SUSTAINABLE ENERGY FOR ALL

Africa Renewable Energy Manufacturing

OPPORTUNITY AND ADVANCEMENT

WITH CONTRIBUTIONS FROM

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Introduction

Africa's demand for power is projected to surge over the coming decades, more than 2x by 2030 and 8x by 2050[1]. This growth will be driven primarily by industrialization as African countries push to electrify and grow their economies while decarbonizing in line with the global energy transition.

Renewables provide a potential solution to meet much of this demand growth: Africa has almost unlimited potential for solar capacity (10 TW) and abundant hydro (350 GW), wind (110 GW), and geothermal energy sources (15 GW)[2].

Building renewable energy capacity would bring two significant benefits: first, it would reduce the amount of energy sourced from fossil fuels, lowering future carbon emissions; second, it would help build local manufacturing capabilities to create employment, grow economies, and develop export partnerships with other countries. Investment in energy-transition technologies creates 3x as many jobs as fossil fuels per investment dollar, and up to 14 million energy transition jobs could be created in Africa by 2030[3].

As part of the emerging South-South cooperation, there are opportunities for strategic partnerships between China, India and ASEAN countries and Africa to accelerate the creation of renewables manufacturing capacity in Africa. For example, China's renewable energy manufacturers could play a critical role in facilitating Africa's growth and help it become a leading global manufacturing hub for renewables. However, these manufacturers require a range of pull factors such as local market potential, availability of necessary infrastructure, favourable enabling environment and a strong local supply chain, to be in place before they will consider investment opportunities in Africa.

This report, by **Sustainable Energy for All, supported by Bloomberg Philanthropies, ClimateWorks Foundation, African Climate Foundation and Chinese Renewable Energy Industries Association**, has assessed the potential of renewable energy in Africa and creates a roadmap for African countries to localize manufacturing. The report draws on multiple sources, including economic analysis from McKinsey & Company.

[1] *Enerdata*

[2] *Enerdata*

[3] *IRENA and AfDB, Renewable Energy Market Analysis – Africa and its Regions, 2022*

Key Messages

1 **Renewables are expected to play a central role in Africa's power sector development, with capacity expected to grow to 180 GW by 2030 and 1.2 TW by 2050[4].** This growth in renewables presents a significant opportunity for the continent to accelerate its overall economic growth, develop new local value chains, reduce the trade deficit, and create between 8 million and 14 million good-quality jobs[5]. As Africa's main trade partner and the leading country in renewables manufacturing, China could be a strong partner for African countries as they develop local manufacturing capabilities.

2 **We identified ten opportunities across eight countries with a high readiness for successfully localizing renewables manufacturing.** This analysis considered key success factors, including demand, manufacturing scale, political stability, policies and regulations, trade relations with China, infrastructure, and the ability to export. Ten opportunities emerged—four in solar photovoltaics (PV) and battery materials refining, three in only solar PV assembly, and three in only battery materials refining. Ultimately, ten countries ranked favorably in this analysis: Morocco, South Africa, Egypt, Ghana, Algeria, Tunisia, Nigeria, Namibia, Kenya and Tanzania.

3 **We looked at renewables manufacturing in Africa from the perspective of the Chinