent are short-term, with less than 2% of loans having a tenor of ten years or longer (AfDB, 2017b). This can in part be attributed to a lack of information transparency on profitability and credit history, an underdeveloped financial market, and low remittances compared to other major markets such as India (AfDB, 2017b).

A high cost of capital and a short repayment period skew the financing landscape toward high-margin ventures, and in many cases (particularly in the early years, as order books remain patchy) manufacturing is not necessarily a high margin activity. The high return requirements implied by such high discount rates effectively shut out manufacturing as a viable sector for investment. The result (as seen across much of Africa today) is that manufacturing in many cases simply does not occur.

Access to capital

Beyond the question of the cost of capital is the ability of manufacturers to access capital whether from traditional commercial banks or from the local capital market. While markets such as Kenya and South Africa have functioning capital markets, many countries throughout Africa do not. The result is that firms need to rely on local banks or on international lenders for the capital required to scale their business.

Access to affordable credit is one of the most binding constraints on manufacturers in Africa (AfDB, 2017a). There are several factors that underpin this challenge:

- Many companies lack collateral (particularly at the early stages);
- Many manufacturers lack a credit history, which many banks require before disbursing loans;
- Lenders often face a profound information asymmetry concerning project profitability. Banks simply have no way of reliably forecasting how profitable a particular manufacturing venture will be. If future cash flows cannot be reliably predicted, and no comparable examples exist within the country, the profitability of the business cannot be modelled, nor can the company's ability to repay its loans.

International partnerships and collaboration with manufacturers from the EU (for instance) could provide one valuable synergy between African and EU-based companies, to help ensure that access to capital remains open. Furthermore, there is growing interest from donors, development finance institutions, and impact funds to develop blended finance models that can considerably de-risk manufacturing investments in Africa.

Skills gaps and skills shortages

By 2060, it is estimated that the African population will reach 1.6 billion, with over 70% of that population being under the age of thirty (AfDB, 2017a). This demographic structure can be turned into a powerful economic and industrialization dividend if this workforce is endowed with the skills required to compete, and to innovate. However, Africa lacks key skills in the renewable energy technology sector, with only 2.3% of the global 13.7 million jobs in this sector located in Africa (IRENA, 2023).

Overall, many countries throughout Africa lack the scientists, entrepreneurs, and engineers necessary to transform the manufacturing landscape. In Burundi and Morocco, only 3% and 12% of students study scientific subjects such as engineering, manufacturing, and construction, respectively. By comparison, the share of students studying such subjects rises above 20% in countries such as Germany, Austria, Mexico, and Malaysia (AfDB, 2017b).

One clear implication of this is that training, combined with sustained, long-term investments in skills will be necessary to support African countries' ability to increase local value-added.

Bureaucracy and challenges regarding ease-of-doing business
There is also an unfavourable business environment due to issues with business regulation, financing, corruption, and investments (AfDB, 2017b). However, the business environment has improved in some respects in a number of African countries. For instance, the average time required to start a new business declined from 63 days in 2005 to 27 days in 2016, while the cost of business start-up procedures has also declined over the same time period (AfDB, 2017a). The aggregate value of ease-of-doing-business was discontinued by the World Bank in 2019.

Despite the progress, there is an ongoing need to do more to improve and simplify regulations and combat corruption (Amundsen, 2022), e.g., through digitalization. In particular, manufacturers frequently face corruption issues at the port, with shipments being delayed until bribes are paid to release them (Mugabi, 2022).

2.4 Policy framework and support measures

Government policy is vital to catalysing private investment, both in renewable energy project deployment (demand creation) and in manufacturing investment (supply creation). Successful examples of the scale-up of manufacturing around the world are almost always directly or indirectly the product of a supportive policy environment, backed by a clear strategy.

Countries across Africa differ widely in their openness and attractiveness to manufacturing investment. There are several levers that governments can use to bolster their attractiveness:

- **Stimulate local demand:** The presence of strong local demand can help with both de-risking manufacturing business cases and the early success and growth of manufacturing companies. "No market, no manufacturing." Some measures to stimulate local demand could include local content rules, export and import restrictions, and government off-take agreements under a price guarantee.
- **Improve the reliability of power supply:** businesses need reliable power to operate. If efforts to improve the reliability of grid-based power supply are likely to take time, reforms to allow greater C&I self-consumption (including corporate Power Purchase Agreements (PPAs), wheeling charges to regulate access to the transmission/distribution grid, removing size limits for embedded generation projects, among others) can help.
- **Invest in key supporting infrastructure** such as roads, bridges, rail, and ports to improve the speed of movement goods thereby saving costs, e.g., from lengthy waiting times at ports.
- **Invest in local workforce and skills** development through training institutions, including universities and colleges and applied apprenticeship programs.
- **Introduce reforms to tax, legal, financial, and regulatory frameworks** as manufacturing investment is always sensitive to the tax regime. While African governments have an urgent need to increase tax revenues, manufacturers frequently "shop around" for favourable tax rules and incentives before a location decision. In addition, measures related to financing support such as credit facilities (e.g., via Ex-Im Banks) as well as reforms to create more open and dynamic capital markets can play an important role in mobilizing credit on attractive terms and unlocking manufacturing investment.

A further approach that certain governments have started taking is to set up a single point of contact between the government and manufacturing firms, often in the context of Special Economic Zones (SEZ). There are also efforts to improve regional trade and provide investment platforms, such as the East African Community (EAC).

Another key tool is export credit agencies (ECAs) and Import-Export Banks, which provide targeted financing support for projects and ventures that would otherwise not occur, as in many cases in Africa, neither commercial lenders nor traditional international financial institutions (IFIs) are able or willing to accept the political or commercial risks involved. ECAs can provide a range of guarantee instruments, make vital capital available to companies looking to expand, and diversify their footprints with new facilities abroad.

In addition, the combination of a lower cost of capital and flexible repayment terms have led to greater interest in venture debt as an attractive alternative to equity financing. Venture debt enables startups to scale their businesses without sacrificing their ownership stake (AVCA, 2023). For many African-run companies, this makes partners offering venture debt more attractive than investors offering venture capital, and could provide a further vehicle underpinning strategic partnerships.

These main levers listed above need to be considered on a high level. In addition, the analyses of business cases will complement these with further measures.

Over the last fifty years, one of the challenges is that industrialised countries have lowered and, in some cases, eliminated the tariffs applied on unfinished goods (namely raw materials), while tariffs have been increased on finished goods (AfDB, 2017a). This has made it more difficult for countries across Africa to break out of the historical pattern of harvesting and exporting raw materials. Partly in response, countries like Ethiopia are trying to do the same, introducing import tariffs that mirror this trend. For instance, the total import duties on finished manufactured products such as cars imported into Ethiopia are 35%, on top of an excise tax ranging from 5 – 60% depending on the size of the vehicle, and a 15% VAT rate (Shemsu, 2023). Altogether, such taxes and fees can more than double the cost of imported goods.

However, it is important to underscore that aggressive protectionist policies can face retaliation risks from other trading partners (IMF, 2023a). Furthermore, providing targeted incentives to manufacturers does not guarantee success. Effective eligibility criteria need to be established and implemented as was done under the U.S. Inflation Reduction Act (IRA) (Hogan Lovells, 2022). A key differentiator in the case of the U.S. is that unlike Africa, the U.S. is home to a large solar, wind, and battery market. In fact, many of the manufacturers who have responded to the generous incentives on offer are doing so with a view to serving primarily U.S.-based domestic demand for solar, wind, and battery technologies.

As the market for solar, wind, and electric mobility (two-wheelers, three-wheelers, and passenger cars) grows in the coming years, Africa's attractiveness in terms of localizing manufacturing investment closer to this demand will grow, creating many significant growth opportunities.

2.5 Lessons from Special Economic Zones

A special economic zone (SEZ) is a location in which the laws and rules governing companies differ from the laws and rules that govern the city, state, or country in which the special economic zone is located. The rules and laws that apply to companies located within the special economic zone are preferential, and involve one or more of the following:

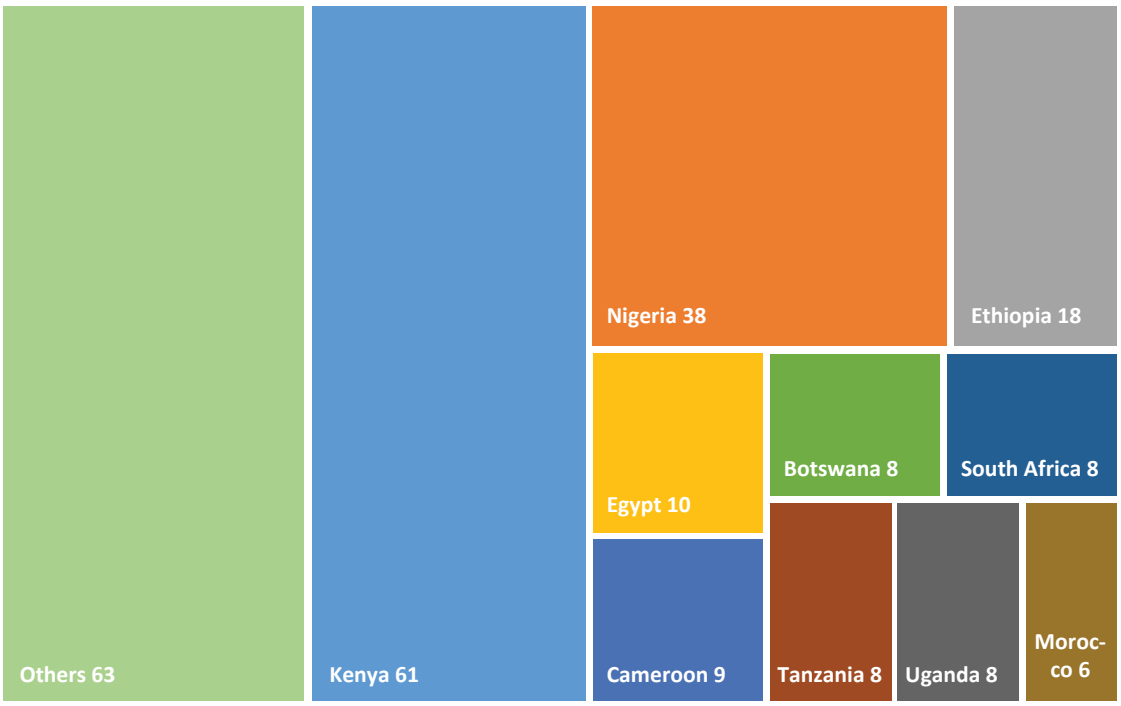
- lower taxes;
- easier and faster business registration and permitting processes;
- a streamlined legal regime;
- a special customs arrangement, allowing for lower import/export duties, and
- exemptions from various business fees.

While SEZs are not a panacea, as many have failed to deliver significant benefits or create lasting manufacturing industries, they remain one tool that governments can use to attract foreign manufacturing investment and to build local supply chains. In principle, the safe and stable SEZ environment can enable goods to be produced at a lower cost.

SEZs have emerged across Africa, growing from 20 in the early 1990s to 237 in 2020, with a further 53 currently in the planning phase (Rodríguez-Pose, Bartalucci, Frick, Santos-Paulino, & Bolwijn, 2022). Indeed, SEZs are becoming

an important part of African industrial policy, as countries with already mature zones are expanding and diversifying them, while others are encouraging the development of new ones.

Figure 8: Number of special economic zones in Africa by country. The total is 237. Data source (UNCTAD, 2021)



As can be seen in the graph, Kenya currently has the greatest number of SEZs in Africa, following the adoption of specific policies starting in 2015 aimed specifically at catalysing investment in manufacturing (Laryea, Ndonga, & Nyamori, 2020).

However, despite the presence of 237 SEZ across the continent, the performance of SEZs in Africa falls behind SEZs in other parts of the world (Collins T. , 2022). Only an estimated 15% of the SEZs across Africa operate at full capacity, with many remaining under-developed (Collins T. , 2022).

While there are many factors at play, and each SEZ's performance (whether strong or weak) is linked to location- and market-specific circumstances, research supported by interviews suggests that four factors have played a dominant role (Rodríguez-Pose, Bartalucci, Frick, Santos-Paulino, & Bolwijn, 2022):

- a mismatch between SEZs' sectoral focus and the host country's comparative advantage;
- lack of provision of adequate infrastructure;
- lack of co-ordinated, high-level political support;
- a failure to embed the SEZ within the surrounding economy.

Based on examples from Ethiopia, Morocco and South Africa, SEZs in Africa have been found to be more likely to succeed when they encourage institutional collaboration and linkages with the local economy, and when they are part of a clear long-term strategy (Rodríguez-Pose, Bartalucci, Frick, Santos-Paulino, & Bolwijn, 2022). In addition, countries across Africa often lack leverage to influence international capital flows, and struggle to enforce technology transfer and local skills development, reducing the long-term benefits as well as the local economic development impacts (Tesfaye, A., 2023). Countries with limited domestic manufacturing capacity should be wary of accepting unfavorable foreign partnerships simply to attract local investment, as such an approach is unlikely to translate into sustained skills and knowledge transfer (Collins T. , 2022).

These lessons can be applied to the emerging renewable energy sector SEZs including the Vaal SEZ in South Africa with its strong focus on green hydrogen (Vaal SEZ, 2022) and possibly the battery sector DRC-Zambia SEZs (African Export-Import Bank, 2023). These green SEZs (green industrial clusters) have the potential to deliver a genuine partnership between African countries and the EU. Africa would localise its renewable energy technology value chains, facilitating its energy transition, while the EU could secure sustainability of supply chains to meet its Directive on Corporate Sustainability Due Diligence (European Commission, 2022b).

From a policy tool perspective, African SEZs predominantly offer fiscal incentives (87%) followed by special customs provisions at 73% (Rodríguez-Pose, Bartalucci, Frick, Santos-Paulino, & Bolwijn, 2022).

03

Strengthening European-African Cooperation

03/ Strengthening European-African Cooperation

The role of investment environment and policy frameworks is reflected in the experiences of existing manufacturing companies across Africa. To be able to strengthen the European-African cooperation by identifying specific opportunities, we need to talk to the company leaders and let them tell their stories. To this end, this chapter presents a selection of case studies from various RE manufacturing value chains in the first subsection. The second subsection compiles a summary of business case competitiveness based on the case studies. Two further subsections highlight (actual and potential) Africa-EU synergies and list a few hot spots and measures/investments to consider.

3.1 Case studies – technologies and value chains

The business cases described in this section have been selected based on interviews conducted by the project team with company representatives and experts from Europe and Africa. The cases are meant to represent a wide range of manufacturing businesses across the renewable energy manufacturing sector in many countries in Africa. Table 4 provides an overview, ordered by technology (solar, wind, batteries, green hydrogen, grid equipment) and alphabetically within each category. The companies have been selected arbitrarily; the interviews were both in-person and online and included qualitative discussions of questions potential investors would ask, such as organizational structure, Unique Selling Points (USP), motivation and expectations, product range, partnerships, and perceived challenges.

Table 4: Overview of Business Cases

Company Name	Country	Product(s)	Number of employees	Unique Selling Point
Auxano Solar Nigeria Ltd	Nigeria	PV panels and inverters	62	Speed for the informal market, locally enforceable warranties
AZUR SPACE Solar Power GmbH	Germany	Production technology for PV modules for CPV	250	High efficiency of solar PV, also in locations with high temperature
Ener-G-Africa	South Africa	PV modules 20 W, growing to utility-scale	53	Affordable product, sales channel to 4 million stove customers in Southern Africa
Sustainable Solar Systems (Pty) Ltd	South Africa	Containerised solar + BESS power	40	Speed, deferred payment, local service
Nordex / WBHO	South Africa	Wind turbine tower segments	200	Precast close to site, market leader
eBee	Kenya	Electric bikes	500	Green jobs for youth and women, full in-house service
GOGO Electric	Uganda	Electric motorcycles and battery packs	200	In-house battery circular economy, tested battery packs for Ugandan conditions
IG3N (Pty) Ltd	South Africa	Battery packs	35	Black owned/led, in-house BMS
Roam Electric	Kenya	Electric motorbikes & buses	150	Product suits a variety of business models, after sales service
Wahu Mobility Ltd	Ghana	Cargo e-bikes	100	Community building, carbon credit financing model

Mitochondria Energy Systems	South Africa	Reversible Fuel cells	400 (expected)	Established local supply chain
Actom	South Africa	Transformers, Cables/Lines	6800	Broad range of products, cost advantages, 50%+ Black-run and operated
Korica Uganda	Uganda	Transformers	100	Products completely built in Uganda, not just assembled
Microcare	South Africa	Inverters	50	Robust high-quality product built for Africa

Power Solution For All!
100 MW Solar PV assembly
Auxano Solar Nig. Limited, Lagos, Nigeria

Product
- PV panels (100 - 550 W), along with inverters, for installation-ready systems

Processes
- Assembly specialist with 62 employees, full commercial activities begins in Jan 2024

Business Model
- Flexible: B2C (informal Nigerian market); B2B

Unique Selling Points (USP)
- Speed (shorter turn-around time than importing from China)
- Locally enforceable warranties

Motivation
- Starting the solar manufacturing ecosystem, adding value rather than trading, serving as example for others to follow

Manufacturing Drivers and Challenges
- Competition on prices is fierce
- Loan duration does not match time-to-market of the product
- Political stability (planning horizons are only 4 years between elections)

Opportunities
- Large Nigerian market. Building an ecosystem of inputs (glass, frames), financing. Make a difference as model factory

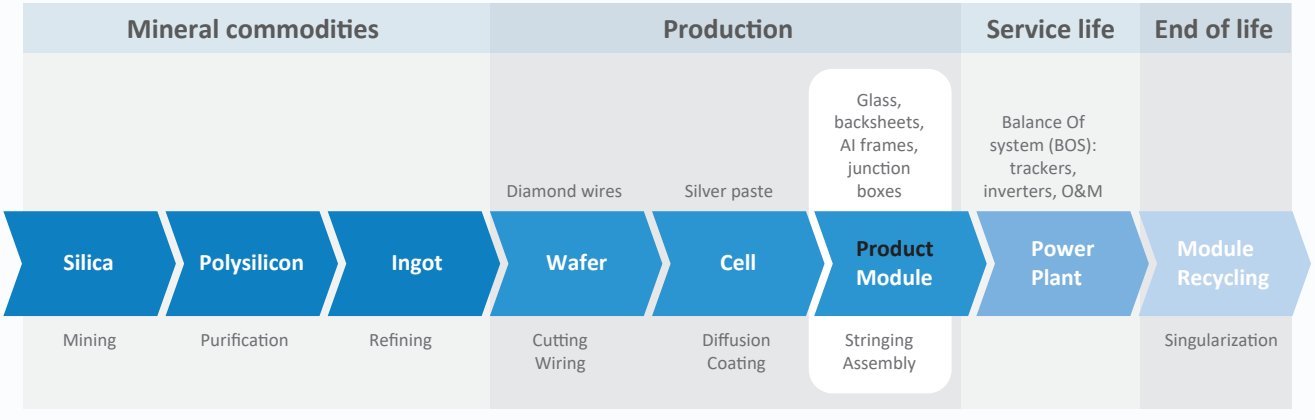
Auxano Solar is the first privately owned PV manufacturing company in Nigeria.

Company was founded in 2014, ventured into assembling in 2016 with 6.5 MW/yr. Started a new 100 MW solar panel factory In 2021, USD 2 million investment by Shell's impact investor All On.

Founder Chuks Umezulora builds on the recent positive perception of solar power, showing with a 7-year manufacturing plan where resources can impact a growing ecosystem of solar manufacturing. Downstream activities will attract upstream investments. With gov't strategic interventions, de-risking is possible in Africa (following China's example), Chuks says.

Auxano serves both Nigeria's informal B2C markets with quick returns, and the structured market of B2B power plant installations for slightly higher margins.

Competing on price with China is difficult. However, as the market is globally determined by input prices, speed, flexibility, and local market knowledge can be the competitive edge.



The C3PV fab
Concentrating Photovoltaics (CPV)
AZUR SPACE Solar Power GmbH, Heilbronn, Germany

Product
- Production technology for PV modules using optics to concentrate sunlight on high-efficiency multi-junction PV cells

Processes
- Cristal growth via MOCVD, cell production with adapted semiconductor processes, automated cell receiver production, and module production suitable for local production.

Business Model
- B2B partnering for technology transfer of module assembly and parts manufacturing in the Global South

Unique Selling Points (USP)
- Suitable 30 MW capacity for the beginning
- CPV offers module efficiency >35%
- Energy payback is 10x faster than PV
- Temperature coefficient suitable for hot locations
- CPV has a strong track record in Spain and South Africa

Motivation
- Growth and profit; dissemination of CPV

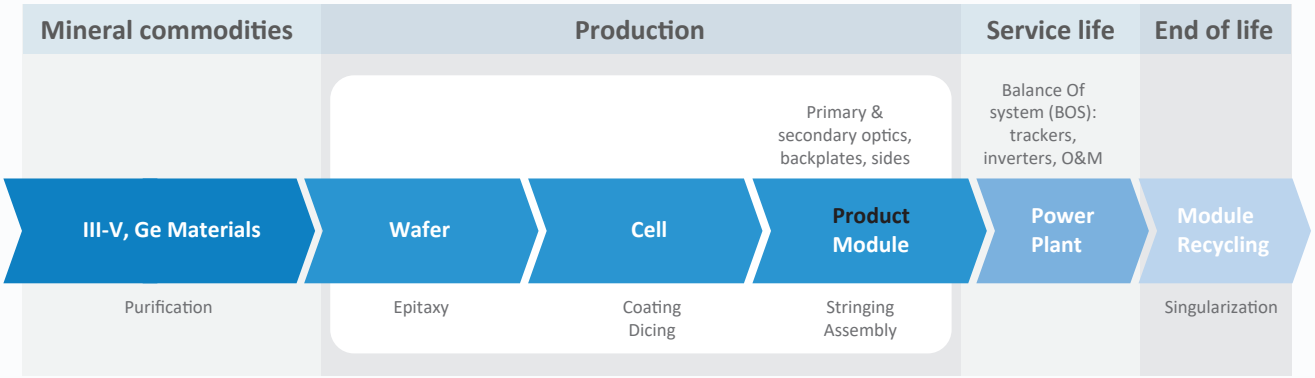
Manufacturing Drivers and Challenges
- Roll-out financing
- Finding qualified local partners
- Opportunities
- Building markets on leading European technology
- Supporting the energy transition

AZUR SPACE Solar Power GmbH is an EU-based high-tech company with a strong 60-year track record in photovoltaics, and particularly in concentrating photovoltaics (CPV) for terrestrial applications. AZUR SPACE has developed and produced solar cells for over 550 space projects (since 1964) and terrestrial CPV projects (since 2003).

The company has built an assembly line for CPV modules that can be transferred to local manufacturers. Likewise, parts of the supply chains can be moved to manufacturers in the Global South. Core elements such as the multi-junction PV-cells will be produced in Germany.

Present partners are in India, South Africa, Chile, USA and China, and strong interest in partnership from Egypt and Dubai. The plan is to transfer a 30 MW/yr module assembly line for local power plants, which are also suitable to generate green hydrogen locally.

CPV is the high-tech variant of photovoltaics. Deploying CPV in Africa would increase the efficiency and reduce the carbon footprint of renewable energy generation.



We sell what we manufacture!
Photovoltaic modules and power systems for end users in rural Sub-Saharan Africa
Ener-G-Africa, Cape Town, South Africa

Products
- PV modules 20 W and up; syst. with power banks 1 Ah and up
- To be sold to end customers in South Africa & other countries

Processes
- Assembly capacity 20 MW (about 20,000 panels monthly)
- 53 employees (all women), 3 shifts, 5 days/week

Business Model
- Business-to-consumer (B2C), vertical and lateral integration
- Organic growth, institutional investments

Unique Selling Points (USP)
- Sales channels established, cost (transport) advantages
- Replacement warranted, and origin certified
- Empowering women: Women-run and operated

Ambitions
- Targeting 70% local supply chain (Al frames, back sheets, glass)
- Grow to 500 MW panel assembly capacity

Manufacturing Drivers and Challenges

Cash flow – due to lack of bridge financing
- Tier 1 industry standard hard to reach,
- Skills trained from scratch needed

Opportunities
- Expert skill exchange
- Bridge financing

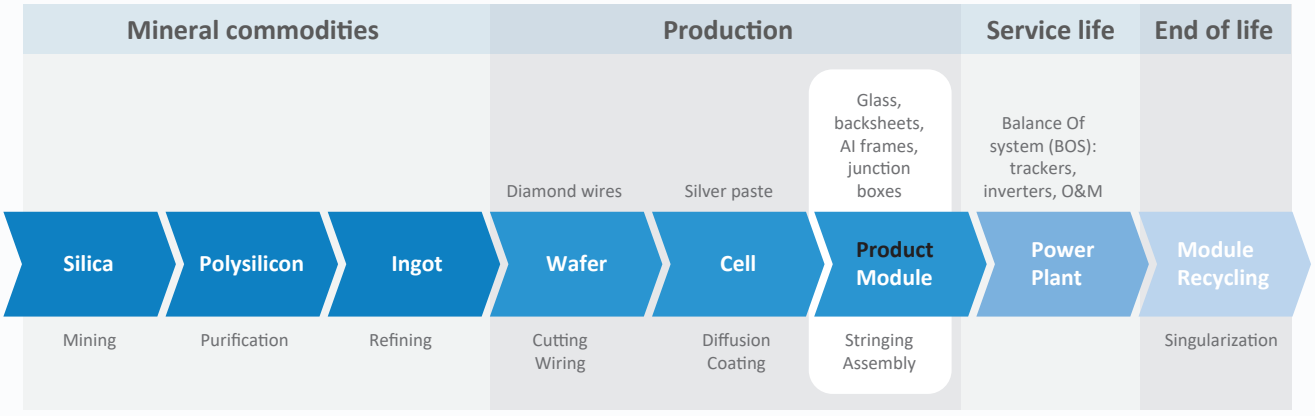
Ener-G-Africa is a women-led PV module assembly company with ambitions: By 2024, it plans to have 200 MW of assembly capacity installed in South Africa, growing to 500 MW by 2026 (investment R135m received 2023). Current capacity is 20 MW.

Funding has been secured to the amount of EUR 6.7m; organic growth is preferred; the idea is to move forward to rooftop and finally to utility-scale panel assembly and plant installations.

Ener-G-Africa was founded 2017 and has manufactured 4 million clean cookstoves in 2022 alone, bringing in the sales channels to the solar diversification.

These sales channels across rural southern Africa (also including Malawi, Angola, Mozambique, Zimbabwe, Ghana, Zambia, Kenya, Tanzania, Uganda, and Rwanda) are enabling solar sales. Panels matching minimum electricity needs (phone charging, battery-powered lights) and disposable incomes of low-income households in SSA sell for EUR 15.50 (ZAR 314).

Opportunities for external partnerships arise when building on the applied business case and sales excellence, with upskilling, and bridge financing.



Flexible turnkey solar systems for remote locations
Containerised solar power
Sustainable Solar Systems (Pty) Ltd. (dba SustainSolar), Cape Town, South Africa

Products
- Modular turnkey, containerised off-grid solar and BESS

Processes
- Design, assembly, commissioning, and remote servicing
- Number of employees: 40 (60 by 2026)

Business Model
- Business-to-business (B2B)
- Back-to-back warranties with supply chain

Unique Selling Points (USP)
- Deferred payment for results-based program grantees (RBF): 6-18 months
- Rapid deployment, customizable systems, easily shipped
- Local after sales servicing from South Africa

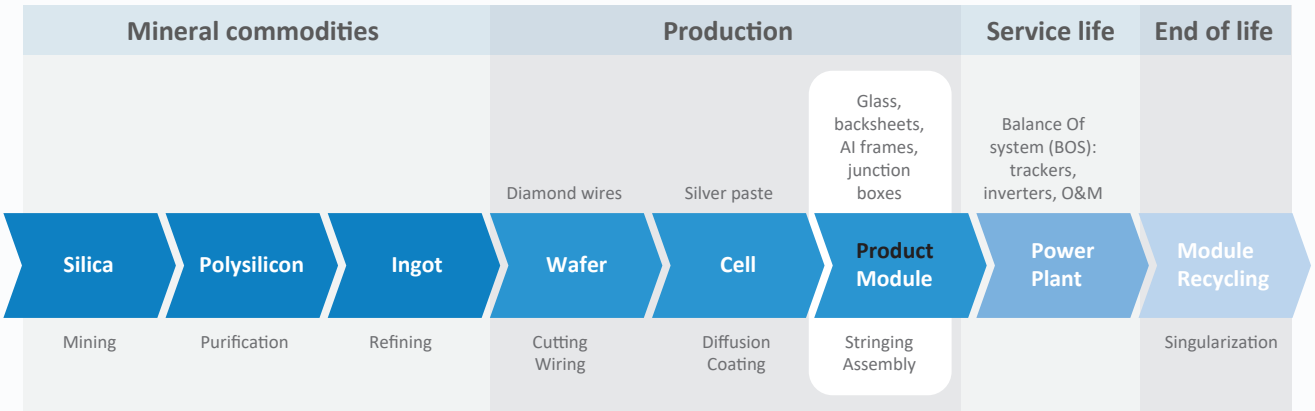
Ambitions
- Business development across entire Africa
- Expand manufacturing activities into Kenya and Nigeria

Manufacturing Drivers and Challenges
- Availability of specific inverters and battery products in local market uncertain; high pricing of some components
- Maintaining strong quality control during expansion
- Opportunities
- Increasing purchasing power with larger scale and number of projects can achieve lower cost and further growth

SustainSolar grows organically, and successfully, in a price-sensitive environment with competition. Most applications are SDG-related, or corporate and industrial (C&I). SustainSolar's USP is its Deferred Payment scheme, devised with assistance by GET.invest, speed of manufacturing and delivery (compared to Chinese competitors), and quality after-sales servicing based in Africa. Company advantages reported include the location in a logistics hub (Cape Town). Challenges concentrate around consumer preference for low-cost over quality, speed, and after sales service – the USPs of SustainSolar.

The ambition of SustainSolar is to grow across Sub-Saharan Africa, based on its enabling vendor finance (such as Deferred payment program for RBF grantees), high quality, and increasingly competitive pricing based on pipeline growth and localization of manufacturing to new regional hubs in East and West Africa.

Portfolio is ranging from 20-40ft power containers offering medium to large (multi-MWh) BESS with optional PV and mounting.



Close to wind farm precast concrete tower supplier in South Africa
Manufacturing segments of precast concrete wind turbine towers.
Nordex / WBHO, Northern Cape, South Africa

Products
- 20 m x 6 m precast segments for concrete towers

Processes
- Weekly production capacity of 43 segments
- 136 segments storage capacity, four 64-ton gantry cranes

Business Model
- Business-to-Business (B2B)

Unique Selling Points (USP)
- Modular precast segment to deliver close to sites
- WBHO renowned constr. comp., Nordex local market leader

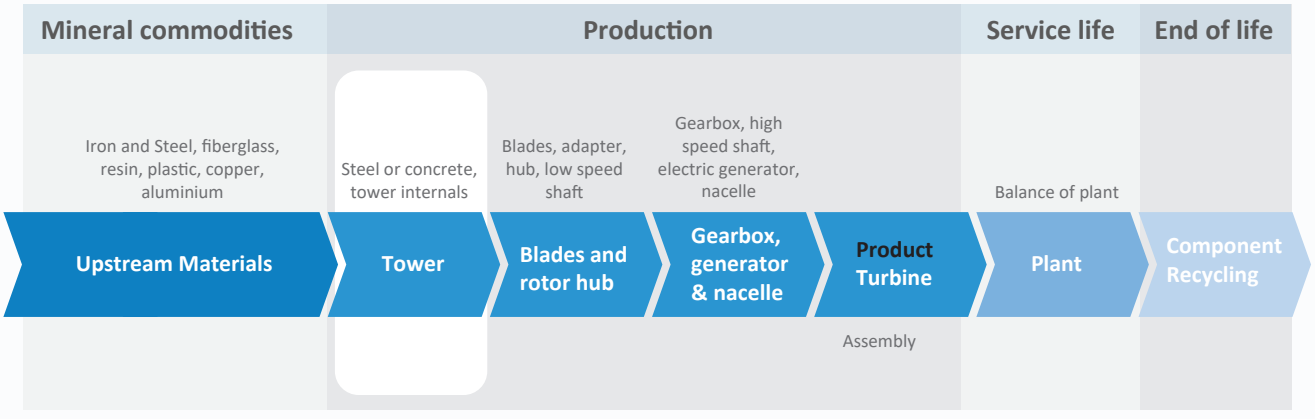
Manufacturing Ecosystem: Drivers and Challenges
- Drivers – following Bid Window 5 in South Africa Nordex South Africa was awarded contracts for 252 MW
- Increased turbine sizes create a favorable environment for local tower manufacturing and concrete towers.
- South Africa has a strong concrete construction industry.
- Challenges – visibility of the REIPPPP bid rounds

Opportunities
- South Africa wind power objective of 14 GW by 2030
- Potential export to SADC region
- Political commitment to promote South Africa's local wind manufacturing with an Energy Strategic Business Unit (SBU) set up in 2020 within the government specialised Industrial Development Corporation (IDC).

Starting tower manufacturing activities can be viable for 100-200 units. It typically has 80% local content and presents significant opportunities for the local steel and concrete industries.

The Nordex/WBHO facility in South Africa is a pioneer Original Equipment Manufacturer (OEM)-led tower manufacturing facility built in 2019. The plant produces precast segments to supply the concrete towers for two wind farms. The facility was built within 70 km of the construction sites.

Sources: (Cement & Concrete SA, 2022), (Nordex SE, 2018), (SAWEA, 2022)



E-Bikes and Battery Assembly in Kenya
Electric two-wheel vehicles for business and consumers
eBee, Nairobi, Kenya

Products
- Cargo e-bikes for last-mile delivery & commuter e-bikes

Processes
- e-bikes assembled locally from imported components
- Currently using an off-the-shelf battery pack from China

Business model
- A mix of both B2B and B2C

Unique Selling Proposition (USP)
- 'Green' jobs for youth (75% of riders) and women (25%)
- Full e-bike service, in-house trained mechanics (50% women)

Ambition
- Local battery assembly plant in Q2/Q3 2024
- Create 200,000 'green' jobs for youths and women by 2030
- Grow to 1,000,000 e-bikes on the road by 2030

Manufacturing Drivers and Challenges
- Import regime on imported components
- Currency fluctuations
- Restrictions on repatriation of profits to foreign investors
- Development of local skills

Opportunities
- Increasing urbanisation and growth of the gig economy
- New legislation to provide cycle lanes on roads

Founded in 2019, originally producing manual bicycles for rural Kenya. Started developing e-bikes in 2021 for Nairobi. Funded by two Dutch family offices and one of the founders.

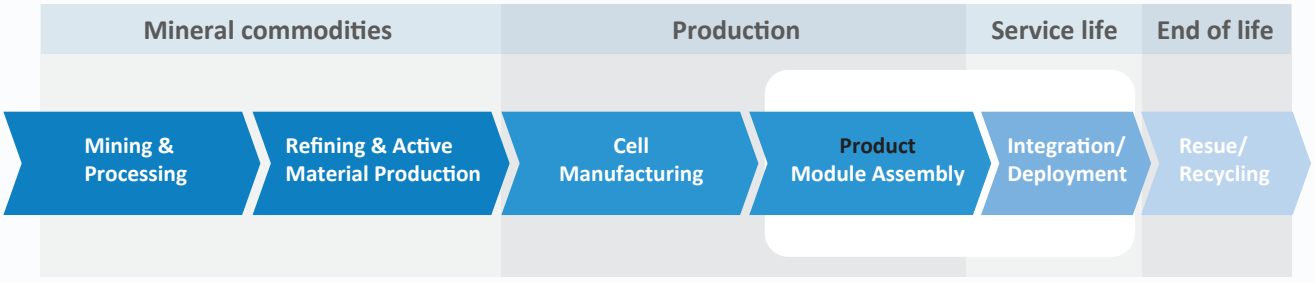
In partnership with a Dutch battery company, now developed own battery pack and BMS for local assembly and repair.

Includes e-bike + service + rider package for e-commerce platforms, a rental service (e-bike + service) for businesses, and direct sales (e-bike only).

Profit margin 15% - 30%.

Currently, about 500 jobs created in Nairobi.

There are plans for regional expansion (Uganda + Rwanda), West Africa as well as to expand product offerings to include three-wheelers.



Mobility Batteries as a Service in Uganda
Electric motorcycles and Battery Assembly
GOGO Electric, Kampala, Uganda

Products
- Electric motorcycles; battery packs

Processes
- Electric motorcycles locally assembled
- 22 MWh/yr battery assembly plant, 200 staff
- In-house training in battery skills for all staff

Business model
- Electric motorcycles sold to customers on a payment plan (B2C) through a microfinance partner
- Battery as a service at battery swapping stations

Unique Selling Proposition (USP)
- In-house battery circular economy, optimising battery value
- Fully road-tested battery packs for Ugandan conditions

Ambition
- Building a semi-automated battery assembly plant to scale pack production from 5,000 to 60,000 units (264 MWh)
- Plant commissioning planned for Q1, 2024

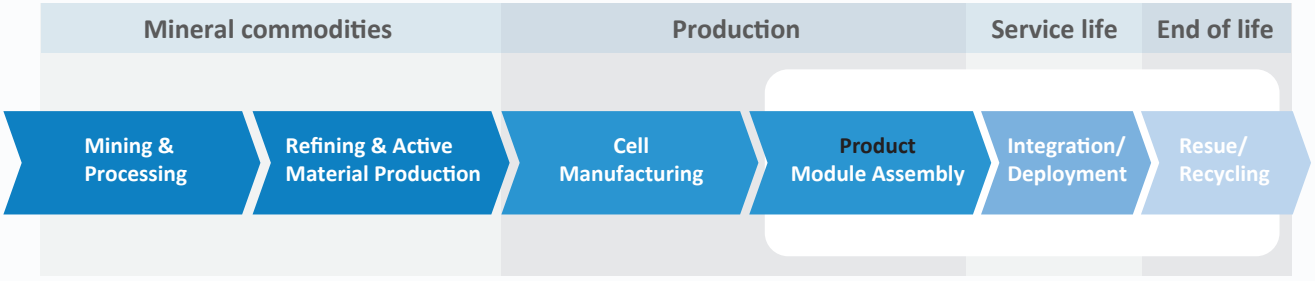
Manufacturing Drivers and Challenges
- Accessing patient capital for R&D
- Development of local skills

Opportunities
- Small scale stationary applications from second-life batteries
- Expanding into regional markets

Founded in 2017 by two partners (Ugandan + German) to develop sustainable transportation and energy solutions to base of the pyramid customers. Funded by founders, strategic partner (just recently), and in discussion with EDFI ElectriFI, with technical support from GET.invest.

Battery cells imported from China. Battery packs designed, assembled, serviced, repurposed, and disposed of in-house.

Gross margin around 40%



Modern High-Power Battery Packs from South Africa
Lithium-ion Battery Assembly
IG3N (Pty) Ltd, Randburg, South Africa

Products
- Small battery packs (up to 5 kW) for residential
- Large battery packs (larger than 10 kW) for C&I

Processes
- Lithium iron phosphate (LFP) cells imported from China for local assembly of large packs
- Small packs (40% of sales) imported from China
- 30 full-time staff + 10 interns

Business Model
- Imported cells assembled into packs for stationary applications
- Accredited network of partners installs at customer sites

Unique Selling Proposition (USP)
- Only major black-owned player in sector
- In-house battery management system (BMS) allows battery functionalities tailored to customer needs

Ambition
- Larger high-voltage packs in containers for utility-scale market
- Developing packs for e-mobility

Manufacturing Drivers and Challenges
- Shortage of technical skills
- Financing to scale

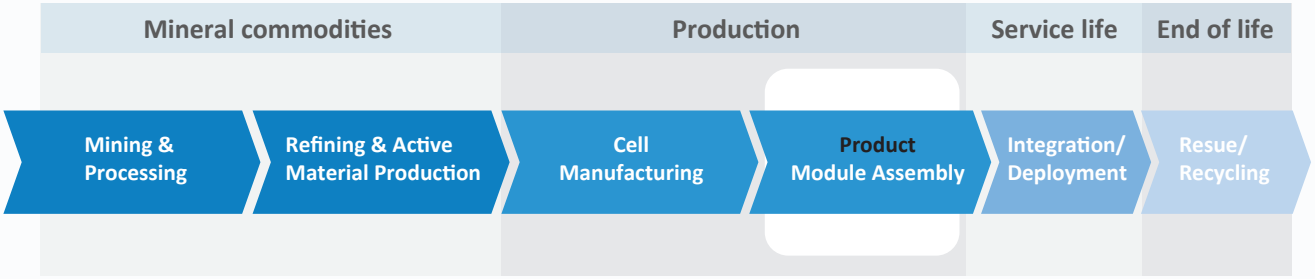
Opportunities
- Expanding into SADC market
- Emerging e-mobility sector in South Africa

IG3N (Pty) Ltd is a manufacturing start-up that assembles LiFePO4 batteries and is currently the "Premier player" [assembler] in the lithium-ion battery storage market in South Africa. The company's core market is on stationary storage in conjunction with Solar PV and focuses on superior products and on the incorporation of the latest technologies to battery functionality. One of the key focus areas is on exporting to the SADC region and the rest of Africa, as extraordinary opportunities exist on the rest of the continent, especially in the development of mini and micro-grids to impact development.

Founded in 2018, and last round of funding (PE) was $1,3M in 2021. Current local production capacity of 60 MWh/yr at 60% capacity utilisation. Business now scaling up.

All co-founders had established careers in the energy sector prior to IG3N, hence well-connected to the energy ecosystem both in South Africa and the SADC. Led by a black female co-founder. Teach and train more to encourage wider technology adoption.

Average profit margins of 15%. Larger packs have higher margins (17% – 19%).



Electric Motorbikes, Buses, and Battery Assembly in Kenya
Assembling electric motorbikes
Roam Electric, Nairobi, Kenya

Products
- Electric motorbikes (mass production) & buses (pilot stage)

Processes
- Design and assembly in Kenya
- 5,000 – 10,000 motorcycles/year
- 30 – 50 MWh/yr battery packs

Business model
- Motorbikes sold or leased (to own) in B2B (for delivery and security) and B2C (delivery and taxi) models

Unique Selling Proposition (USP)
- Product suits variety of business models, in-house software optimised for large fleet operators or financing partners
- After sales service, including battery pack maintenance

- Ambition
- 90,000 motorcycles/yr (560 MWh/yr battery packs) by 2025
- 225 buses in operation by 2025
- > 2,000 direct + 100,000 indirect jobs in 5 years, 40% women

Manufacturing Drivers and Challenges
- Access to capital
- Import regime on imported components

Opportunities
- Only pilot project with a BRT-ready bus in East Africa
- Increasing urbanisation and growth of the gig economy

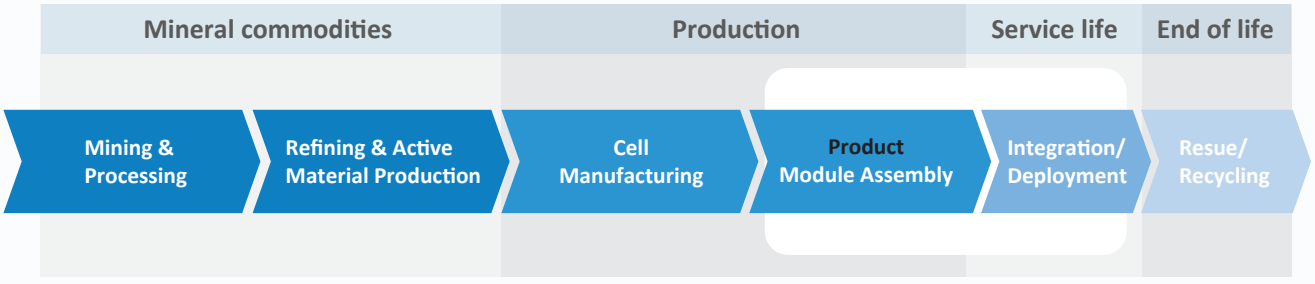
Founded in Kenya in 2017 by Swedish entrepreneurs, Roam started off converting petrol/diesel Safari vehicles to electric power. The company has since refined its business model to focus on electric motorbikes and buses.

Components sourced predominantly from India/China, including battery packs. Plans to increase local battery pack assembly when economics permit.

For B2C, partner with microfinance institutions.

Gross margin about 15%.

Battery packs sold or rented from battery hubs and swap stations. For sustainable electric mobility reliable and affordable electricity from renewable sources is required.



Cargo e-bikes for delivery service providers in Ghana
E-Bike Assembly
Wahu Mobility Ltd, Accra, Ghana

Products
- Cargo e-bikes for last-mile delivery

Processes
- Hardware/software design in Ghana
- e-bike assembly in Ghana (20 factory workers, scaling to > 100), about 20,000 units p.a. total capacity

Business model
- e-bikes sold to delivery riders (B2C)

Unique Selling Proposition (USP)
- Ecosystem model / building a community around Wahu app
- Carbon credit (Paris Agreement Article 6.2) financing model, unique in this sector, currently in validation phase

Ambition
- Build a 300 MWh battery pack assembly plant in Accra
- Build 5 regional e-bike assembly micro-factories across Africa
- Create > 100,000 sustainable jobs for youths by 2028

Manufacturing Drivers and Challenges
- Accessing patient capital for R&D
- Import regime on imported components
- Finding financiers willing to broker carbon credit asset finance

Opportunities
- Carbon credit finance
- Increasing urbanisation and growth of the gig economy

Founded in 2022 as an organic partnership between Cargo Bikes Africa (Ghanaian startup) and a German project group, leading to a merger. Component manufacturing not locally but global, including battery packs

Profit margin 20% - 25%.

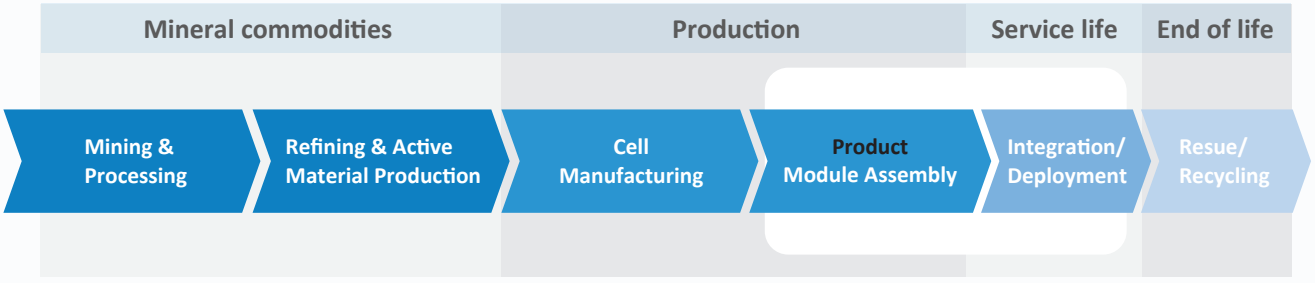
Mobility is envisioned as a service, with e-commerce platforms serving as delivery aggregators.

Sales through either cash or on 18-month payment plan.

Additional challenges faced by companies relying on components sourced globally include currency fluctuations, and a shortage of local skills.

Possibility to build own solar power plant.

Outlook: Introducing a Wahu e-car, locally manufactured.



Supporting the Transition to Green Hydrogen
Reversible Fuel Cell manufacturing production in South Africa
Mitochondria Energy Systems, South Africa

Products
- Project Phenix Fuel Cells for stationary applications (medium-to-large businesses) and microgrids
- 50 kW modules, larger capacities possible (modular system)

Processes
- 63% components of FCs available locally
- Long-term plan to localise 93% of components (42% at SEZ)
- 400 direct jobs/factory expected

Business Model
- Business-to-consumer (B2C) and Business-to-business (B2B)

Unique Selling Points (USP)
- Cutting-edge fuel cell technology with high performance
- Well established (locally) supply chain

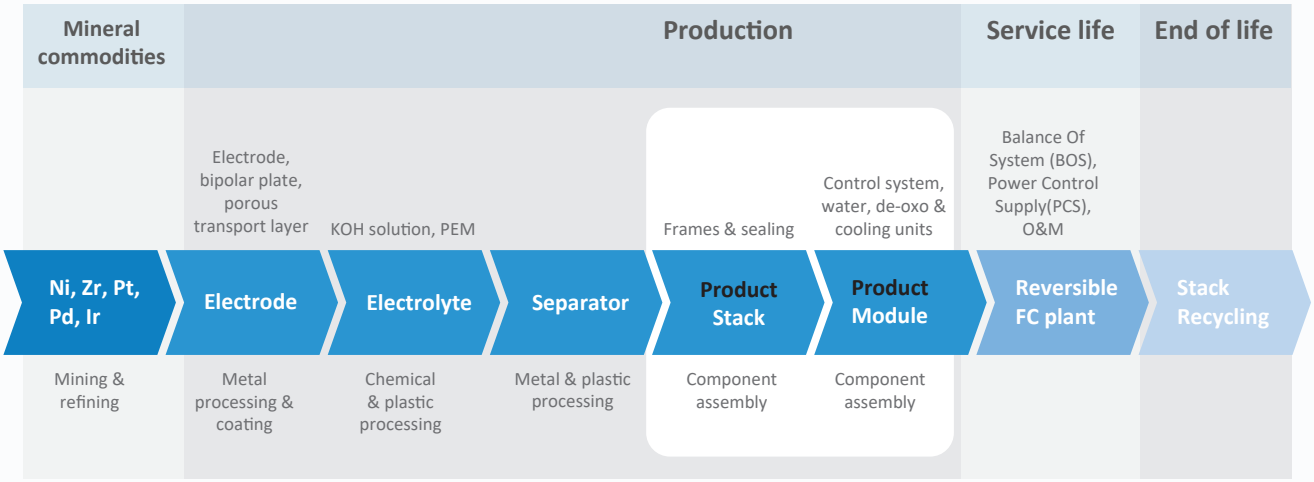
Ambitions
- Establish first Hydrogen Valley Innovation Hub in South Africa
- FC manufacturing plant in Vaal SEZ (R4,3 bn in 4 years)
- Manufacturing Ecosystem: Drivers and Challenges
- Strong support from Vaal SEZ and local/ international entities (Emfuleni Municipality allocated 700 hectares of land for this)
- Expected public/private investment to be attracted of R4 bn

Opportunities
- First Mover Advantage
- Synergies with other green technologies

The company's overarching goal is to cultivate its proprietary intellectual property (IP) and locally manufacture reversible fuel cells, enabling the provision of comprehensive and distributed energy services. The business model rejects dependence on public or centralised funding models where customers pay for a service. Instead, it embraces a decentralised approach, necessitating meticulous design of service provision to yield returns for private investors without burdening end consumers with additional costs.

The funding for the initial analysis of technologies and pre-feasibility studies was sourced from public entities such as the IDC (Industrial Development Corporation), DBSA (Development Bank of Southern Africa), and DTIC (Department of Trade, Industry and Competition, Republic of South Africa). In 2018, strategic collaborations began with technological partners, predominantly from Europe, including AVL (Austria), Ceres Power (UK), and JA (Jendamark Automation, South Africa). This phase also involved the identification of key partners within the supply chain.

The primary market focus is the South African region, with plans in place for subsequent expansion into other regions and Europe.



Your one-stop global energy-solution partner
Electrical power system and electro-mechanical equipment in rural Sub-Saharan Africa
ACTOM (Pty) Ltd, Johannesburg, South Africa

Products
- High Voltage Equipment, Medium Voltage Switchgear
- Distribution Transformers, Power Transformers,
- Smart Technologies: Protection, Automation, Metering

Processes
- Power transformer assembly capacity around 2,800 MVA/yr
- 6,800 employees

Business Model
- Business-to-business (B2B) and -to-consumer (B2C)

Unique Selling Points (USP)
- Sales channels established
- Cost (transport) advantages perceived
- 50%+ Black-run and operated

Ambitions
- Organically grow to R15bn turnover in the medium term
- Empower black people
- Manufacturing Ecosystem: Drivers and Challenges
- Skills trained from scratch

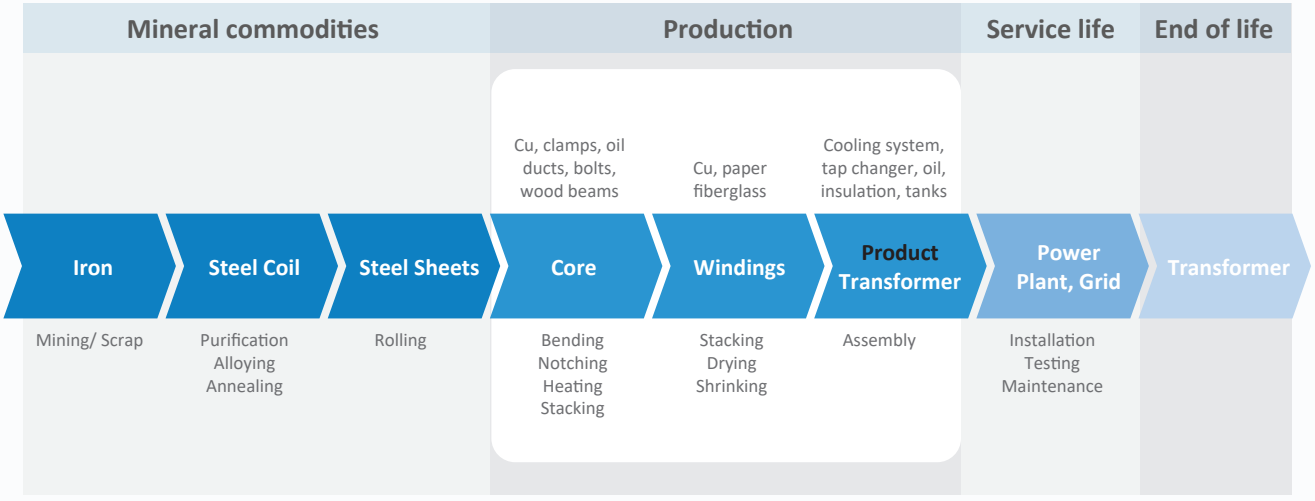
Opportunities
- Massive need for electrical equipment in the region

ACTOM (Pty) Ltd is the largest manufacturer, solution provider, repairer and distributor of electro-mechanical equipment in Africa, with an annual order intake in excess of R11 bn.

ACTOM is a black empowered company with 34 operating units, 53 production, service and repair facilities, and more than 33 distribution outlets throughout Southern Africa.

The ACTOM Power Transformers (APT) division manufactures a full range of transformers from 2 MVA to 315 MVA with voltages up to 275 kV. These transformers are supplied to Utilities for their Generation, Transmission and Power Distribution requirements as well as the mining and Industrial sector, public works authorities and wind and solar renewables applications.

The APT Services division offers transporting, erecting and commissioning of units to site as well as comprehensive maintenance plans and site services. APT's own In-house developed Condition Monitoring system further allows the customer to monitor their transformers in real time on the APT customer interface platform.



True Manufacturer of Transformers in Uganda
Manufacturing power and distribution transformers.
KORICA (U) Ltd, Kampala, Uganda

Products
- Power transformers, Distribution transformers,
- Repair services, Testing transformers.

Processes
- Monthly production capacity of over 150 transformers
- Over 100 employees

Business Model
- Business-to-Consumer (B2C) and -to-Business (B2B)
- Unique Selling Points (USP)
- Long-lasting, high-performing transformers
- compatible with local technical requirements

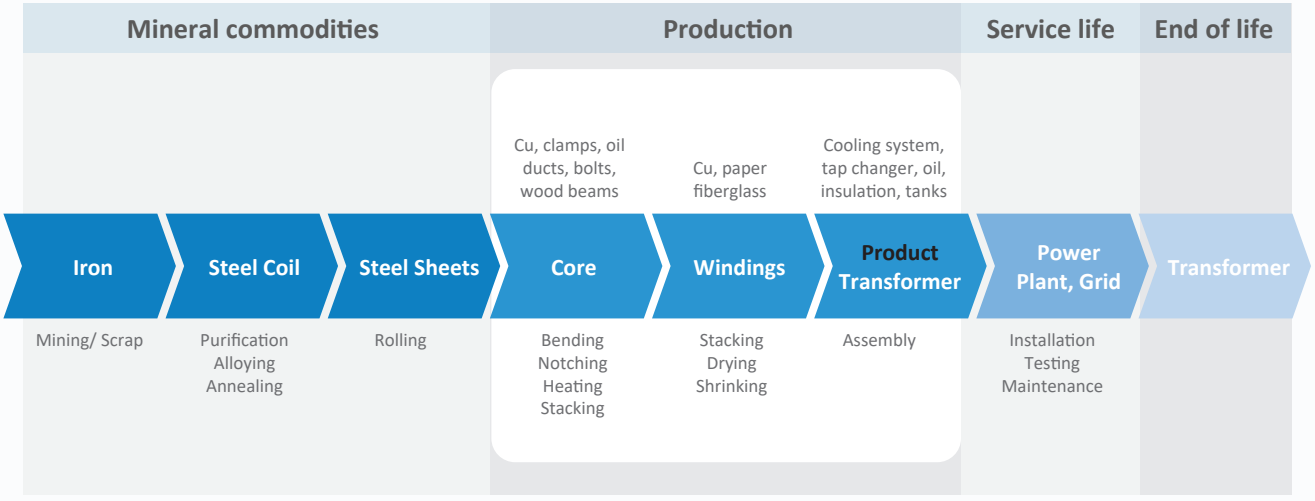
Ambitions
- Selling products to government agencies

Manufacturing Ecosystem: Drivers and Challenges
- Drivers – Participating in local projects
- Export to neighbor countries

Opportunities
- Need for distribution transformers in rural areas of Uganda
- Increasing demand for transformers, especially as the country begins oil production

KORICA was established in 1995 and has been manufacturing transformers in Uganda for over 20 years as the first factory to produce quality transformers in the country. The factory has the capacity to manufacture transformers ranging from 25 kVA to 2500 kVA for 11 kV and 33 kV voltage levels. KORICA can also manufacture custom rated transformers as per customer requirements. Apart from customers in Uganda, KORICA supplies transformers to customers in Rwanda, Burundi and South Sudan.

There is a government policy in Uganda called BUBU (Buy Uganda Build Uganda) which can be attractive to local manufacturers as long as government agencies follow through and implement the policy to ensure that manufacturers benefit from the policy. In addition, the tax imposed on imported transformers can encourage local manufacturers who have products of the same or better quality than the imported ones.



Be Bold | Be Bright | Be the Future | Be First with MICROCARE
Manufacturing solar and electronic components for residential, commercial and agricultural customers
MICROCARE, Gqeberha, South Africa (SA)

Products
- Pure sine wave bi-directional inverters,
- Solar charge controllers,
- MICROCARE mini-grid, Solar monitoring, Solar pumping,

Processes
- ~ 50 employees

Business Model
- Business-to-Consumer (B2C) and -to-Business (B2B)
- Designing, developing, manufacturing and installing

Unique Selling Points (USP)
- Manufacturing products which are robust, resilient, tough and built for Africa, Providing high power quality
- Excellent technical support both on-site and remote

Ambitions
- Preparing SA for high electricity prices and loadshedding
- Be a part of greener future in SA using local technology

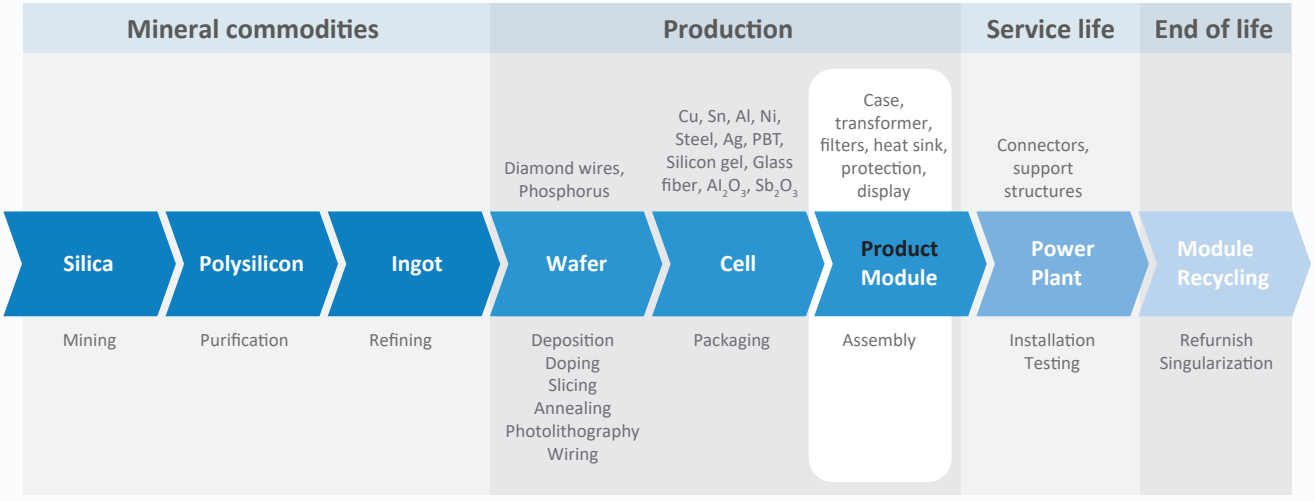
Manufacturing Ecosystem: Drivers and Challenges
- Drivers – Providing best possible SA product, with efficient and reliable customer service experience
- Challenges – Lack of local business protection, struggling domestic economic environment, increasing prices

Opportunities
- Need for off-grid solution in the region

MICROCARE was established in August 1990, manufacturing solar and electronic components during a time when electricity was cheap and clean energy was not often a priority. Today it strives to be the local industry leader and the solar component manufacturer of choice in SA.

In SA, the grid infrastructure is very centralised and not well maintained. Because of massive debt and a struggling economy, there is not a lot of money to invest in grid equipment, but there is a great opportunity for alternative energy.

Bottom-up approaches, i.e., mini-grids and micro-grids, can be considered as an alternative due to the failure of top-down development in Africa. This is where MICROCARE comes in with products that are robust, resilient, tough, and built for Africa. MICROCARE has strategically partnered with certified MICROCARE installers and distributors throughout the country to ensure that the end user receives ongoing support for their investment. MICROCARE has also partnered with Merchant West Holdings to assist installers in offering financing to their customers.



3.2 Analysis of business case competitiveness

3.2.1 Solar Component Manufacturing (Auxano, AZUR SPACE, Ener-G-Africa, Sustain Solar)

"Nobody wants to be the first, but eventually everybody follows," says Chuks Umezolora, Co-founder and COO of Auxano Solar Nig. Ltd., about getting solar manufacturing started. He has succeeded in financing, building, and opening a 100 MW PV module assembly factory in Lagos (Falaiye, 2023), a factory size considered entry-level capacity in PV manufacturing. Capex for assembly is lower than for other steps in the PV value chain (Figure 9), and labor intensity is higher. Based on 2021 data (IEA, 2022), approximately 600 jobs/GW are created in module assembly, 500 jobs/GW of cell production, 250 jobs/GW in wafers & ingots, and 100 jobs/GW in polysilicon refining. Auxano Solar received an investment of USD 2 million by Shell's All On investor for module assembly, affording a certain degree of flexibility, yet knowing that profitability is globally negative since 2015 (IEA, 2022). Chuks says: Problems coming up help your business case because you solve them.

Figure 9: Investment required for PV manufacturing plants. Data from (IEA, 2022)

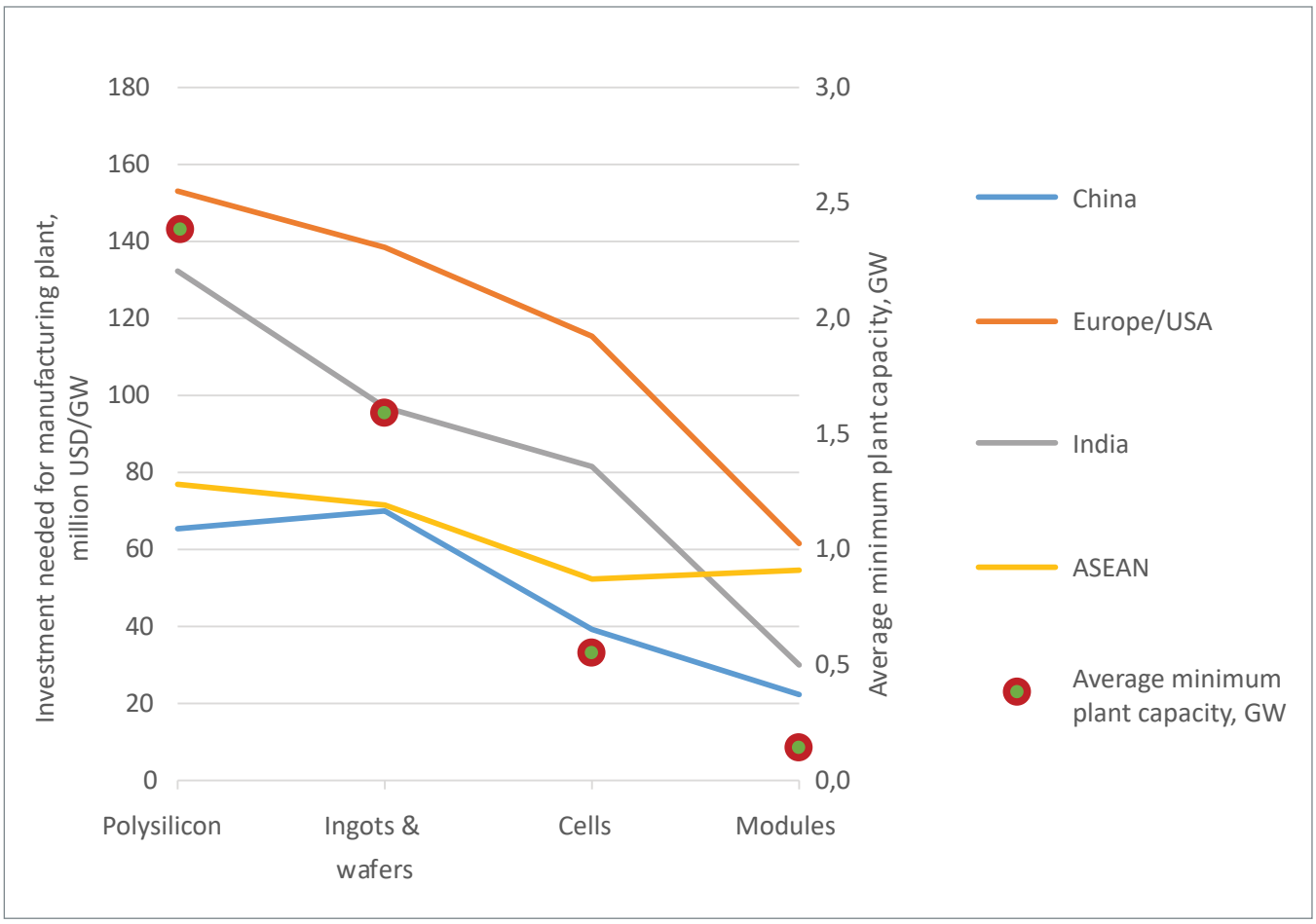
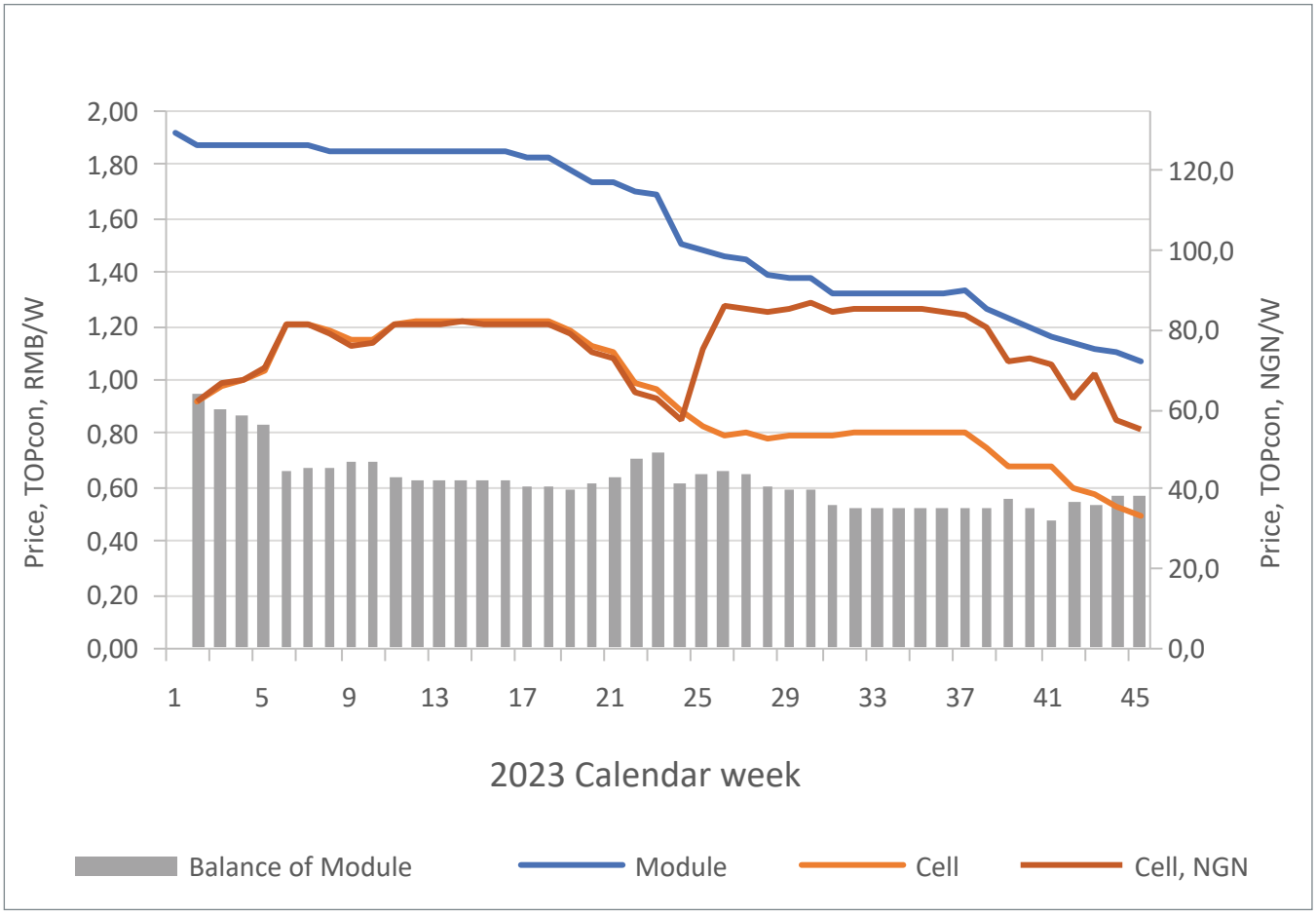


Figure 10: Investment required for PV manufacturing plants. Data from (IEA, 2022)



Solar module manufacturing is financially risky. Figure 10 shows that cells, the main constituent for modules, cost 20% more in week 24, 2023 than the assembled module cost week 45, 2023 (TaiyangNews, 2023), due to fast decreasing prices. At the same time, the cost of cells for Nigerian manufacturers like Auxano Solar increased by 36% overnight due to the devaluation of the Naira on Jun 14, 2023 (Reuters, 2023). Module manufacturers can partially accommodate the volatility by forward contracts, hedging the currency risk. However, having to pay precursors in hard currency while receivables are earned in local money remains a challenge. The situation is compounded for manufacturers who are not integrated across the value chain, who have to buy many inputs internationally, and who do not have a diverse portfolio of markets into which to sell their products.

At the heart of the business competitiveness of manufacturers focusing on the solar PV production is the significant global excess production capacity, much of which is triggered by a surge in investments from China and other markets like the U.S., India, Turkey, and Vietnam. The conditions for the entry into the market remain challenging, with global manufacturing capacity estimated at nearly 1 TW (Molina, 2023), versus annual demand of roughly 400 GW in 2023 (Maisch, 2023).

3.2.2 Wind Turbine Manufacturing

While new capacities are expected to increase at a 15% annual growth rate (GWEC, 2023a), the global wind manufacturing industry is experiencing a phase of reorganization pushed by competitive market forces, a rise in interest rates, and government-led reindustrialization and relocalization programmes in Europe and the USA. This industry is also highly concentrated, with 60% of turbine manufacturing capacities in China, and 19% in Europe (GWEC, 2023a). Technical complexity, certification and reliability issues, competition with imported components, are making it

difficult for newcomers. The short to medium term prospects for manufacturing large-scale wind turbines entirely in Africa are weak. Challenges notwithstanding, the continent could, according to announced projects, install 60 GW (Global Energy Monitor, 2023, 2024) of new large-scale wind turbines over the next 10 years as part of its power system expansion plans. Manufacturing localisation opportunities to support this growth must be differentiated into the three main segments of the wind value chain: tower including internals, nacelle components, and blades.

Made of steel or concrete, wind towers are heavy, large and require specific logistics to be transported via existing port and road networks to usually remote locations, challenges further reinforced by increased turbine sizes. Towers represent 14% of the total value of a wind farm project and 25% of the wind turbine value alone (Urban-Econ, EScience, 2015). The logistic complexity creates an opportunity for local manufacturing and backward synergies with existing concrete and steel industry (that serve other markets for the construction of ports, bridges, buildings and other large-scale infrastructures). Wind towers are thus the first natural candidates for local manufacturing and a specific local content of 80% can typically be achieved. The Nordex/WBHO precast concrete facility in South Africa is an example of local manufacturing addressing this issue.

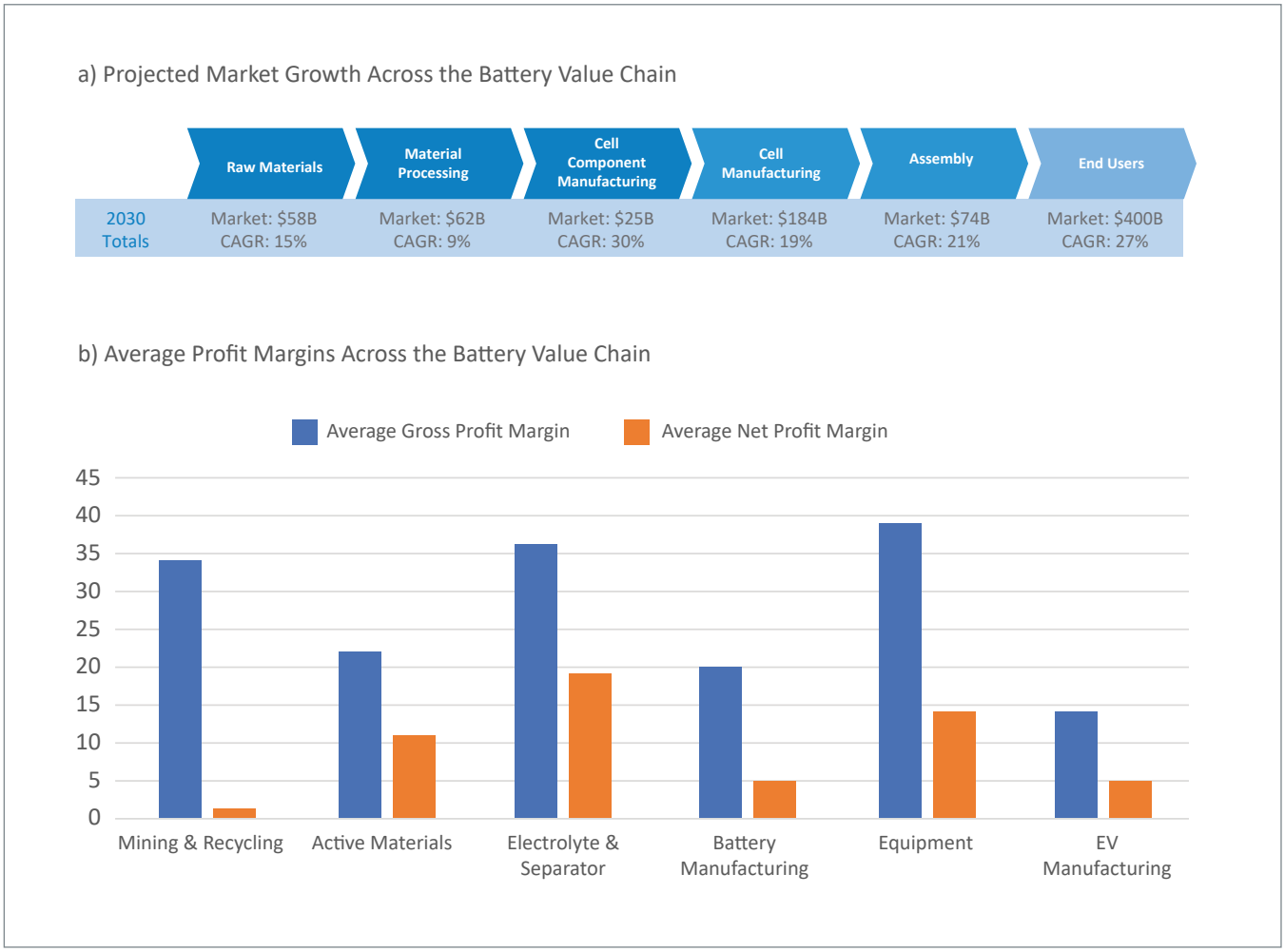
Localisation opportunities in the coming 5 years are smaller for the other two segments. For gearbox and wind generator manufacturing (i.e., parts that comprise the nacelle), quality assurance is an important issue, and developers (as well as their financial backers) mitigate the risk of failure and of costly project downtime by procuring from recognised, established players. Original Equipment Manufacturers (OEMs) tend to be conservative, and wind turbine components that involve moving parts are less likely to be outsourced to newcomers. Wind turbine blades are made of composite materials and manufacturing could be localised with adequate skill transfer. However, the closure of Siemens Gamesa's blade factory in Tangiers, Morocco after 5 years of operation is a reminder of a fierce global competition and small margins (exacerbated by inflation on raw materials). Opportunities exist in South Africa and Morocco. A critical challenge remains the adequation of the mould to different turbine types which may call for facilities dedicated to a single OEM or less specialised ones with multiple moulds.

A structural limiting factor is the small size of most African power systems, many of which are not able to annually integrate several hundreds of megawatts of wind. The ability to build a robust wind power manufacturing market depends on the size of the addressable market – the wind market in Africa remains small so far. Intra-Africa trade could be an option; however, challenges to creating a more interconnected power system point to a horizon better measured in decades than in months or years.

3.2.3 Battery Manufacturing and Applications (eBee, GOGO, IG3N, Roam, Wahu)

While high growth is projected for the global battery industry, profitability is low in general (Figure 11). Cell manufacturing averages only 5%, still better than the 1% for mining and recycling. In this kind of business, economies of scale and operational efficiency are decisive for profitability. With net margins of 15% - 19%, IG3N Ltd, a battery pack assembly business, is below the global average of 19%.

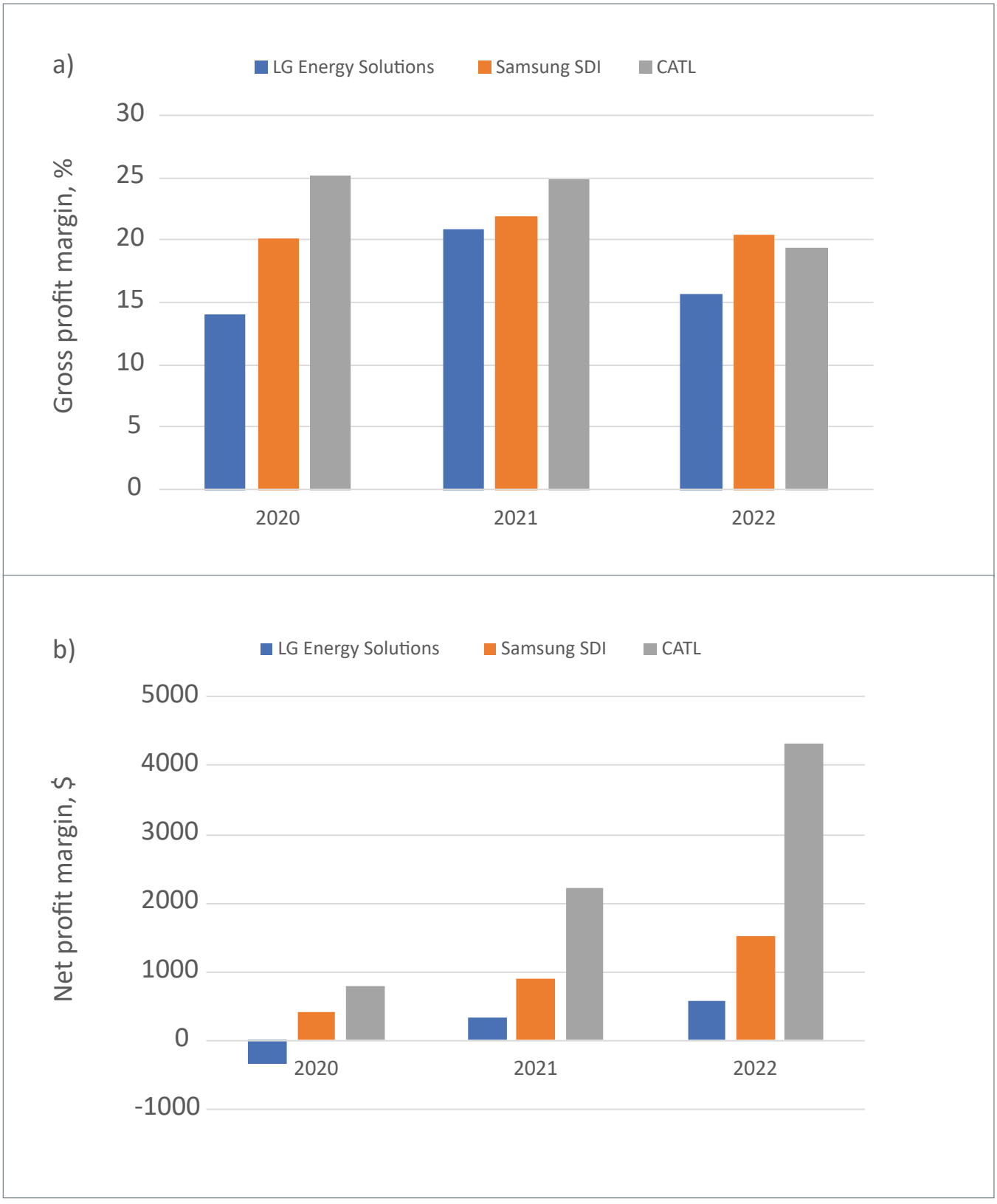
Figure 11: Overview of the global battery industry value chain (a) projected growth by 2030 (CAGR is the Compound Annual Growth Rate), and (b) average profitability in %. Data from (Volta Foundation, 2024)



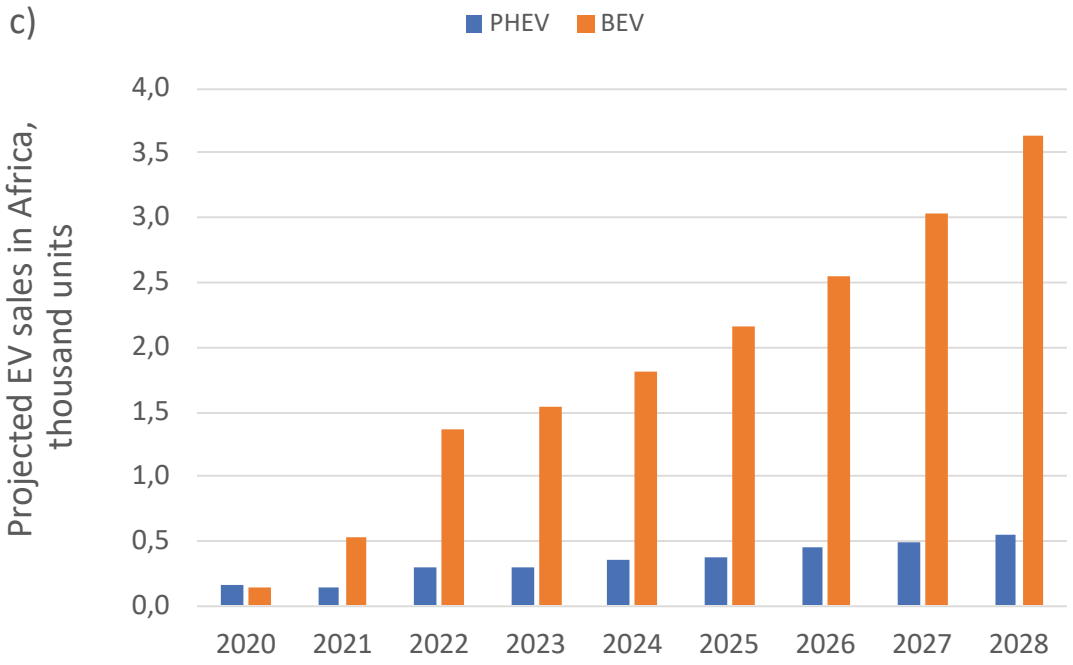
Figures 12 (a) and (b) show profitability indicators for selected large Asian battery (cell and pack) manufacturers in the three-year period 2020 – 2022. Gross margins have decreased (high cost of goods sold) due to high prices of cathode and anode materials. However, net profits went up, reflecting (largely internal) economies of scale, particularly evident for CATL, by far the largest of these manufacturers. Cell manufacturing being a scale business immediately puts Africa, with its small market, at a disadvantage. Figure 12 (c) shows a five-year EV sales volume forecast for Africa. With less than 5,000 vehicles forecast in 2028, this is minuscule compared to, e.g., Europe, where about 1,000 times more vehicles are projected to be sold. This is the main reason why an ecosystem for cell manufacturing is building up in Morocco – the country has advantages to serve both the European and North American markets.

On the other hand, Figure 12 (d) shows that the African electric motorcycle market is about 1,000 times larger than that for EVs (volume of units basis). Estimates suggest that only about 0.5% of this market is currently addressed (UNEP, 2023). Accordingly, many of the business cases discussed in this study are startups seeking to tap into this market, along with that of the comparatively small e-bike (and even much smaller three-wheeler) market. As the market is much larger than the operating scale of these startups, interviewees indicated there was no competition among the e-mobility players themselves. They identified petrol vehicles as the only real competition. Asian operators would be the most likely e-mobility competition, but they would have to contend with a tough market demanding a significantly different technical and commercial solution along with only a nascent ecosystem.

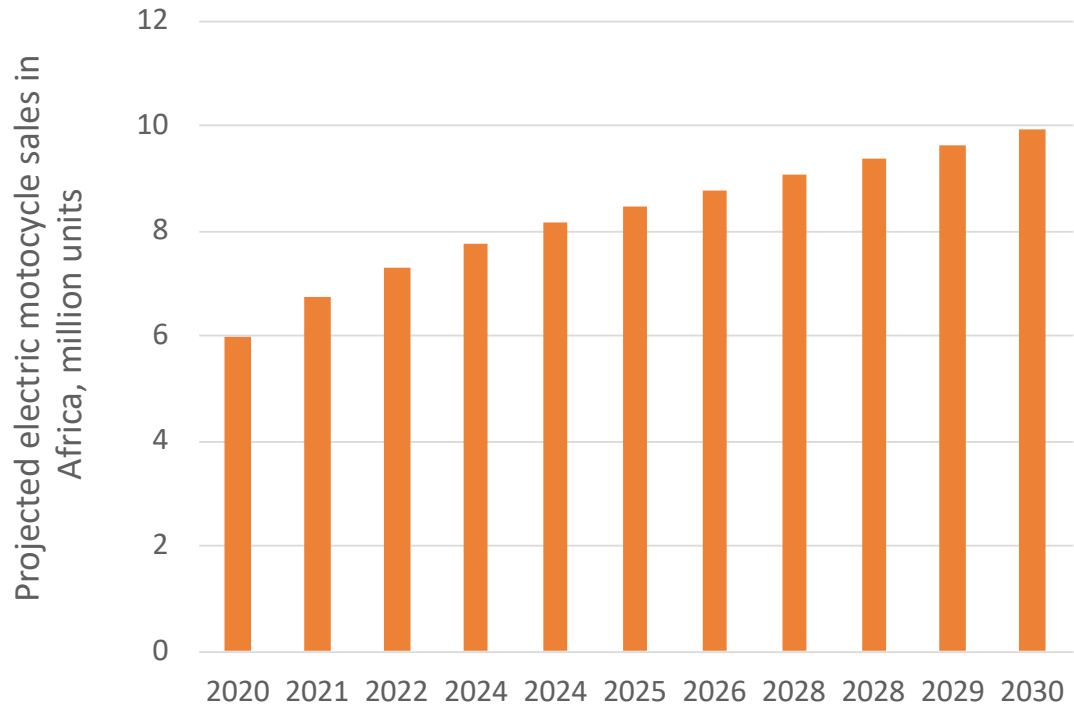
Figure 12: (a) and (b): Gross and net profit margins for selected Asian battery manufacturers, Data from (Volta Foundation, 2024); (c): projected EV sales in Africa (BEV are Battery Electric Vehicles, PHEV are Plug-in Hybrid Electric Vehicles, Data from (STATISTA, 2023), and (d): projected electric motorcycle sales in Africa, Data from (UNEP, 2023)



c)


PHEV
BEV
Projected EV sales in Africa, thousand units
4,0
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0,0
2020
2021
2022
2023
2024
2025
2026
2027
2028

d)


Projected electric motocycle sales in Africa, million units
12
10
8
6
4
2
0
2020
2021
2022
2024
2024
2025
2026
2028
2028
2029
2030

Unsurprisingly, current manufacturers in Africa are ecosystem builders who are heavily hands-on in the ecosystem and have already gone through several iterations to develop viable technical and commercial solutions. Interviewees said that with their solution, motorcycle/bike owners save at least 50% more from day one compared to using petrol vehicles. The imperative for ecosystem building means that operators often engage in noncore business activities either directly or through partnerships. Some view themselves as an energy network operator (battery swap stations), but also operate an electric motorcycle sales and maintenance business for their customers.

The theme of ecosystem building also applies to cell manufacturing. For example, the Chinese investors currently in the early stages of building the battery industry in Morocco appear to have adopted a deliberate ecosystem strategy. Announced projects so far address lithium refining (Manthey, 2023; LG Chem, 2023), NMC and LFP precursor manufacturing (Westerheide, 2023), cathode production (Simpara, 2023), electrolyte/separator manufacturing (Rahhou, 2023), cell and pack manufacturing (Erraji, 2023), and recycling (Rahhou, 2023). The ecosystem strategy bakes in operational efficiency, even in CAPEX. For example, cell manufacturing plant CAPEX is about double (€106 M/GWh) for the EU compared to Asian projects (€55 M/GWh) reflecting favourable labour costs, vendor proximity, vertical integration, and policies for the latter (Volta Foundation, 2024).

3.2.4 Green Hydrogen Manufacturing (Mitochondria)

The primary emphasis in the Green Hydrogen business case is on high-performance technologies from Europe or the United States, which boast a track record of both production and utilization. North African-manufactured equipment appears to have great potential to compete in regional and European markets. This potential is mostly attributed to its adherence to rigorous regulatory, operational, and safety standards, coupled with high product quality and efficiency.

Furthermore, particular emphasis is placed on the critical supply chains essential for executing production processes efficiently, ensuring a timely and cost-effective manner. Numerous electrolyser and fuel cell manufacturers (Cummins, Acciona-Nordex, Siemens, etc.) operate as integral components of multinational corporations with diverse engagements across various sectors. This strategic positioning affords them a distinct advantage, enabling the seamless manufacture of complementary equipment while leveraging established supply chains. In the Mitochondria business case, the local supply chain is well established: 63% of components of fuel cells are available locally by distribution or manufacturing and a long-term strategy (>5 years) has been established to localise 93% of components with 42% manufactured at the Vaal Special Economic Zone (Vaal SEZ)[1].

Currently, the primary hurdle lies in securing access to affordable capital to navigate the project through its initial phases and to attract private investors in subsequent stages. Central to attracting financial backers is the presence of reliable off-take agreements; countries across the EU can play an important role in this regard, helping to de-risk local business cases by committing to certain volumes of green hydrogen production. Beyond that, the real strength lies in leveraging synergies with various green technologies, such as PV, wind energy, biogas, and more.

3.2.5 Grid Equipment Manufacturing (Actom, Korica, Microcare)

Business cases from grid equipment manufacturing companies indicate the advantages that local companies have in supplying products tailored to the conditions in their respective countries. These advantages form the most convincing unique selling points, including in particular well-established sales channels, cost advantages through short transport distances, robust and long-lasting products that have been extensively tested under the prevailing local conditions in the region. Typically, the company decision makers put a strong emphasis on service and maintenance. Concepts supporting empowerment of black people are addressing the persisting economic imbalances in the countries.
However, in a more global context, grid equipment manufacturers in Africa struggle to compete with cheap

[1] Information provided by Mr. Mashudu Ramano, founder of Mitochondria Energy Systems, prior to the interview on December 12, 2023.

imported products, especially as the laws and regulations in their countries often only provide limited levels of protection, and manufacturing like any other industry suffers from poor and improperly maintained infrastructure such as reliable power supply. Special skills are usually only available if trained from scratch.

3.2.6 General Competitiveness Factors of Manufacturing Businesses

Everything other than manufacturing will sort itself out, says Filip Lövestrom, CEO Roam Electric, Kenya.[2] Manufacturing is about quality. The product must be manufactured in line with international norms, must perform well for the duration of the warranty, and meet customer expectations. The product must be safe, recyclable, and have a low carbon footprint. Manufacturing is about speed. Customers expect the product to be delivered in the shortest time possible. Flexibility of manufacturing in terms of product variations, and in terms of manufacturing volumes should be high. Automation helps achieving this while maintaining a high level of quality. Manufacturing is about cost. The cost of the product is determined largely by the costs of capital, labor, and materials, plus overhead costs for administration, communications, marketing etc. In some cases, it is possible to replace major capital expenditure by labor and vice versa. Some processes are more labor intensive than others. Manufacturers need to be ready to transform products, processes, and workforce, with capital and know-how available now, and do so at competitive cost.

Manufacturing operates in a business ecosystem of suppliers, competitors, and customers. There is constant competition for higher quality, faster speed, and lower cost. Companies need to constantly restructure their businesses and improve their products and manufacturing processes in order to continue to meet customer expectations. Policy is crucial for business ecosystems. In order to grow and thrive, a purposeful industrial policy and government commitment is needed. Governments can support manufacturing for a range of strategic reasons, including job creation, to ensure resilience to global shocks and sudden changes to global trade flows, to nurture strategically important industries, and to protect security of supply. Challenges such as the lack of state capacity, and of fiscal resources, help explain the comparatively low level of value-added manufacturing occurring in Africa today.

[2] At the REFA Conference, Nairobi, Oct 4-6, 2023

Figure 13: Comparison of value added. Data from (UNIDO, 2021), (UNSTATS, 2021)

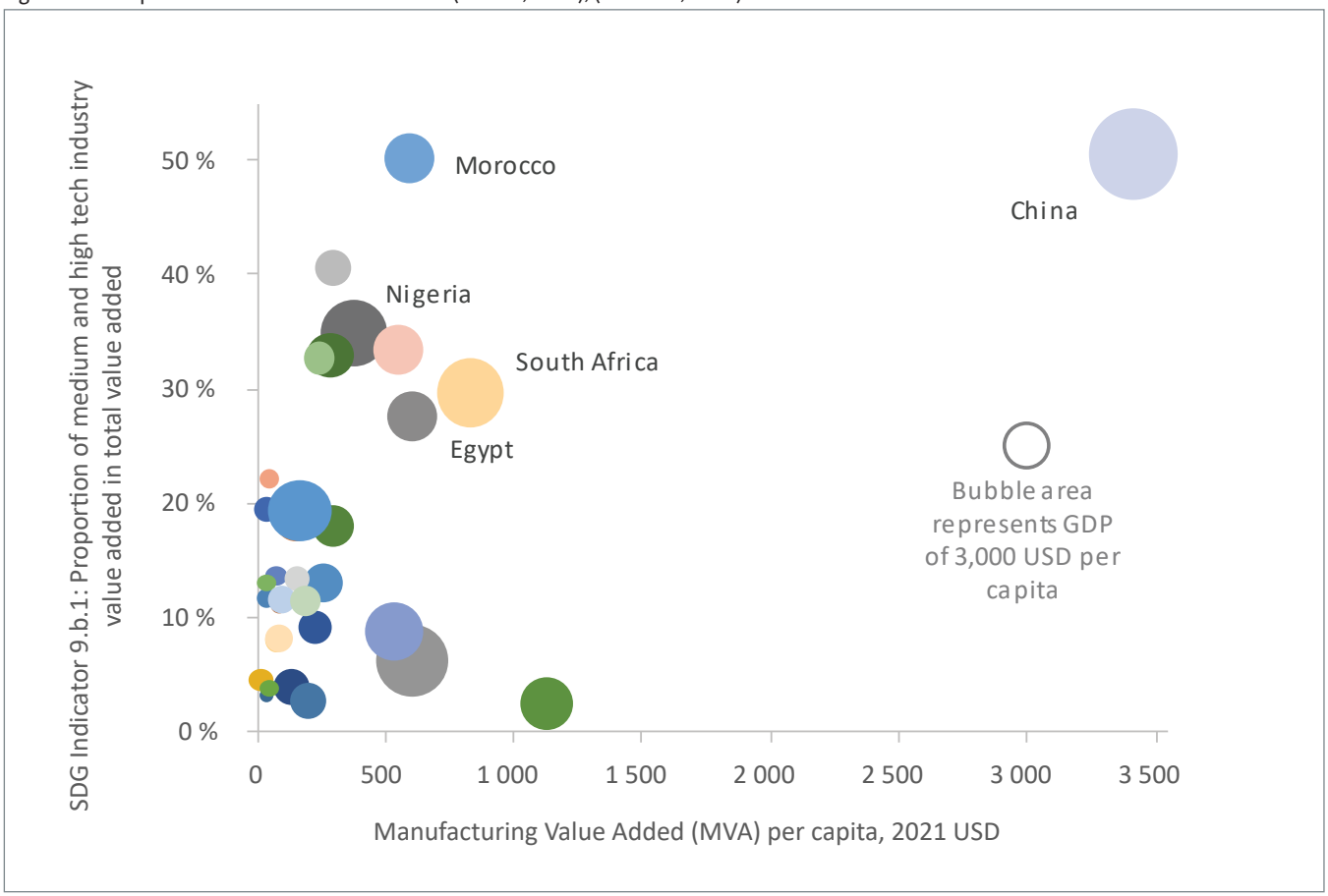
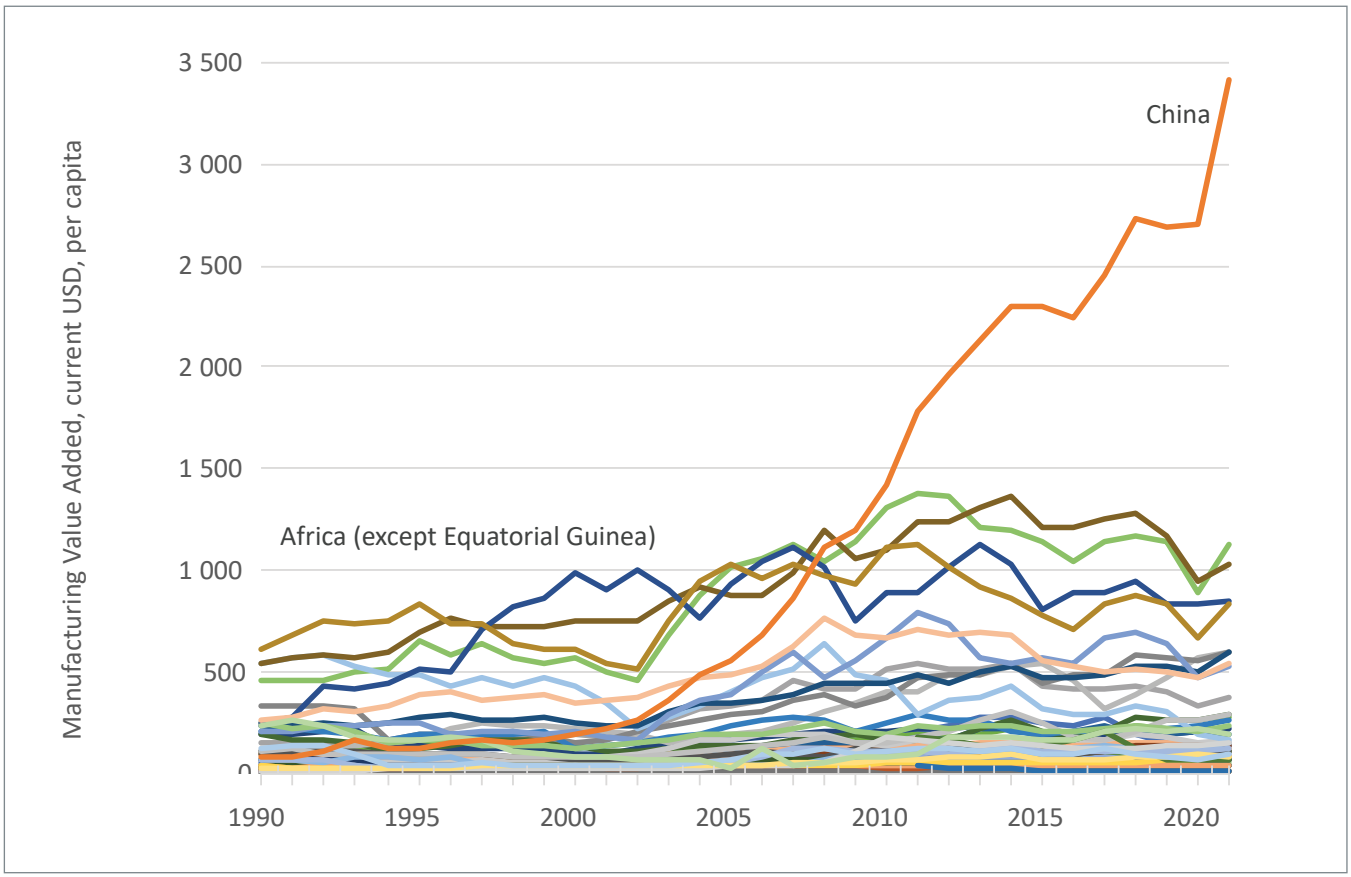


Figure 14: Development of Manufacturing Value Added. Data from (UNIDO, 2021)



The data indicate that countries throughout Africa are lagging behind (Figure 13 and Figure 14). While the global competitiveness of a range of industries measured collectively may not fully represent the specific competitiveness of a particular niche or sub-sector, it indicates that there is still much work to be done to increase local value added, including manufacturing value added, in Africa.

3.3 Highlighting of Africa-EU synergies

Manufacturing partnerships between Africa and Europe exist, the most prominent example being at present the automotive industry. In this chapter we briefly look at lessons from this example, and then discuss in detail the potential synergies in Green Hydrogen and battery manufacturing.

3.3.1 Lessons from automotive industries in Morocco and South Africa

In manufacturing, the automotive sector has spearheaded automation and reaped the associated benefits in terms of scale and quality. The sector has established a highly differentiated global supply chain of OEMs and Tier 1-3 partners, pursued extensive standardization, and has come to rely on increasingly sophisticated logistics featuring a large number of production hubs (e.g., the US, Mexico, France, Germany, China, South Korea, Japan).

Europe is the strongest trading partner for Africa in the automotive sector, which is a global industry also in Africa. Morocco runs a trade balance of zero (Maroc Office des Changes (OC), 2023), South Africa had a positive automotive trade balance of EUR 2.5 billion in 2022 (SARS, 2023). Automotive trade within Africa is small compared to the export markets. In the case of South Africa (Figure 16), neighbouring countries import (often heavy-duty vehicles (Sanon & Slany, 2023)), but a continent-wide supply chain is lacking, while there is a supply chain available locally, numbering 180 Tier 1 among 430 component suppliers across the country (UNCTAD, 2021; Sanon & Slany, 2023).

Figure 15: Morocco – automotive (HS 87) exports and imports 2020-22. Data from (Maroc Office des Changes (OC), 2023)

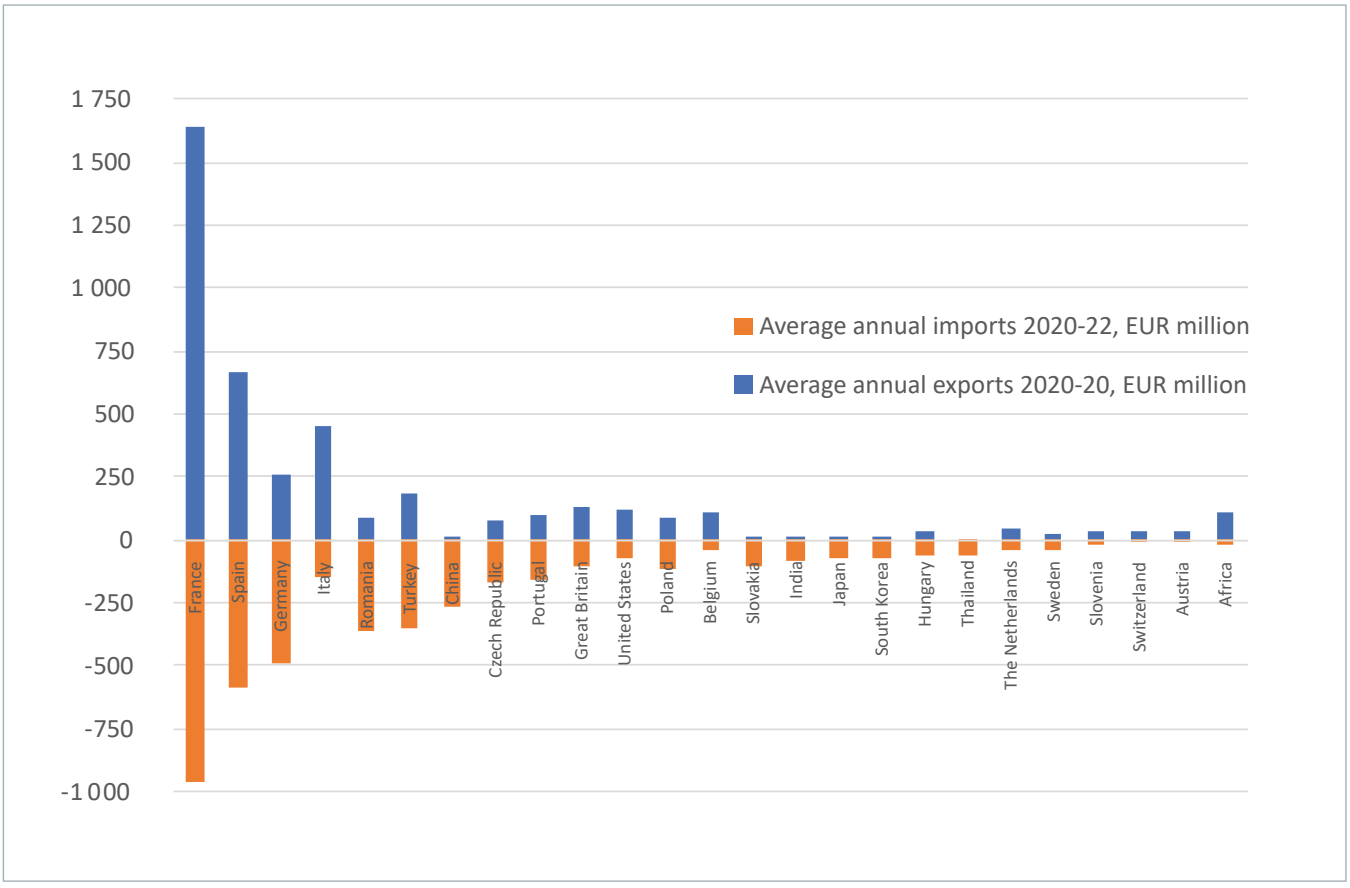
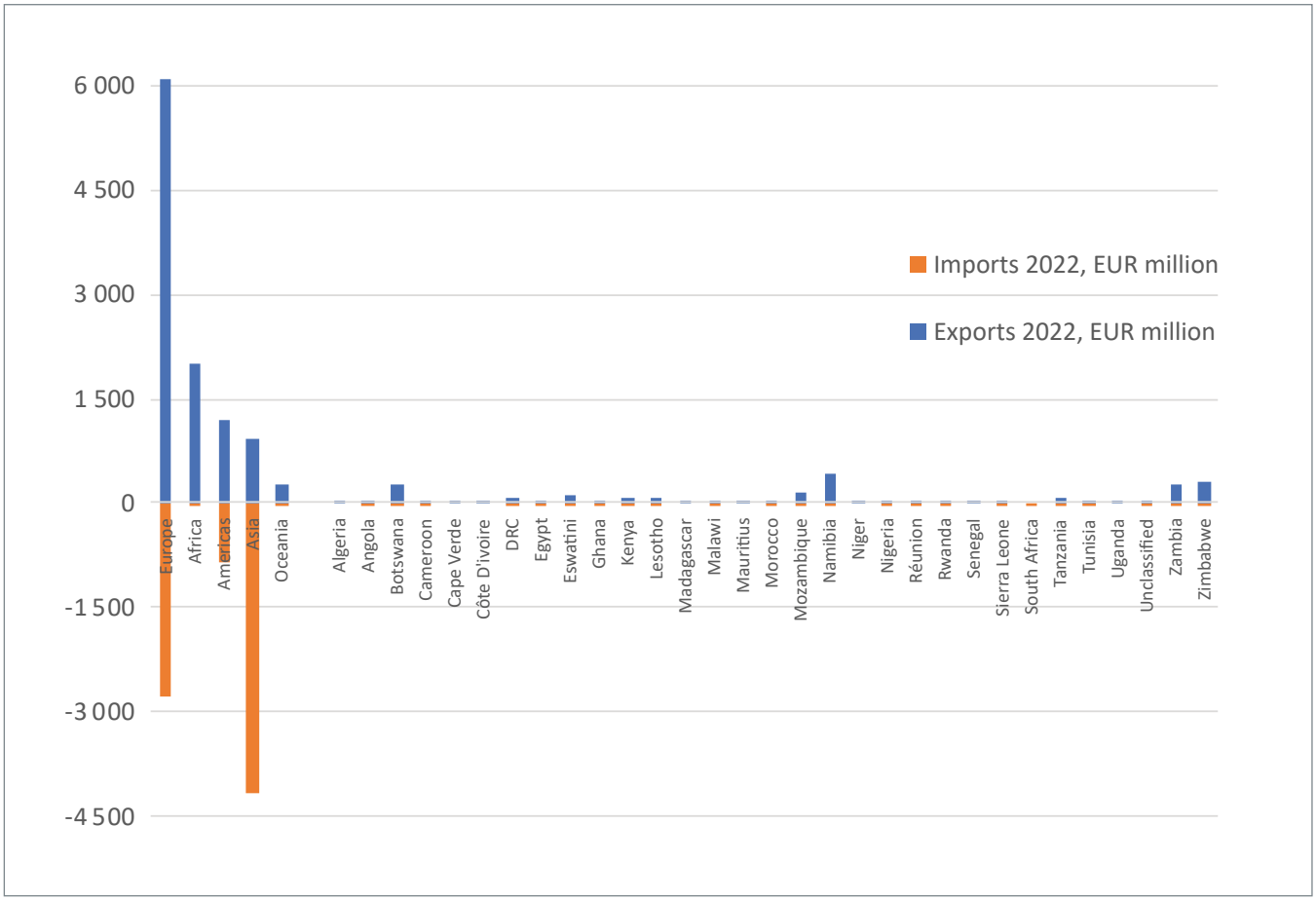


Figure 16: South Africa – automotive (HS 87) exports and imports 2022. Data from (SARS, 2023)



Local competences from the automotive industry can support other industries of similar complexity, like the manufacturing of renewable energy components. The fact that automotive in Africa is dominated by markets in Europe and has historically been built on technology from Europe may provide a blueprint for improvement of relations in manufacturing of renewables.

3.3.2 Green Hydrogen EU-Africa synergies

The European Union (EU) has been a major supporter of energy projects in Africa, providing €13.8 billion from 2014 to 2020. The Africa-EU Energy Partnership guides this cooperation, aligning with both the African Union's Agenda 2063 and the EU's climate and energy goals, REPowerEU and the Global Gateway Initiative. The overarching objective of the 'EU external energy engagement in a changing world' strategy (European Commission, 2022a) is to prepare the EU for renewable hydrogen trade, facilitating imports of ten million tons (Mt) of hydrogen annually by 2030. This strategy recognises the European Union's dependence on imports to fulfil its upcoming renewable energy needs and identifies African nations (Egypt, Morocco, South Africa, Namibia) as potential collaborators for importing renewable hydrogen and its derivatives in long-term, mutually beneficial relationships, bolstering climate ambitions, the energy transition, and Sustainable Development Goals (SDG).

African nations are actively pursuing the establishment of a hydrogen economy with a focus on exports. Algeria, Egypt, Morocco, Namibia, Tunisia, and South Africa, among others, have already unveiled national strategies (UN Office of the Special Advisor on Africa, 2023), and various export-oriented renewable hydrogen projects in Angola, Mauretania and Kenya have been announced throughout the continent (Reuters, 2022; Reuters, 2023; EIB, 2023). However, prioritizing the buildup of renewable energy for hydrogen exports only by emerging exporters may pose a potential threat to their domestic energy transition and contribute to an increase in fossil fuel consumption in their electricity mix. If the rising demand for domestic electricity is met through new or expanded fossil-based generation capacity, it is likely that these installations will remain operational for their entire design life, potentially exceeding

30 years which could lead to a fossil-based technology lock-in, stranded assets, and may also impose higher debt burdens on developing countries supporting investments through co-financing from sovereign wealth funds. IRENA suggests that hydrogen trade should be based on bilateral agreements to mitigate such risks (IRENA, 2022). Rapid investments in partner countries may result in the establishment of production capacity that does not meet the 'green' criteria under EU law (Delegated Regulation 2023/1184).

Solar and wind power generation is complementary to green hydrogen. While there is some caution on manufacturing solar modules locally (UNCTAD, 2023), there may be opportunities emerging for production sites of renewable energy components adjacent to hydrogen production sites (Namibia Ministry of Mines and Energy, 2023). EU-supported strategic investments should create win-win partnerships (European Commission, 2023a). Under the Global Gateway Initiative and the Critical Raw Materials (CRM) Act (European Commission, 2023c), access to critical raw materials through diversification of supply chains opens opportunities for co-operation with African manufacturers, on top of large solar and wind power niche markets, including rural electrification (business cases Sustain Solar, Ener-G-Africa), telecommunications (business case Tesco), and C&I applications, which can serve as steppingstones into the vast African market of more than 1.4 billion people in 54 countries.

3.3.3 Batteries and EU-Africa Synergies

Table 5 assesses prospects for mutual value-creating EU-Africa partnerships across the battery value chain in the short-term (5 years). Key value streams for Africa include foreign direct investment (FDI), technology transfer, and off-take for business case viability. For the EU, key value streams include diversification of critical minerals supply chains and opportunities for vertical integration.

Table 5: Exploration of EU-Africa partnership opportunities

Value Chain	Knowledge, innovation, and technology transfer potential	EU Off-take
Mining & Processing	The EU has exploration expertise that would benefit Africa. Already, the AfricaMaVal initiative is gaining traction (AfricaMaVal, 2022). Africa generally has adequate mining and mineral processing skills. The EU could also consider collaborating with Australian / Canadian players already active in Africa to invest in critical minerals.	Battery mineral concentrates as feedstock to numerous refining plants planned, under construction, or already in operation across Europe. A large and stable EU export market improves the scale and bankability of African projects.
Refining	Combining the EU expertise and the large-scale production of battery mineral concentrates, there is an opportunity for partnership. Some mining entities, e.g., Ecograf (graphite) already prioritise ESG metrics.	Currently, only small plants are in operation in Europe for battery-grade metal salt production. Large-scale merchant refineries (under construction or announced) will be a key export market.
Precursor Manufacturing	While EU expertise in this area could be adequate (e.g., BASF and Umicore), refineries of the feed-stock for the precursor cathode active material (pCAM) plant must be built first.	There are only small plants currently in operation in Europe for both cathode and anode active material production. Large-scale plants are either under construction or simply announced.
Cell Manufacturing	European competence is rapidly growing with some dedicated facilities for knowledge, innovation, and technology transfer being established, e.g., Fraunhofer FFB (Germany) and UKBIC (UK). Considering the EU's main focus on NMC chemistry, several ecosystem elements are yet to be developed before cell manufacturing becomes a realistic proposition in Africa.	Not foreseeable for NMC in the short-term. What is more likely is that as the segments both upstream and downstream of cell manufacturing develop, the African market will emerge to justify local cell manufacturing. Meanwhile, investing in lab scale or pilot cell lines could support building of local skills in advance.

Module/Pack Assembly + System Integration / Deployment	We foresee an optimal opportunity that combines EU expertise with Africa's readiness to build regional pack assembly hubs. Furthermore, the EU can bring digital innovation to system integration.	EU offtake negligible, if any. However, this is essential ecosystem building to support regional African markets (e-mobility + ESS).
Second-Life	EU expertise in LIBs pack "design for recycling" could catalyse Africa's emerging sector. Many European companies, e.g., BOS AG and EcarACCU. Development of policies and standards.	EU offtake unlikely, but essential ecosystem building, not only for the African ESS market, but also for the circular economy connected to recycling.
Recycling	The EU possesses growing expertise in LIBs recycling and circular economy. The first phase (up to 2030) would focus on building regional facilities for black mass production (the spokes). Black mass would be shipped to the EU for final metallurgical processing to recover battery metals (the hubs), creating an EU-Africa hub-spoke LIB recycling ecosystem for a circular economy.	Umicore, Eramet, InoBat Auto, Avesta Battery and Engineering, Altillium Metals, Librec, BASF, Accurec Recovery, Northvolt Ett, etc. Recovered battery metals enter Europe's battery value chains, a process that could facilitate both compliance with the new Batteries Regulation (Regulation (EU) 2023/1542) and EU critical minerals security.

3.4 Overview of hot spots and measures/investments needed

'Hot spots' as used here refer to geographically localised value chains that could represent viable, near-term investment opportunities for European partners. Investments might be valuable in terms of diversification, the support of strategic sectors as well as securing access to critical raw materials. In the manufacturing value chains of renewable energy components, limited access to raw materials causes high supply chain risks – these risks are cross-cutting, and apply to all technologies explored here to varying extents (Carrara, et al., 2023).

Potential hot spots presented here includes telecommunication service electricity as a niche, and two larger technologies: Green Hydrogen and batteries are two technologies where the forecasted demand is highest, yet least predictable, given the low starting points, the options in the technology roadmaps and possible changes in demand (European Commission, 2023b). Regions blessed with natural resources such as sunlight or wind, and critical raw materials (Figure 1) can be identified.

3.4.1 Telecommunication Service Electricity

Powering telecom towers with small scale wind solar and battery solutions
Manufacturing small wind solar and storage systems for telecommunication towers
Generic case TESCO company, high potential in Nigeria

Products
- Small scale wind turbines
- Solar panels
- Battery packs
- Small transformers and Power Management Systems.

Possible processes
- Wind turbine manufacturing or assembly
- Solar panel manufacturing or assembly
- Battery manufacturing or assembly
- Transformers

Business Model
- Business-to-Business (B2B) power as a service model
- Unique Selling Points (USP)
- Electricity for Towercos or MNOs in bad / off grid locations
- Locally manufactured products to optimise the supply chain and maintenance
- Products tailored to needs & constraints of telecom industry

Manufacturing Ecosystem: Drivers and Challenges
- Drivers – local manufacturing markets for TESCOs will be driven by an increasing number of MNOs or tower companies adopting low carbon commitment in their corporate strategy.
- Hybrid solar, wind, and batteries system enable optimal supply and storage size given the available area around the tower.
- Challenges – Without local content policies, imported small scale turbines, panels, and batteries can limit the local manufacturing potential to assembly.

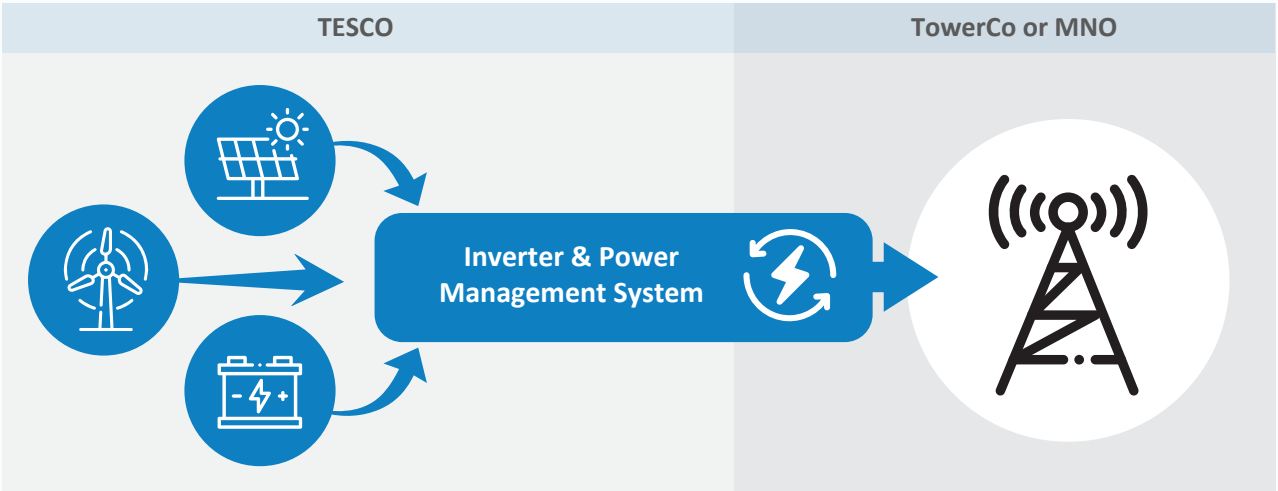
Opportunities
- Replacing diesel generators in the telecom industry
- Nigeria is anticipated to be the second largest market for TESCOs in the world by 2030. Ethiopia, Angola and Mozambique are also among the most promising markets.

TESCOs are Energy Service Companies supplying power as a service to mobile network operators (MNOs) or telecom tower companies (Towercos).

Reliable electricity supply to telecom towers is a known issue for the African telecom industry and diesel generators are a commonly used but polluting option to supply power in bad grid or off-grid locations.

The market is rapidly shifting to more demand for small-scale renewable based systems, pushed by ambitious low carbon corporate commitment made by international MNOs and Towercos. If accompanied by the proper measures, this can create new opportunities for local manufacturing of small-scale solar, wind and storage systems, as well as transformers or customised power management systems to supply the African market.

The African TESCO market is expected to increase rapidly with potentially 369 thousand sites in SSA by 2030. As implemented for large scale plants, manufacturing in Africa can be incentivised by adopting fiscal measures or regulatory measures based on progressively increased local content targets



Designed using images from Flaticoom.

3.4.2 International Electrolyser – Green Hydrogen technology manufacturing ecosystems

Electrolyser manufacturing for Green Ammonia production in North Africa
Diverse international electrolyser OEM

Products
- Alkaline and PEM Electrolyser stacks 1 MW to 5 MW; systems (+BOP) up to 20 MW, larger capacities are possible
- To be sold to end customers initially (demonstration projects) and to utilities, EPCs, promoters of large-scale GH2 projects

Processes
- Factories with 0.5-1 GW/year modules manufacturing capacity
- Electrolyser stacks and system manufacturing capacity reinforcement with new factories up to 1 GW by 2026
- 300-400 employees per plant
- ~40% engineers, highly skilled technicians

Business Model
- Business-to-consumer (B2C) and Business to Business (B2B)
- Vertical and lateral integration

Unique Selling Points (USP)
- Proven technology
- Cost (logistics, maintenance, & workforce training) advantages
- Complementary equipment manufacturing & supply capacity

Ambitions
- Increase manufacturing capacity to cover increasing demand
- Electrolyser costs reduction and performance improvement

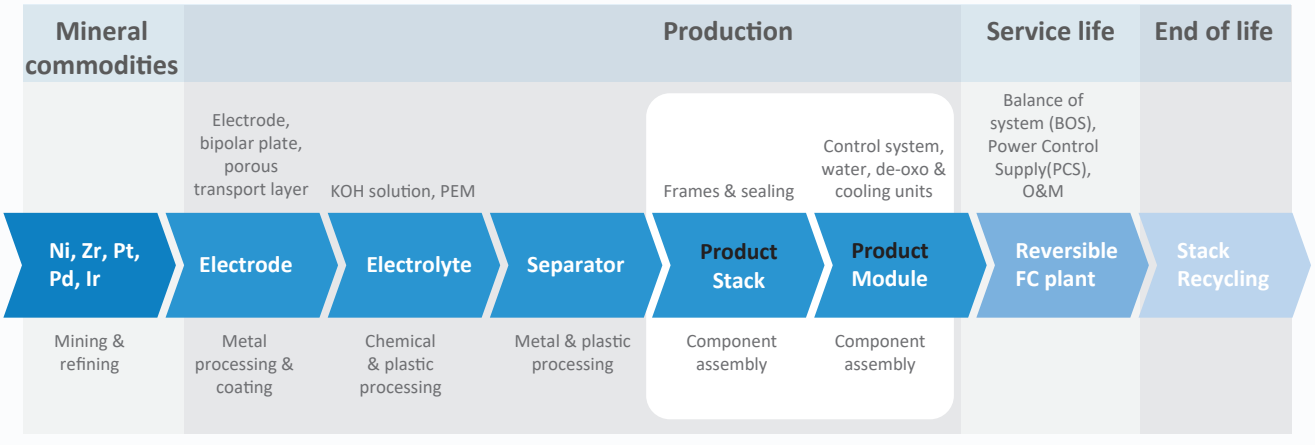
Manufacturing Ecosystem: Drivers and Challenges
- Strong Governmental support and ambitious national targets for GH2, including manufacturing plants deployment
- Strong increased demand for electrolysers and global limited electrolyser manufacturing capacity
- Specific skills (e.g. welding) training required
- GH2 costs reduction required (availability of low-cost financing is crucial for the successful development of GH2)

Opportunities
- Large number of GH2 applications (markets) including exports
- First Mover Advantage
- Synergies with other GH2 technologies (Fuel Cells)

The principal business case primarily focuses on large-scale projects to produce Green Hydrogen (GH2) by using renewable sources such as wind and solar energy. The main use of this GH2 is to generate green ammonia, which can be utilised in the domestic fertiliser market and potentially exported to Europe, particularly North African countries like Morocco, Tunisia, Egypt, and Algeria.

Electrolyser manufacturers see the need for setting up local manufacturing plants to meet national and regional demand, driven by logistical, maintenance, and workforce training considerations.

Key requirements for establishing local manufacturing include a sustainable project pipeline, a status as a priority Original Equipment Manufacturer (OEM) in the project portfolio, strong government support through subsidies and reduced taxes, and access to essential infrastructure, logistics and skilled labour to ensure a secure supply chain and successful manufacturing.



The growth of electrolyser and fuel cell markets is closely linked to the green hydrogen sector. Electrolysers are crucial for H2 production, while fuel cells efficiently utilise H2. Understanding the green hydrogen ecosystem is vital for strategies in manufacturing these technologies, with synergies between them offering product flexibility.

The existing domestic hydrogen market, mainly grey H2 from fossils, serves industries like ammonia production, methanol synthesis, steel manufacturing, and oil refining, especially in North Africa. The African market, currently at 3 Mtons H2/year, is expected to grow to 4 Mtons by 2030. The strategy for green hydrogen (GH2) is to replace grey H2 in these existing hard-to-abate sector, aiding in meeting demand and decarbonizing industries. Plans also include exporting GH2 or green ammonia to Europe.

However, challenges include the high cost of GH2, currently 5 to 10 €/kg. To be competitive, it needs to drop below 2 €/kg, requiring low electricity costs and a 40% reduction in electrolyser CAPEX, possibly through automated manufacturing. Overcoming this price gap is essential to stimulate local GH2 demand and transition to a sustainable hydrogen economy. In Europe, the US, and Asia, various tools and programs are addressing this challenge.
Focusing on electrolyser and FCs manufacturing, Original Equipment Manufacturers see the need for setting up local manufacturing plants for electrolysers to meet national and regional demand, driven by logistical, maintenance, and workforce training considerations. According to interviewees, key requirements for establishing local manufacturing include a sustainable project pipeline, a status as a priority OEM in the project portfolio, strong government support through binding policies, subsidies and reduced taxes or others, and access to essential infrastructure, logistics and skilled labour to ensure a secure supply chain and successful manufacturing.

3.4.3 Green Hydrogen Hot Spots and Measures

Several countries with favourable renewable energy conditions aim to export renewable hydrogen to the EU, particularly in the African context. However, achieving low production costs does not guarantee low EU import costs. The IEA projects additional costs for transporting renewable hydrogen by ship: USD 2 per kgH2 for ammonia and USD 2.5 per kgH2 for liquid hydrogen, with incremental increases based on distance (IEA, 2023d) and the Hydrogen Council suggests that pipeline transportation is more cost-effective than shipping (McKinsey, 2022).

This is in line with the European Hydrogen Backbone (EHB) initiative (EHB, 2023) that aims to establish a clean hydrogen infrastructure network with a projected backbone of ~53,000 km by 2040. This requires an estimated investment of €80-143 billion, connecting Europe and North Africa through corridors A (Italy-Tunisia) and B (Spain-Morocco), granting competitive advantages to these countries as potential exporters of green hydrogen (GH2) from North Africa.

Reinforcing this, a recent EIB study (EIB, 2022) identifies a GH2 USD 1.5 trillion potential in three hot spots in Africa: Mauritania and Morocco in North-Western Africa, Southern Africa, and Egypt. Mauritania and Morocco could produce up to 12.5 million tons, exporting 7.5 million tons through a pipeline to Spain. Egypt could generate 20 million tons, exporting 12.5 million tons via a pipeline to Greece and Italy and through shipping to Japan and India. The Southern Africa hub could produce 17.5 million tons, allocating 2 million tons for export as ammonia and liquefied hydrogen.

3.4.4 Battery Hot Spots and Measures

While there is growing interest in exploration for battery minerals, more immediate upstream opportunities relate to capital requirements to enable junior miners to either bring advanced projects into production or build refining capacity to produce battery-grade metals. There are several prospects across the key battery minerals, e.g., lithium (DRC, Mali, Namibia, Ghana, Nigeria, Zimbabwe), manganese (South Africa, Gabon), nickel (Madagascar, Tanzania), graphite (Madagascar, Mozambique, Tanzania), and copper (DRC, Zambia).

In the midstream, the DRC-Zambia partnership aims to build a 100,000 t/yr NMC precursor plant targeting the EU

market. Although a BloombergNEF study found this to be a globally cost-competitive opportunity (BloombergNEF, 2021), a key challenge will be securing sufficient nickel and manganese feedstock for the proposed plant. Manganese is currently mined by the artisanal and small-scale mining (ASM) sector, infamous for its poor ESG credentials. These supply chain challenges demand that the DRC-Zambia Partnership address two central issues. First, a clear strategy for developing regional battery value chains is imperative to secure the supply chains for the precursor plant. Instead of (or in addition to) pursuing bilateral agreements, the EU could facilitate multilateral architectures carefully designed to bring together all the required regional value chains. Second, both the DRC and Zambian governments should consider integrating the ASM sector into the mainstream economy through licensing and regulating their operations to ensure they meet the ESG threshold for EU markets. This could help secure a local manganese supply.

In cell manufacturing, South Africa and Morocco are the frontrunners. About $10 B investment has been announced by Chinese players to build virtually an entire cell manufacturing ecosystem in Morocco (Reuters, 2023; Simpara, 2023; Rahhou, 2023; Lee, 2023; Yang, 2023).

Currently, the battery pack assembly landscape varies considerably across Africa. The focus in South Africa is predominantly stationary applications (ESS) whereas for both East and West Africa, the primary driver is two- and three-wheeler e-mobility. The e-mobility sector is fragmented with several small players. Typically, assemblers import their batteries (cells, modules, or packs) from China, although product design seems to always be in-house. A key question that emerges, particularly in e-mobility, is whether to import cells for local pack assembly or packs for direct system integration. Both business models exist. It is evident that local assembly will eventually emerge both in East and West Africa. An emerging USP in pack assembly is designing the packs for repairability and recyclability. There are already some European players delivering these product features, creating a concrete opportunity for technology transfer. The key drivers to be competitive are economies of scale and product quality. By aggregating regional demand for battery packs into a single assembly plant, sufficient economies of scale could be achieved (we estimate around 2 GWh/yr each from our interviews) to make local pack manufacturing competitive.

Finally, in the downstream segment of end-of-life (EoL) LIBs recycling, no recycling facilities currently exist in Africa despite rising volumes of EoL LIBs. From our interviews, we estimate that the continent needs at least four recycling hubs serving West Africa (e.g., in Nigeria), East Africa (e.g., in Kenya), and North Africa (e.g., in Morocco), and Southern Africa (e.g., in South Africa). The regional hub model is essential to ensure sufficient feedstock to support black mass production facilities of 5,000 – 10,000 t/yr capacity. A preliminary and conservative financial analysis of a 5,000 t/yr NMC 622 black mass plant (producing 2,500 t/yr product) yields: $35 M CAPEX, $10 M OPEX, and $15 M revenue from the sale of black mass ($6,000/t). These are our own preliminary estimates taking into account our interviews and similar studies (Latini, et al., 2022; Pagliaro & Meneguzzo, 2019; Lander, et al., 2021; Alfred H Knight, 2023; Curran, 2021; Benchmark Mineral Intelligence, 2023; Neometals Ltd, 2023).

3.4.5 European legislation affecting manufacturing in Africa

The European Union finances flagship infrastructure projects in Africa in its Global Gateway Initiative (European Commission, 2023d), investing into infrastructure, supply security and value chains. For Africa, EUR 150 bn have been earmarked for projects like the Lobito Corridor across southern Africa making accessible critical raw materials (European Union, 2023e), and the power interconnection Italy-Tunisia (EBRD, 2024), opening the door to electricity market integration.

The EU supports African industries in often levying little or no taxes on imports, as is the case in the automotive industry (see section 3.3.1). Preferential treatment can have a positive impact on manufacturing industries in Africa. In recent years globalization and the international division of labour have come under pressure from policies designed to dilute the concentration in value chains, such as PV manufacturing in China. Attempts are under way to reshore manufacturing, in Europe through the Net-Zero Industry Act (NZIA) and in the US from the Inflation Reduction Act among others. The EU's NZIA aims to have an aggregate of 40% of annual deployment needs of renewable energy technologies defined as "strategic" manufactured in the EU by 2030 (European Commission, 2023f), (European Commission, 2023g). The eight strategic net-zero technologies are solar, wind, batteries and

storage, heat pumps, electrolysers and fuel cells, biogas, carbon capture and storage, as well as grid technologies.

The NZIA is accompanied by the Critical Raw Materials Act (European Commission, 2023a), intended to secure access to the raw materials required for the development of the industry and products envisioned. Since 60% of the value of renewable energy components can be manufactured outside the EU, opportunities for partnerships exist, and need to be encouraged.

The EU's Carbon Border Adjustment Mechanism (CBAM) (European Parliament, 2023h) is designed to protect the competitiveness of European companies, by adding a levy onto imported carbon-intensive products. While renewable energy components are not covered by the CBAM, chances are that they will be included in the future (Davies, 2023) to prevent manufacturers from leaving the EU for locations promising lower cost, yet higher carbon emissions (carbon leakage). Using foresight, it is necessary to manufacture products intended for export into the EU using a low-carbon energy mix. Again, this can create manufacturing and export opportunities in Africa where natural resources (such as high solar irradiance, or high-quality CRM) favour local production causing low emissions. It can also be an opportunity for European companies or joint ventures to take advantage of favourable resources and the potential advantages created by CBAM and CRMA, in effect adding Non-Price Criteria (NPC) to localization decisions of companies.

Environmental, Social and Governance (ESG) goals are fundamental. The Solar Stewardship Initiative and the Initiative for Responsible Mining Assurance are industry efforts to this regard, alongside the EU's Supply Chain Act (the EU Corporate Sustainability Due Diligence Directive (CSDDD)) designed to stop child labor and forced labor in supply chains of large corporations (European Commission, 2022b).

04

Recommendations to the Global Gateway Initiative

04/ Recommendations to the Global Gateway Initiative

This chapter delivers recommendations based on the analyses presented in the previous chapters. In the first subsection we provide high-level recommendations concerning European-African cooperation to the Global Gateway Initiative; the second subsection offers recommendations that are less amenable to cooperation efforts but can be implemented by national governments in Africa; the third subsection lists technology-specific recommendations for each of the analysed technologies of PV, wind, green hydrogen, batteries, and grid technologies. The final subsection groups recommendations for business-related support activities by business case categories.

4.1 High-level Recommendations to the Global Gateway Initiative

The aspirations of countries in Africa to produce a growing share of goods at home, create local jobs, and stimulate economic growth, are not being met and supported. At the same time, there are profound synergies for the EU in an emerging, innovative, economically strong and more resilient Africa. This points to an opportunity for the EU, and for the Global Gateway initiative in particular.

Transformative partnerships are needed to diversify and increase the resilience of renewable energy supply chains. Economic and industrial partnerships have to be forged on equal terms, and have to be built recognizing that countries throughout Africa have many potential investment partners. The EU's approach therefore needs to be strategic, and focused on win-win opportunities. It is vital to ensure that agreements and partnerships are fair: one-sided agreements are not sustainable.

The EU already invests in major projects of common interest within the EU Member States, the Western Balkans, and other countries. Extending this to Africa will **require new financing modalities**, including a more pro-active role of key investment vehicles like the EIB, the KfW, and the EBRD.

The EU needs to expand the role its export credit agencies (ECAs) in particular in order to strengthen the presence of EU companies operating overseas. Existing vehicles like the KfW IPEX's (KfW IPEX-Bank, 2024) and the DEG's ImpactConnect (DEG Invest, 2024) focus on Africa, but their capacity need to be significantly expanded.

Receivables earned in local currencies create currency convertibility risks, as the recent depreciation of the Naira in Nigeria vividly underscores. **Currency risk mitigation instruments** are therefore central to the success of foreign financed manufacturing ventures across the continent. They can be mitigated by diversifying the buyer pool, and signing off-take agreements with buyers in Euros.

Increasing the availability of "venture debt" could also serve as a key catalyst. Early stage and high-growth companies, including in the manufacturing sector, often prefer to remain private longer, seeking to minimise founder dilution during the company's early growth years.

It remains vital to learn from history, and learn for instance from China's success in solar, EVs, and battery production. It has been made possible by combining a strategic vision, making low-cost, longer-tenor capital available, and by simultaneously **fostering stronger local market demand**. A pragmatic approach to fostering manufacturing partnerships with the EU would:

- ***Focus on mid-sized manufacturing companies*** *rather than solely small start-ups, or mega-projects (long lead times, uncertain long-term viability).*

- ***Avoid a strategy based solely on large flagship projects**, as the risks of failure are often higher. Time-to-market delays pose a higher risk to the success of large projects in particular.*
- ***Prioritise places with basic manufacturing ecosystems already in place.** It takes seeds to grow clusters.*
- ***Provide patient capital**, i.e., capital for long-term investments.*
- ***Prioritise companies operating in Special Economic Zones**, as these often benefit from a host of advantages when exporting, whether to the EU or elsewhere.*
- ***Provide open access to targeted training**, including for C-level executives running companies in Africa. Technical professions in manufacturing also require vocational training.*
- ***Look at cross-technological synergies.** If plan A is to sell cables and wiring to the distributed solar PV sector, Plan B could be to sell cables and wiring to the wind power sector, the mini-grid market, to local electricians, or the smart home market.*
- ***Build strong local representation in the countries themselves.** A clear and continuous presence is needed to build trust, deepen networks, and foster synergies.*
- ***Support policy, legal, and institutional strengthening.** Assisting partner countries in developing and implementing country-appropriate policies can help unlock investment.*
- ***Consider local history.** The countries selected for partnerships under the Global Gateway Initiative each have their own unique history, domestic politics, strengths, and fragilities: better understanding the local market can help avoid costly mistakes.*
- ***Hope for 1 in 3; plan for 1 in 30**: nurturing manufacturing success is challenging. Recognise that not all companies that receive backing will survive.*

The Global Gateway initiative should support by funding **Africa-focused investment forums**, which provide a valuable opportunity for business-to-business exchanges, for the cross-pollination of ideas and technologies, as well as for forging of both large-scale and smaller-scale industrial partnerships.

A further area where strategic partnerships and support can be valuable is in supplying **public warehousing**. Publicly-funded warehousing can help fill a current unmet need of many manufacturers in Africa, namely, the need for safe and reliable storage space. Whether located near existing ports, or manufacturing companies or clusters, public warehousing can strengthen the integrity of the supply chain, and reduce a range of investment risks.

Design sustainable, inclusive projects. Render baseless any possibility of forced labour, child labour, and sexual abuse. Neo-colonialist arguments are hard to defeat after the fact. **Select products with a stable, determined market demand.**

4.2 Recommendations for Governments in Africa

As highlighted previously (see 2.4) there are five levers that countries can use to bolster their attractiveness:

- **Stimulate local demand:** "No market, no manufacturing." The presence of strong demand can help de-risk manufacturing business cases and is essential for competitiveness.
- **Improve the reliability of power supply:** businesses need reliable power to operate.

- Invest in key supporting infrastructure such as roads, bridges, and ports; public warehousing infrastructure. Proximity to ports plays a key role.
- **Invest in local workforce and skills development:** while skills take time to build, they are foundational to future prosperity and economic development: both for workers and for C-level executives.
- Provide a clear signal of a national manufacturing strategy. This can include a high-level strategy including **reforms to tax, legal, and regulatory frameworks** to attract manufacturing investment: e.g. single point of contact for manufacturers, supportive legal framework for attracting foreign direct investment.

Indeed, countries that succeed in attracting manufacturing investment (China, Vietnam, India, Bangladesh, the USA, etc.) have harnessed their local advantages, and supported manufacturing with tax, policy and regulatory changes to create a favorable environment for manufacturers. This is what individual countries across Africa need to do today.

Technology choice
However, it is likely to prove difficult for countries in Africa to compete in terms of fiscal resources with the US, China and the EU. African countries (which are economically much smaller) will need to compete differently. This means that while countries will need to learn from the manufacturing powerhouses, what worked in China and in the West may not work in Africa. In the near term, competing differently could mean focusing more on assembly and on beneficiation, and on designing products that are fit for the local conditions in the country or region they are about to be employed (robust, affordable, where demand is nearby and strong) rather than for global markets.

Infrastructure governance
Dysfunctional ports have direct and debilitating impacts on manufacturing businesses. More focus should be placed on improving governance, transparency, and efficiency of ports, as such investments pay dividends for all who rely on the ports, either directly or indirectly. Improving the functioning of ports can have major positive knock-on effects on manufacturing ecosystems.

Supporting financial rules
Attracting foreign investment is often a priority; and naturally, once investments have arrived, governments often want them (and the money and profits that come with them) to stay. But in order for capital to stay, it has to come in the first place. And in terms of attracting initial investments, **the rules governing how capital can be safely retrieved (repatriated) play a role.** Simply put, if it is too difficult or costly to exit a market, many investors and funds will choose not to enter in the first place.

4.3 Technology-specific Recommendations

Solar Photovoltaics
Manufacturing photovoltaic components is a vulnerable business: global prices have decreased 15% year-on-year, while installed volumes have increased 35% every year since 2000 (Leutz, Couture, & Ackermann, 2023). Profit margins are positive increasingly only for companies vertically fully integrated (IEA, 2022). Currency risks can be destructive for assembly firms, last in the value chain, and first choice of entrepreneurs and politicians for their favourable work to Capex ratio, and 100 MW entry size. Assemblers depend on buying precursors which can be highly capital intensive and long-runners in procurement, and need reliable sources of finance and forward contractual support. Yet, there are options for solar power component makers:

- Design and produce durable products demanded by Africa's lower-income households, and the continent's rapidly growing informal markets.
- Prepare to make replacement parts locally. Ensure their availability.
- Plan for recycling of electrical parts, including solar. The market for recycling will grow.
- Design and optimise products to tap into emerging growth markets such as agrivoltaics.
- Next-level technologies may offer first-mover advantages. Evaluate all options.

- Check out 'unsexy' products: even though less appealing at first glance, clamps and fasteners, plugs and cables can be a sales hit.
- Invest in people and teams.

Wind Power

Wind industry in Africa is key to respond to Africa's growing electric demand and meet its electricity access challenge in the short and long-term. Local wind manufacturing in Africa faces an extremely narrow path to economic viability due to global overcapacities (mainly in China), a sluggish global market, small and inconsistent demand from countries in Africa, combined with ongoing reshoring initiatives in Europe and the US that are driving industrial reconfiguration.

- The most viable opportunities reside in the balance of plant and wind tower manufacturing segments. For these segments, supporting a strong domestic market with long term visibility (through programmes instead of individual projects) is identified as first priority.
- A second priority is to create the conditions for backward linkages with the local concrete or steel industry in order to adapt their products to meet the specifications of the wind industry. Manufacturing prospect for rotor hub (including blades), as well as nacelle components are weak beyond assembly of imported components in the medium term.
- The maintenance and repair market for existing wind farms may be an opportunity to train a skilled workforce, manufacture spare parts, and progressively manufacture more technically complex components.

Critical to the success of any efforts to boost wind power-related manufacturing in Africa is the creation of large and growing wind power markets, either to serve local power systems, to supply green hydrogen production, or for renewable energy exports to Europe.

Green hydrogen recommendations

The green hydrogen market faces a significant challenge due to the gap between production costs and the willingness of customers to pay, worsened by high interest rates, energy prices, and supply chain issues. Both reducing costs and finding areas where customers will pay more are necessary.

Despite a 43% increase in subsidies for hydrogen since 2022 (Martin, 2023), with USD 170bn for production and USD 16.7bn for demand, there's still a focus on production over demand. Many off-takers are hesitant to sign long-term contracts due to the immature market and unclear policies, unless prices are competitive. Less than 5% of global P2X projects are moving beyond the announcement stage due to this uncertainty that reduces their bankability. Government interventions like carbon pricing and subsidies are essential to close the cost-willingness gap.

In the manufacturing sector, hydrogen OEMs need support to navigate the ramp-up curve safely. The Global Gateway initiative can assist by:

- Encouraging OEM engagement in new business models, like risk/revenue-sharing with EPC, operators, and off-takers; identifying key GH2 application sectors, assessing export potential, and establishing country-based bilateral partnerships with binding GH2 targets.
- Facilitating ecosystem building by establishing strong regional component supply chains and promoting partnerships with regional stakeholders such as EPC and project developers, offering OEM+EPC tandems to move beyond a stack-only perspective.
- Advancing the development of codes and standards for technology modularity, offering standardised stack solutions to enhance transparency and trust among EPCs/operators, and aiding their commercialization and application both regionally and internationally.
- Supporting education and training initiatives to build a skilled workforce aligned with green technologies. These initiatives are vital for creating specialised jobs and fostering new technology-based enterprises in the green

hydrogen sector.

Battery technologies

Our assessment across the battery value chain reveals NMC cell manufacturing as the least attractive market segment for EU-Africa partnership in the short term. However, distinct opportunities were identified both upstream and downstream of this segment. The investment cost profile ranges in the low hundreds of millions of Euros for the upstream versus about a tenth for the downstream segments.

- In the upstream segments, AfricaMaVal will deliver on exploration (AfricaMaVal, 2022). Focus should now shift to supporting advanced projects (i.e., close to production) from junior miners of key battery minerals through capital injections and off-take of the mineral concentrates. For mines already producing mineral concentrates, the focus should be on value addition through building refining capacity. However, economies of scale become a critical success factor. The EU could provide impetus to this by moving beyond bilateral agreements to multilateral arrangements, ideally at the level of the Regional Economic Communities (RECs).
- Supporting the development of regional battery strategies and standards. This can be an opportunity to develop regional value chain frameworks to enable regional value addition.
- In the downstream segments, regional battery pack assembly hubs are a compelling opportunity, alongside the possibility of co-location with regional recycling facilities for the production of black mass. The latter can be viewed as spokes for the EU hubs that would perform the final metallurgical processing of the black mass to recover the battery minerals, thereby integrating the EU and African value chains into a circular economy. Just as important is the second-life segment, some aspects of which are already being addressed by the ENERGICA project (ENERGICA, 2022).
- ESG is a major impediment in integrating the African and EU value chains, with the former often failing to meet the expectations of the latter. The professionalisation of the ASM sector is fundamental to achieving ESG mandates.
- The current extreme fragmentation of battery initiatives across Africa could be partially overcome by supporting the establishment of an African Battery Association that would coordinate battery activities across the continent, providing a focal point for EU engagement.

Grid Technologies

The weakness of power system infrastructure in many African countries signifies a huge need for basic power system equipment like transmission line components, distribution lines and cables, transformers for substations, generators, and distribution, and all kinds of secondary equipment (insulators, circuit breakers, measurement transformers, data recording and control devices, etc.). The IEA (IEA, 2023c) assumes a need of USD 45 bn annually. Power electronic inverters are needed in huge quantities mainly for renewable-based generator systems (both solar PV and wind), battery electricity storage, and long-distance power transmission over HVDC. All charging infrastructure for electric vehicles needs inverters.

In order to support sustainable economic growth and allow businesses to thrive, stable, secure, accessible, cheap and reliable power supply infrastructure is essential. It is therefore critical that this huge need be turned into stable and consistent market demand for grid equipment. The vast majority of these technologies can be manufactured locally in many countries in Africa. Some selected opportunities to support development towards this goal are:

- Providing advice and financial support to power system owners/operators to expand, reinforce, renew, and maintain their power system infrastructure.
- Manufacturing facilities can be built up in collaboration with European companies supplying much of the machinery and automation equipment needed in the various manufacturing processes.

Testing and quality assurance facilities are likely needed to ensure that locally produced products can qualify for larger regional and international tenders on grid-related infrastructure projects.

4.4 Business case classification and support activities

RE manufacturing business cases can be roughly categorised into three classes according to the size and maturity of the companies:

- Agile start-ups and small enterprises
- Mature, competitive medium-sized corporations
- Large, high-tech multi-national industry

The selected business cases from this report, potential products, and locations for the manufacturing of renewable energy component are shown in Table 6 mapped to the above classes.
Based on the same classes, Table 7 summarises the technology-specific support activities (objectives, interventions/ means, instruments, partners) to be developed for manufacturing renewable energy components in Africa.

Table 6: Manufacturing renewable energy components in Africa: selected business cases, potential products and locations

	AGILE START-UPS AND SMALL ENTERPRISES	MATURE, COMPETITIVE MEDIUM-SIZED CORPORATIONS	LARGE, HIGH-TECH MULTI-NATIONAL INDUSTRY
Manufacturing focus	Assembly, niche products	Established product lines, lateral integration	Vertically integrated anchors for supply chains
Business case (examples from study)	Auxano Solar, Ener-G-Africa, Mitochondria, eBee, GoGo Electric, Roam Electric, Wahu!	Nordex/WBHO, Actom, electrolyser/FC manufacturers (eg. Proton Ventures, Acciona)	[hardly exists in renewable energy components (except Seraphim South Africa), existing sector on which to learn is automotive] Electrolyser manufacturers (e.g. John Cockerill, Cummins, Siemens)
Country of business case	Nigeria, South Africa, Kenya, Uganda, Ghana	South Africa, Morocco, Egypt	[Morocco, Egypt, South Africa]
Potential country list	DR Congo, Egypt, Ghana, Kenya, Mauritania, Morocco, Namibia, Nigeria, South Africa, Tunisia, Zambia		
Technology (solar, wind, battery energy storage systems (BESS), electrolysers, grid components)	Solar, BESS, electrolysers/ fuel cells (FC)	Wind, grid components, electrolysers/FC	Electrolysers/FC, mining industry
Products and processes	PV modules Battery pack assembly Assembly of light electric vehicles (LEV) Electrolyser/FC stacks & modules production	Wind towers Transformers/ cables Electrolysers/FC modules and plants	Extraction and refining of CRMs Co, Li, Cu Electrolysers/FC modules and plants

Competitive advantages based on USPs	Robust, locally warranted products Serving (also) informal markets, exceptional sales channels Owning fleet, management software, plus microfinance partners Collaboration with technology and supply partners in Europe Local supply chain well established (Vaal SEZ)	Proximity to sites Combining local strengths Knowledge of local product requirements, sales channels established Risk mitigation through diversification Offering services (commissioning, maintenance, monitoring)	Complementary equipment (for electrolysers) manufacturing and supply capacity
Relevance of mining sector and Critical Raw Materials (CRM)	Access to refined and processed raw materials is fundamental, as product may hinge on upstream precursor, company may bet on material-enabled technology Criticality of Co and Li in BESS, and Cu in grid components, perceived competitive advantages for mineral-endowed areas, e.g. South Africa for PEM electrolyser and FC manufacturing, leverage of the country's extensive platinum group metal (PGM) reserves and expertise Industry needs to be professionalised (labour issues in artisanal and small-scale mining (ASM)) Mineral beneficiation is part of the upstream value chains of renewable energy components, strengthening the mining sector will support the competitiveness of the downstream industry, and vice versa		
Needs (from business case interviews and desktop research) in view of successful manufacturing of renewable energy components	Technology know-how and skilled workforce Local supply chains, even for basic input materials like glass, and Al profiles Infrastructure for logistics (ports, electricity) Financing (Capex (patient capital, venture debt limiting dilution of ownership), bridge loans in production and project) Collectively called manufacturing ecosystems (in manufacturing ecosystems competitive production factors are found, shared and individual companies' objectives are met, in a sustainable way)		

Table 7: Technology-specific support activities to be developed for manufacturing renewable energy components in Africa

	AGILE START-UPS AND SMALL ENTERPRISES	MATURE, COMPETITIVE MEDIUM-SIZED CORPORATIONS	LARGE, HIGH-TECH MULTI-NATIONAL INDUSTRY
Market and demand	'No market, no manufacturing': follow and foster local demand, creating markets; distinguish demand from need Unsexy products may sell best, focus on competitiveness of the company		Explore local and global markets
	Create traction and increase sales of initial product: Conferences, fairs, product presentations, industry association membership (customer lists), certification	Solidify market standing: Supply chain management, customer loyalty, expansion into neighbouring countries, certification	Reduce barriers: Permissions, taxes, capital repatriation, market development incentives

Industrial policy	Grow clusters based on prioritizing places with basic manufacturing ecosystems already in place, avoiding the pitfalls of Special Economic Zones (SEZ) Learn from existing role model industries involving complexity and automation, and undergoing restructuring, like automotive (Electric Vehicles) Incentivise green products, offering a competitive advantage under Net Zero Industry Act (NZIA) and Carbon Border Adjustment Mechanism (CBAM) Sign win-win, eye-level partnerships for mutually beneficially agreements (example: clear production and offtake clauses)		
	Push incubation of start-ups, generate the fabric that entrepreneurship thrives in, such as university-industry partnerships	Promote technology transfer/joint venture (e.g. with business case Azur Space Solar) Industry restructuring (digitalization, product changes)	
Financing	Provide guarantee instruments Give access to patient capital and venture debt (>5 years) for Capex, bridging loans in production and project Assist with forward contracting Lower or insure currency risks Educate and create transparency		
	Plan for company survival as low as 1 in 30		
Skills	TVETs, Skill building and upskilling, on all levels up to C-level		
Associations	Multiplicators, e.g. fair organisers, trade organizations	EU-centred: modelled to EU SME Centre, EUSECA, Fraunhofer for tech transfer Africa-centred: regional/ local industry associations like AfSIA, SAPVIA, etc. Standards: ISO, IEC, TUV, UL, Patent offices	World Economic Forum (WEF), conferences, etc.
Facilitators, agencies	Change agents (GET.transform, GET.invest, cluster development agents), consultants Industry associations, unions, companies Export Credit Agencies (ECAs), European Investment Bank (EIB) and other Development Finance Institutions (DFI)		
	Entrepreneurs		

05 References

Abraham, C., Rix, A., Ndibatya, I., & Booysen, M. (2021). Ray of hope for sub-Saharan Africa's paratransit: Solar charging of urban electric minibus taxis in South Africa. Energy for Sustainable Development, 64, 118-127. doi:https://doi.org/10.1016/j.esd.2021.08.003

AfDB. (2016). Annual Development Effectiveness Review 2016. Retrieved December 20, 2023, from https://www.afdb.org/fileadmin/uploads/afdb/Documents/Development_Effectiveness_Review_2016/ADER__2016_EN.pdf

AfDB. (2017a). Industrialize Africa: Strategies, Policies, Institutions and Financing, African Development Bank. Retrieved from https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/industrialize_africa_report-strategies_policies_institutions_and_financing.pdf

AfDB. (2017b). Why does Africa's industrialization matter. Retrieved from https://www.afdb.org/en/news/01/28/2019-1407/why-does-africas-industrialization-matter-challenges-and-opportunities-724

AfricaMaVal. (2022). Building EU-Africa partnerships on sustainable raw materials value chain. Retrieved February 1, 2024, from https://africamaval.eu/

African Export-Import Bank. (2023, April 17). Afreximbank and UNECA sign agreement to establish special economic zones for the production of Battery Electric Vehicle. Retrieved from United Nations Website: https://www.un.org/africarenewal/magazine/april-2023/afreximbank-and-uneca-sign-agreement-establish-special-economic-zones-production

Agarwal, P., Black, A., Lemma, A., Mkhabela, V., & Stuart, J. (2022). The African continental Free Trade Area and the Automotive Value Chain. Report, ODI. Retrieved 12 04, 2023, from http://cdn-odi-production.s3-website-eu-west-1.amazonaws.com/media/documents/VVC_paper_final___.pdf

Alfred H Knight. (2023, December 7). Black Mass and the Battery Revolution: An Overview of Experimental Research Conducted by Alfred H Knight. Retrieved May 23, 2024, from https://www.ahkgroup.com/black-mass-and-batteries-an-overview-of-experimental-research-conducted-by-alfred-h-knight/

Amundsen, I. (2022). Coping with corruption: Small and medium enterprises in Ghana. Retrieved from https://www.u4.no/publications/coping-with-corruption-small-and-medium-enterprises-in-ghana.pdf

AVCA. (2023, April). Venture Capital in Africa Report 2022. Retrieved February 1, 2024, from https://www.avca.africa/media/m3db4yt0/02175-avca-vc-report-2023_4-final-1.pdf

Bank of Ghana. (2023). Interest Rates. Retrieved from https://www.bog.gov.gh/economic-data/interest-rates/

Bellini, E. (2018, October 9). Ecoprogetti supplies 250 MW production line for Moroccan bifacial module fab. Retrieved October 1, 2023, from PV Magazine: https://www.pv-magazine.com/2018/10/09/ecoprogetti-supplies-250-mw-production-line-for-moroccan-bifacial-module-fab

Benchmark Mineral Intelligence. (2023, September 11). The evolving black mass market. Retrieved May 23, 2024, from MMTA: https://mmta.co.uk/the-evolving-black-mass-market/

Bhambhani, A. (2024, 01 17). Meyer Burger May Shutter German Module Fab By April 2024 - German Cell Production To Feed US Modules; Blames Distorted European Market Conditions For 2023 Financials. Retrieved 01 17, 2024, from Taiyang News: https://taiyangnews.info/meyer-burger-may-shutter-german-module-fab-by-april-2024

BloombergNEF. (2021, November). The Cost of Producing Battery Precursors in the DRC. Retrieved February 18, 2024, from https://assets.bbhub.io/professional/sites/24/BNEF-The-Cost-of-Producing-Battery-Precursors-in-the-DRC_FINAL.pdf

Carrara, S., Bobba, S., Blagoeva, D., Alves Dias, P., Cavalli, A., Georgitzikis, K., . . . Pennington, D. (2023). Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study. doi:doi:10.2760/386650

Carreon, A. R. (2023, 05 50). The EV Battery Supply Chain Explained. Retrieved 05 16, 2024, from Rocky Mountain Institute (RMI): https://rmi.org/the-ev-battery-supply-chain-explained/

CEIC. (2023a). Egypt Bank Lending Rate. Retrieved from https://www.ceicdata.com/en/indicator/egypt/bank-lending-rate

CEIC. (2023b). Nigeria Bank Lending Rate. Retrieved from https://www.ceicdata.com/en/indicator/nigeria/bank-lending-rate

Cement & Concrete SA. (2022, June). Concrete Beton - Number 169. Retrieved January 21, 2024, from https://cemcon-sa.org.za/issues/issue169/offline/download.pdf

Collins, L. (2023, January 9). John Cockerill to build Africa's first electrolyser gigafactory as it expands global production to 8GW by 2025. Retrieved October 1, 2023, from hydrogeninsight.com: https://www.hydrogeninsight.com/electrolysers/john-cockerill-to-build-africa-s-first-electrolyser-gigafactory-as-it-expands-global-production-to-8gw-by-2025/2-1-1385020

Collins, T. (2022, November 4). Do Special Economic Zones work in Africa? Retrieved from https://african.business/2022/11/trade-investment/do-special-economic-zones-work-in-africa#: :text=In%20Africa%2C%20the%20first%20SEZ,of%20the%20continent's%2054%20countries.

CORDIS. (2022, 08 16). Concentrating Photovoltaic modules using advanced technologies and cells for highest efficiencies, Grant agreement ID 640873. doi:https://doi.org/10.3030/640873

Curran, P. (2021, April 28). The Economics Around Lithium-Ion Battery Recycling Are Strong and Growing. Retrieved May 23, 2024, from GLG Insights: https://glginsights.com/articles/the-economics-around-lithium-ion-battery-recycling-are-strong-and-growing/

Davies, R. (2023). Navigating new turbulences at the nexus of trade and climate change: implications and options for Africa. TIPS. Retrieved 02 07, 2024, from https://africanclimatefoundation.org/wp-content/uploads/2023/06/800793-ACF-Trade-and-finance-report-03A.pdf

de Oliviera Vasconcelos, D. (2021). Renewable energy statecraft and asymmetric interdependence: how the solar energy industry is wielding China with geopolitical power. Journal of Contemporary Eastern Asia, 20(2), 259-277. doi:doi.org/10.17477/jcea.2021.20.2.259

DEG Invest. (2023). Up-Scaling Financing Commitments 2022. Retrieved October 1, 2023, from https://www.deginvest.de/DEG-Dokumente/Unsere-L%C3%B6sungen/F%C3%B6rderprogramme/Up-Scaling-Commitments-2022.pdf

DEG Invest. (2024). ImpactConnect – We finance progress. Retrieved February 1, 2024, from https://www.deginvest.de/Unsere-L%c3%b6sungen/ImpactConnect/index-2.html

Dianah, E. (2023, January 25). Matatu investors now eye electric vehicles. Retrieved August 30, 2023, from The Standard, Enterprise, The Entrepreneur's Magazine: https://transformative-mobility.org/wp-content/uploads/2023/06/230125_NAIROBI_TheStandard_News.pdf

DMRE. (2023, 07 03). South African Renewable Energy Master Plan (SAREM), An industrial and inclusive development plan for the renewable energy and storage value chains by 2030, Draft III for Public Consultation. Retrieved 01 07, 2024, from https://www.dmr.gov.za/Portals/0/Resources/Renewable%20Energy%20Masterplan%20(SAREM)/South%20African%20Renewable%20Energy%20Masterplan%20(SAREM)%20Draft%20III.pdf

DTIC. (2023). Electric Vehicles. Retrieved 12 07, 2023, from www.thedtic.gov.za/wp-content/uploads/EV-White-Paper.pdf

EBRD. (2024). STEG - ELMED power interconnector - Submarine cable. Retrieved 02 14, 2024, from https://www.ebrd.com/work-with-us/projects/psd/54389.html

Ecoprogetti srl. (2023). ECOPROGETTI - Specialist in photovoltaic production process. Retrieved October 1, 2023, from

Ecoprogetti Website: https://ecoprogetti.com/

EHB. (2023). The European Hydrogen Backbone (EHB) initiative. Retrieved February 1, 2024, from https://ehb.eu/

EIB. (2022). Africa's extraordinary green hydrogen potential. Retrieved 01 21, 2024, from https://www.eib.org/attachments/press/africa-green-hydrogen-flyer.pdf

EIB. (2023, March 1). Kenya: EIB and Kenya strengthen green hydrogen cooperation. Retrieved from EIB Website: https://www.eib.org/en/press/all/2023-083-european-investment-bank-and-kenya-strengthen-green-hydrogen-cooperation

Eljechtimi, A. (2022, November 17). Siemens Gamesa plans to sell its Morocco turbine blade factory. Retrieved December 20, 2023, from Reuters: https://www.reuters.com/markets/deals/siemens-gamesa-plans-sell-its-morocco-turbine-blade-factory-2022-11-17/

ENERGICA. (2022). ENERGICA - Energy access in urban and rural Africa. Retrieved February 1, 2024, from http://energica-h2020.eu/

Erraji, A. (2023, 12 24). China's Gotion High-Tech to Open Electric Vehicle Battery Plant in Morocco. Retrieved January 2024, from Morocco World News: https://www.moroccoworldnews.com/2023/12/359753/chinas-gotion-high-tech-to-open-electric-vehicle-battery-plant-in-morocco

ESECA. (2023). European Sustainable Energy Cluster partnership for Africa. Retrieved 10 10, 2023, from Climate Chance: https://www.climate-chance.org/en/best-pratices/eseca

ESI Africa. (2023, December 6). Nigeria: 'Ultra' low-carbon footprint solar panel plant to be built. Retrieved December 20, 2023, from https://www.esi-africa.com/renewable-energy/nigeria-ultra-low-carbon-footprint-solar-panel-plant-to-be-built/

ETIP. (2024). PV Manufacturing in Europe: Ensuring resilience through industrial policy. Retrieved 01 17, 2024, from https://etip-pv.eu/publications/etip-pv-publications/

European Commission. (2022a, May 18). EU external energy engagement in a changing world. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022JC0023

European Commission. (2022b, February 23). Proposal for a Directive on corporate sustainability due diligence and annex. Retrieved November 26, 2023, from https://commission.europa.eu/publications/proposal-directive-corporate-sustainability-due-diligence-and-annex_en

European Commission. (2023a, 03 16). A secure and sustainable supply of critical raw materials in support of the twin transition. Retrieved 01 18, 2024, from https://circabc.europa.eu/rest/download/7ce37e41-1d9a-4f96-a24b-4f89207700bf

European Commission. (2023b). Study on the Critcal Raw Materials for the EU 2023, Final Report. Retrieved 01 19, 2024, from https://op.europa.eu/en/publication-detail/-/publication/57318397-fdd4-11ed-a05c-01aa75ed71a1

European Commission. (2023c, 03 16). Critical Raw Materials: ensuring secure and sustainable supply chains for EU's green and digital future. Retrieved 01 18, 2024, from https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1661

European Commission. (2023d, 12). Global Gateway EU-Africa flagship projects. Retrieved 02 14, 2024, from Factsheet: https://international-partnerships.ec.europa.eu/document/download/ed505ccf-18ef-4fe9-816b-587d28f10633_en?filename=infographics-global-gateway-flagship-projects-2023-2024-eu-africa_en.pdf

European Commission. (2023f). The Net-Zero Industry Act: Accelerating the transition to climate neutrality. Retrieved 02 15, 2024, from https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en

European Commission. (2023g, 06 19). Commisssion Staff Working Document for a Regulation of the European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act). Retrieved 02 15, 2024, from

SWD(2023) 219 final: https://single-market-economy.ec.europa.eu/document/download/9193f40c-5799-4b1d-8dfc-207300e9610d_en?filename=SWD_2023_219_F1_STAFF_WORKING_PAPER_EN_V9_P1_2785109.PDF

European Parliament. (2023h, 05 16). Regulation (EU) 2023/956 of the European Pariament and of the Council of May 2023 establishing a carbon border adjustment mechanism. Retrieved 02 07, 2024, from Official Journal of the European Union, L130/52: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0956

European Union. (2023e, 10 26). Memorandum of Understanding on a Partnership on Sustainable Raw Materials Value Chains between the European Union presented by the European Commission and the Republic of Zambia. Retrieved 02 14, 2024, from https://single-market-economy.ec.europa.eu/document/download/c7aefb66-ef6b-411c-860d-b76505ff4f1d_en?filename=MoU_CRM_EU-Zambia_26_10_2023_signed.pdf

Falaiye, H. (2023, 10 05). All On, Auxano commission 100MW solar panel factory. Retrieved 10 10, 2023, from Punch Newspaper: https://punchng.com/all-on-auxano-commission-100mw-solar-panel-factory/

Garcia, F., Taniparti, N., & Barrios, D. (2023, May 18). Port Resiliency in the Face of Global Shocks: The Case of Walvis Bay in Namibia. Retrieved December 20, 2023, from https://growthlab.app/namibia-walvis-bay

Gill-Wiehl, A., Price, T., & Kammen, D. M. (2021, November). What's in a stove? A review of the user preferences in improved stove designs. doi:10.1016/j.erss.2021.102281

Global Energy Monitor. (2023, 2024). Global Energy Monitor. Retrieved from https://globalenergymonitor.org/

Gopolang Moloko, M. (2022, October 3). The brutal impact of Eskom's load shedding. Retrieved from https://memeburn.com/2022/10/the-brutal-impact-of-eskoms-load-shedding/

Green Building Africa. (2019, June 3). Top 10 Tier 1 Solar Module Manufacturer Seraphim Has State of the Art Factory in South Africa. Retrieved December 20, 2023, from https://www.greenbuildingafrica.co.za/top-10-tier-1-solar-module-manufacturer-seraphim-has-state-of-the-art-factory-in-south-africa/

GWEC. (2023a). Global wind report 2023. Retrieved October 1, 2023, from https://gwec.net/wp-content/uploads/2023/04/GWEC-2023_interactive.pdf

GWEC. (2023b, October). Status of Wind Power in Africa. Retrieved from https://gwec.net/wp-content/uploads/2023/10/Status-of-Wind-in-Africa-Report-V4.pdf

Hogan Lovells. (2022, August 15). The IRA: what's in it for manufacturers? Retrieved from https://www.engage.hoganlovells.com/knowledgeservices/news/the-ira-whats-in-it-for-manufacturers

Husk. (2023). Husk Power Systems. Retrieved October 1, 2023, from https://huskpowersystems.com

Hutchins, M. (2023, January 19). Africa closing-in on GW level solar. Retrieved from https://www.pv-magazine.com/2023/01/19/africa-closing-in-on-gigawatt-level-solar/

Hyphen Hydrogen Energy. (2023). Pioneering the African Green Hydrogen revolution. Retrieved October 1, 2023, from https://hyphenafrica.com/

IEA. (2021, May). The Role of Critical Minerals in Clean Energy Transitions. Retrieved September 11, 2023, from https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

IEA. (2022). Solar PV Global Supply Chains. Retrieved July 26, 2023, from https://www.iea.org/reports/solar-pv-global-supply-chains

IEA. (2023a). Africa Energy Outlook 2022. Retrieved from IEA Website: https://www.iea.org/reports/africa-energy-outlook-2022/key-findings

IEA. (2023b). Electrolysers. Retrieved October 1, 2023, from https://www.iea.org/energy-system/low-emission-fuels/electrolysers

IEA. (2023c, September). Financing Clean Energy in Africa, World Energy Outlook Special Report. Retrieved November

23, 2023, from https://www.iea.org/reports/financing-clean-energy-in-africa

IEA. (2023d). Global Hydrogen Review 2023. Retrieved 01 21, 2024, from https://www.iea.org/reports/global-hydrogen-review-2023

IEA. (2023e, June). Renewable Energy Market Update: Outlook for 2023 and 2024. Retrieved October 1, 2023, from https://iea.blob.core.windows.net/assets/63c14514-6833-4cd8-ac53-f9918c2e4cd9/RenewableEnergyMarketUpdate_June2023.pdf

IEA. (2023f). RePowerEU Plan: Joint European action on gas supply security. Retrieved October 1, 2023, from https://www.iea.org/policies/15688-repowereu-plan-joint-european-action-on-gas-supply-security

IEA. (2024). Renewables 2023: Analysis and forecast 2028. Retrieved 01 14, 2024, from https://iea.blob.core.windows.net/assets/3f7f2c25-5b6f-4f3c-a1c0-71085bac5383/Renewables_2023.pdf

IG3N (Pty) Ltd. (2023). I-G3N | Lithium Battery Manufacturer. Retrieved October 1, 2023, from https://www.i-g3n.co.za/

IMF. (2023a, April 14). IMF's Sub-Saharan Africa Regional Economic Outlook: The Big Funding Squeeze. doi:https://www.imf.org/en/News/Articles/2023/04/14/pr23119-sub-saharan-africa-regional-economic-outlook-the-big-funding-squeeze

IMF. (2023b, June). Trade Disrupted. Retrieved from https://www.imf.org/en/Publications/fandd/issues/2023/06

IRENA. (2022, January). Geopolitics of the Energy Transformation: The Hydrogen Factor. Retrieved from https://www.irena.org/publications/2022/Jan/Geopolitics-of-the-Energy-Transformation-Hydrogen

IRENA. (2023). Renewable Energy and Jobs. Retrieved from https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Sep/IRENA_Renewable_energy_and_jobs_2023.pdf?rev=4c35bf5a1222429e8f0bf932a641f818

ITA. (2023, 05 06). International Trade Administration, U.S. Department of Commerce (ITA). Retrieved 12 04, 2023, from South Africa - Country Commercial Guide: Automotive: https://www.trade.gov/country-commercial-guides/south-africa-automotive

Jacobo, J. T. (2023, March 28). Nigeria breaks ground on US$171 million solar cell production plant. Retrieved September 26, 2023, from pv-tech.org: https://www.pv-tech.org/nigeria-breaks-ground-on-us171-million-solar-cell-production-plant

KfW IPEX-Bank. (2024). Your specialist for international project and export finance. Retrieved February 1, 2024, from https://www.kfw-ipex-bank.de/International-financing/KfW-IPEX-Bank/

Kuhudzai, R. J. (2023, August 23). Construction has started at Africa's first dedicated Gigawatt-hour battery factory in Cape Town, Clean Technica. Retrieved from https://cleantechnica.com/2023/08/23/construction-has-started-at-africas-first-dedicated-gigawatt-hour-battery-factory-in-cape-town/

Lander, L., Cleaver, T., Rajaeifar, M. A., Nguyen-Tien, V., Elliott, R. J., Heidrich, O., . . . Offer, G. (2021, July). Financial viability of electric vehicle lithium-ion battery recycling. doi:https://doi.org/10.1016/j.isci.2021.102787

Laryea, E., Ndonga, D., & Nyamori, B. (2020). Kenya's Experience with Special Economic Zones: Legal and Policy Imperatives. doi:10.3366/ajicl.2020.0309

Latini, D., Vaccari, M., Lagnoni, M., Orefice, M., Mathieux, F., Huisman, J., . . . Bertei, A. (2022, August). A comprehensive review and classification of unit operations with assessment of outputs quality in lithium-ion battery recycling. doi:https://doi.org/10.1016/j.jpowsour.2022.231979

Lee, A. (2023, September 19). Chinese Battery-Parts Maker, African Fund Plan $2 Billion Venture in Morocco. Retrieved May 23, 2024, from Bloomberg: https://www.bloomberg.com/news/articles/2023-09-19/cngr-al-mada-plan-2-billion-battery-parts-venture-in-morocco

Leutz, R., Couture, T., & Ackermann, T. (2023). Specific Support Study: Solar, Specific Support Study in support of the Continental Power System Masterplan (CMP) through the EU's Technical Assistance Facility (TAF) for

African Union in the sustainable energy sector, Specific Support Study on the Solar. GET.transform and Energynautics GmbH. Retrieved from cmpmwanga.nepad.org/Solar_delFinal

LG Chem. (2023, 9 25). LG Chem Teams Up with Huayou Group to Build LFP Cathode Plant in Morocco. Retrieved January 2024, from LG Chem: https://www.lgcorp.com/media/release/26808

LSF. (2023, December 1). Manufacturing Localisation Potential in Renewable Energy Value Chains. Retrieved December 20, 2023, from https://www.lsf-sa.co.za/post/manufacturing-localisation-potential-in-renewable-energy-value-chains

Maisch, M. (2023, October 30). Europe to add 58 GW of solar in 2023. Retrieved January 21, 2024, from PV Magazine: https://www.pv-magazine.com/2023/10/30/europe-to-add-58-gw-of-solar-in-2023/

Manthey, N. (2023, 4 18). LGES & Yahua want to process lithium in Morocco. Retrieved January 2024, from Electrive: https://www.electrive.com/2023/04/05/lges-yahua-want-to-process-lithium-in-morocco/

Maroc Office des Changes (OC). (2023). Trade data download. Retrieved 12 17, 2023, from https://services.oc.gov.ma/DataBase/CommerceExterieur/requete.htm

Martin, P. (2023, August 22). Clean hydrogen production subsidies vastly outweigh support for end-users: BNEF. Retrieved February 1, 2024, from Hydrogeninsight: https://www.hydrogeninsight.com/policy/clean-hydrogen-production-subsidies-vastly-outweigh-support-for-end-users-bnef/2-1-1504673

McKinsey. (2022). Global Hydrogen Flows. Retrieved 01 21, 2024, from https://hydrogencouncil.com/wp-content/uploads/2022/10/Global-Hydrogen-Flows.pdf

McKinsey. (2023a, October 17). Green energy in Africa presents significant investment opportunities. Retrieved November 26, 2023, from https://www.mckinsey.com/capabilities/sustainability/our-insights/green-energy-in-africa-presents-significant-investment-opportunities#/

McKinsey. (2023b, June 5). Reimagining economic growth in Africa. Retrieved from https://www.mckinsey.com/mgi/our-research/reimagining-economic-growth-in-africa-turning-diversity-into-opportunity

McKinsey. (2023c, August). The path to greater productivity and prosperity in Africa. Retrieved from https://www.mckinsey.com/industries/public-sector/our-insights/the-path-to-greater-productivity-and-prosperity-in-africa

Molina, P. S. (2023, June 8). Global PV manufacturing capacity to reach 1TW by 2024. Retrieved from https://www.pv-magazine.com/2023/06/08/global-pv-manufacturing-capacity-to-reach-1-tw-by-2024/

Mondragon. (2021, April 13). Mondragon Assembly's 100MW PV line is at full production at Milltech in Algeria. Retrieved October 1, 2023, from Mondragon Assembly Website: https://www.mondragon-assembly.com/2021/04/mondragon-assemblys-100mw-pv-line-is-at-full-production-at-milltech-in-algeria

Mugabi, I. (2022, October 7). How corruption cripples business at Africa's seaports. Retrieved from https://www.newsclick.in/How-Corruption-Cripples-Business-Africa-Seaports

Namibia Ministry of Mines and Energy. (2023, 12 21). Namibian Green Hydrogen Program Update. Retrieved 01 19, 2024, from https://www.linkedin.com/feed/update/urn:li:activity:7143616466548944896

Neometals Ltd. (2023, August 1). Battery Recycling 'Hub' Engineering Cost Study. Retrieved May 23, 2024, from https://www.research-tree.com/newsfeed/article/neometals-ltd-battery-recycling-hub-engineering-cost-study-1965435

Nordex SE. (2018, September 12). Nordex Group awarded big-ticket contracts in South Africa. Retrieved January 21, 2024, from https://www.nordex-online.com/en/2018/09/nordex-group-awarded-big-ticket-contracts-in-south-africa/

OECD. (1993). Regional Industrial Restructuring: Report on the Maastricht Seminar of 8-9 Oct 1991. Retrieved 01 08, 2024, from https://one.oecd.org/document/OCDE/GD(93)190/En/pdf

Oseni, M. O. (2019, August 6). Costs of unreliable electricity to African firms. Retrieved October 1, 2023, from Energy

for Growth Hub: https://energyforgrowth.org/article/costs-of-unreliable-electricity-to-african-firms/

Pagliaro, M., & Meneguzzo, F. (2019, June). Lithium battery reusing and recycling: A circular economy insight. doi:https://doi.org/10.1016/j.heliyon.2019.e01866

Peterschmidt, N., Mattson, B., & Kidenda, J. (2023, August 23). The Mini-Grid Business: Anchor loads, productive use and rural industrialization - Business model successes and failures. Retrieved October 1, 2023, from INENSUS: https://podcast.inensus.com/2233651/13441556-anchor-loads-productive-use-and-rural-industrialization-business-model-successes-and-failures

Porter, M. (1990). The competitive advantage of nations. Retrieved from https://hbr.org/1990/03/the-competitive-advantage-of-nations

PWC. (2018). Strengthening Africa's gateways to trade - An analysis of port development in sub-Saharan Africa. Retrieved October 1, 2023, from https://www.pwc.co.za/en/assets/pdf/strengthening-africas-gateways-to-trade.pdf

Rahhou, J. (2023, August 20). Chinese Battery Supplier Tinci Shifts Czech Republic Project to Morocco. Retrieved January 2024, from Morocco World News: https://www.moroccoworldnews.com/2023/08/357173/chinese-battery-supplier-tinci-shifts-czech-republic-project-to-morocco

Reuters. (2022, June 15). Angola set to become first supplier of green hydrogen for Germany. Retrieved from https://www.reuters.com/article/germany-angola-green-hydrogen-idINL6N2Y20AE/

Reuters. (2023, June 1). Chinese EV battery maker Gotion mulls factory in Morocco. Retrieved May 23, 2024, from https://www.reuters.com/business/autos-transportation/chinese-ev-battery-maker-gotion-mulls-factory-morocco-2023-06-01/

Reuters. (2023, May 25). Hyphen and Namibia agree next phase of $10 billion green hydrogen project. Retrieved from https://www.reuters.com/business/energy/hyphen-namibia-agree-next-phase-10-bln-green-hydrogen-project-2023-05-24/

Reuters. (2023, 06 14). Nigeria allows naira to drop more than 36% on official market. Retrieved 01 07, 2023, from Reuters News: https://www.reuters.com/markets/currencies/nigeria-allows-naira-drop-more-than-36-official-market-2023-06-14/

Rhodium Group, MERICS. (2023, May 9). EV battery investments cushion drop to decade low: Chinese FDI in Europe 2022 Update. Retrieved December 20, 2023, from https://merics.org/sites/default/files/2023-05/merics-rhodium-group-chinese-fdi-in-europe-2022%20%281%29.pdf

Rivett-Carnac, K. (2022). Insights into the solar photovoltaic manufacturing value chain in South Africa. Report, TIPS and WWF South Africa. Retrieved 01 07, 2024, from www.tips.org.za/research-archive/sustainable-growth/green-economy-2/item/4441-insights-into-the-solar-photovoltaic-manufacturing-value-chain-in-south-africa

Rodríguez-Pose, A., Bartalucci, F., Frick, S. A., Santos-Paulino, A. U., & Bolwijn, R. (2022). The challenge of developing special economic zones in Africa: Evidence and lessons learnt. Journal of Regional Science: Policy and Practice, 14(2). doi:https://doi.org/10.1111/rsp3.12535

Rystad Energy. (2023, March). Africa and Europe set to be the dynamos for the global green hydrogen economy. Retrieved October 1, 2023, from rystadenergy.com: https://www.rystadenergy.com/news/africa-and-europe-set-to-be-the-dynamos-for-the-global-green-hydrogen-economy

Sanon, S., & Slany, A. (2023). Identifying African countries' potential in the African automotive industry – A continental supply chain mapping approach, Background paper commissioned by the UNCTAD secretariat for the 2023 edition of the Economic Development in Africa Report. United Nations Conference on Trade and Development (UNCTAD). Retrieved 09 10, 2023, from https://unctad.org/publication/economic-development-africa-report-2023

SARS. (2023). Trade data download. Retrieved November 22, 2023, from https://tools.sars.gov.za/tradestatsportal/data_download.aspx

SAWEA. (2022, September 22). IDC Explore Wind Sector Industrialisation. Retrieved January 21, 2024, from https://

sawea.org.za/idc-explore-wind-sector-industrialisation/

SEforALL. (2023). Africa Renewable Energy Manufacturing: Opportunity and Advancement. Retrieved October 1, 2023, from https://www.seforall.org/system/files/2023-01/%5BFINAL%5D%2020220115_ZOD_SEForAll_AfricanManufacturingReport.pdf

Shaw, V. (2023, December 16). Weekend Read: Famine to feast – China's solar market in 2023. Retrieved December 20, 2023, from PV Magazine: https://www.pv-magazine.com/2023/12/16/weekend-read-famine-to-feast-chinas-solar-market-in-2023/

Shemsu, M. (2023, February 4). Fed tables revised excise tax on imported vehicle. Retrieved from https://addisfortune.news/fed-tables-revised-excise-tax-on-imported-vehicle/

Simpara, M. (2023, 12 30). BTR New Material to Invest $500 Million in Cutting-Edge Cathode Plant in Morocco. Retrieved January 2024, from Morocco World News: https://www.moroccoworldnews.com/2023/12/359851/btr-new-material-to-invest-500-million-in-cutting-edge-cathode-plant-in-morocco

Spaes, J. (2020, September 28). Solar module factory begins production in Burkina Faso. Retrieved October 1, 2023, from PV Magazine: https://www.pv-magazine.com/2020/09/28/solar-module-factory-begins-production-in-burkina-faso

SRMI. (2022, October). Maximizing Socioeconomic Benefits Triggered by Renewables. Retrieved September 29, 2023, from https://www.esmap.org/sites/default/files/esmap-files/Maximizing%20Socioeconomic%20Benefits%20Triggered%20by%20Renewables_Nov16-22.pdf

STATISTA. (2023, 9 30). Electric Vehicles - Africa. Retrieved January 2024, from STATISTA Market Insights: https://www.statista.com/outlook/mmo/electric-vehicles/africa

Swahn, N., Semini, M., & Strandhagen, J. O. (2016). The role of cultural characteristics in industrial manufacturers' performance, International Workshop of Advanced Manufacturing and Automation. Retrieved from Atlantis Press Website: https://www.atlantis-press.com/article/25862256.pdf

TaiyangNews. (2023, 11 13). Weekly Overview On Prices For Polysilicon, Wafers, Cells, Modules & Solar Glass. Retrieved 11 13, 2023, from TaiyangNews PV Price Index – CW45: https://taiyangnews.info/

Takouleu, J. M. (2020, July 30). Egypt: Mondragon opens solar panel production line in Cairo. Retrieved October 1, 2023, from Afrik 21: https://www.afrik21.africa/en/egypt-mondragon-opens-solar-panel-production-line-in-cairo

Terzi, A., Singh, A., & Sherwood, M. (2022). Industrial policy for the 21st century: Lessons from the past. Discussion Paper 157, European Commission. Retrieved 01 17, 2024, from https://economy-finance.ec.europa.eu/system/files/2022-02/dp157_en_industrial_policy.pdf

Trace, S. (2020, January). South Africa's crippling electricity problem. Retrieved October 10, 2023, from Oxford Policy Management: https://www.opml.co.uk/blog/south-africa-s-crippling-electricity-problem

Truby, J., Philip, P., & Lorentz, B. (2023, 06 19). Green hydrogen: Energizing the path to net zero. Retrieved 01 21, 2024, from Deloitte: https://www.deloitte.com/global/en/issues/climate/green-hydrogen.html

UN Office of the Special Advisor on Africa. (2023, June). Green Hydrogen to Fuel Africa's Rise – Hard Truths and Key Questions. Retrieved from https://www.un.org/osaa/news/green-hydrogen-fuel-africa%E2%80%99s-rise-%E2%80%93-hard-truths-and-key-questions

UNCTAD. (2021). Handbook on Special Economic Zones in Africa: Towards economic diversification across the continent. Retrieved 01 26, 2024, from https://unctad.org/system/files/official-document/diaeia2021d3_en.pdf

UNCTAD. (2023). The Potential of Africa to Capture Technology-Intensive Global Supply Chains. Retrieved 09 10, 2023, from unctad.org/publication/economic-development-africa-report-2023

UNEP. (2023, December). Electric Two-and Three Wheelers: Global Emerging Market Overview. Retrieved February 18, 2024, from UNEP Global Electric Mobility Programme: https://sustmob.org/EMOB/pdf/Global_EmergingMarketsReport_ElectricTwoThreeWheelers.pdf

UNIDO. (2021). United Nations Industrial Development Organization. Retrieved October 13, 2023, from National Accounts Database: https://stat.unido.org/database/National%20Accounts%20Database

UNSTATS. (2021). United Nations, Department of Economic and Social Affairs, Statistics Division. Retrieved 10 21, 2023, from SDG Indicators: https://unstats.un.org/sdgs/metadata/

Urban-Econ, EScience. (2015, January). The wind energy industry localisation roadmap in support of large-scale roll-out in South Africa - Integrated Final Report. Retrieved January 21, 2024, from https://sawea.org.za/wp-content/uploads/2014/04/20150130_Wind_energy_localisation_study.pdf

USGS. (2022). Mineral Resource Data System by common geographic areas. Retrieved from https://mrdata.usgs.gov/mrds/geo-inventory.php

USGS. (2023). Silica Statistics and Information. Retrieved September 11, 2023, from usgs.gov: https://www.usgs.gov/centers/national-minerals-information-center/silica-statistics-and-information

Vaal SEZ. (2022). Vaal Special Economic Zone. Retrieved November 22, 2023, from https://vaalsez.co.za/

Volta Foundation. (2024, 1 28). The Battery Report 2023. Retrieved January 2024, from Volta Foundation: https://www.volta.foundation/annual-battery-report

Westerheide, C. (2023, 9 20). CNGR to build battery materials factory in Morocco. Retrieved January 2024, from Electrive: https://www.electrive.com/2023/09/20/cngr-to-build-battery-materials-factory-in-morocco/

World Bank. (2022a). Total reserves minus gold. Retrieved November 23, 2023, from https://data.worldbank.org/indicator/FI.RES.XGLD.CD?locations=ZQ-ZG&view=map

World Bank. (2022b). World Development Indicators. Retrieved 11 01, 2023, from https://databank.worldbank.org/source/world-development-indicators#

World Bank. (2023). The Container Port Performance Index 2022: A Comparable Assessment of Performance Based on Vessel Time in Port, CPPI. Retrieved 05 15, 2024, from http://hdl.handle.net/10986/39824

Yang, H. (2023, September 24). LG Chem with China's Huayou to make battery materials in Indonesia, Morocco. Retrieved May 23, 2024, from Reuters: https://www.reuters.com/technology/lg-chem-partners-with-huayou-group-build-joint-lfp-cathode-plant-morocco-2023-09-24/

06 Acronyms

ACFTA	African Continental Free Trade Area
ASM	Artisanal and small-scale mining
B2B	Business to Business
B2C	Business to Consumer
BESS	Battery Electricity Storage System
BEV	Battery Electric Vehicles
BMS	Battery Management System
BNEF	BloombergNEF
BOP	Balance of Plant
BRT	Bus Rapid Transit
C3PV	Three-junction cell photovoltaics (a type of CPV)
CAGR	Compound Annual Growth Rate
CBAM	Carbon Border Adjustment Mechanism
CEO	Chief Executive Officer
CMP	Continental Power System Master Plan
CNY	Chinese Yuan
COO	Chief Operating Officer
COSME	Competitiveness of small and medium-sized enterprises
CPV	Concentrating Photovoltaics
CRM	Critical Raw Materials
CRMA	Critical Raw Materials Act
CSDDD	Corporate Sustainability Due Diligence Directive
DEG	Deutsche Investitions- und Entwicklungsgesellschaft
DMRE	South Africa Department of Mineral Resources and Energy
DRC	Democratic Republic of the Congo
DTIC	South Africa Department of Trade, Industry and Competition
EAC	East African Community
EBRD	European Bank for Reconstruction and Development
ECAs	Export Credit Agencies
EDFI	European Development Finance Institutions
EIB	European Investment Bank
EPC	Engineering, Procurement, and Construction
EPCs	Engineering, Procurement, and Construction companies
ESG	Environmental, Social, and corporate Governance
ESS	Electricity Storage System
EU	European Union
EUR	Euro
EV	Electric Vehicle
FC	Fuel Cell
FDI	Foreign direct investment
GDP	Gross Domestic Product
GGI	Global Gateway Initiative

GH2	Green Hydrogen
GNH3	Green Ammonia
GW	Gigawatt
GWEC	Global Wind Energy Council
GWh	Gigawatt hour
H2	Hydrogen
HS 87	Harmonised System, product nomenclature of the World Customs Organization (WCO); Chapter 87 applies to automotive products, 'Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof'
HVDC	High Voltage Direct Current
ICE	Internal Combustion Engine
IDC	Industrial Development Corporation
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IGBT	Insulated-gate bipolar transistor
IMF	International Monetary Fund
IP	Intellectual Property
IRA	Inflation Reduction Act
IRENA	International Renewable Energy Agency
JETP	Just Energy Transition Partnership
LFP	Lithium iron phosphate (lithium ferrophosphate)
LIBs	Lithium Ion Batteries
LMFP	Lithium manganese iron phosphate
LPI	Logistic Performance Index
LSF	Localisation Support Fund
MNOs	Mobile Network Operators
MOCVD	Metalorganic chemical vapour deposition
MVA	Manufacturing Value Added / Megavolt Ampere
MW	Megawatt
MWh	Megawatt hour
NGN	Nigerian Naira
NMC	(Lithium) nickel manganese cobalt oxides
NZIA	Net Zero Industry Act
OC	Office des Changes
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
P2X	Power to X (Power to Heat, Power to Gas, etc.)
pCAM	Cathode precursor active material
PE	Private equity / Polyethylene
PEM	proton-exchange membrane, or polymer-electrolyte membrane
PHEV	Plug-in Hybrid Electric Vehicles
PPAs	Power Purchase Agreements
PV	Solar Photovoltaics
PVC	Polyvinyl chloride
RBF	Results-based Financing
RE	Renewable Energy
RECs	Regional Economic Communities
REE	Rare-earth elements
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
ROW	Rest of the world

SA	South Africa
SADC	South African Development Community
SAREM	South African Renewable Energy Masterplan
SARS	South Africa Revenue Service
SBU	Strategic Business Unit
SDG	Sustainable Development Goal
SEZ	Special Economic Zone
SEforALL	Sustainable Energy for All
SMEs	Small and Medium Enterprises
SRMI	Sustainable Renewables Risk Mitigation Initiative
SSA	Sub-Saharan Africa
TESCO	Telecommunication Service Company
TRE	Time required to get electricity (days)
TW	Terawatt
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
US	United States (of America)
USA	United States of America
USD	United States Dollar
USGS	United States Geological Survey
USP	Unique Selling Point
VAT	Value Added Tax
ZAR	South African Rand

07 Declaration of Interest

Chapter 3 of this report includes descriptions of selected existing companies. The authors declare they have no financial or other direct or indirect relationship to any of these companies except as expressly listed below. No money has been paid for inclusion of any company profile in this report. The descriptions have been compiled by the authors on the basis of interviews with company representatives, and publicly available information. Any errors are solely the authors'.

Ralf Leutz declares to have worked with the business case Azur Space Solar Power GmbH in a research project in 2023. The authors declare no competing interests.

December 2024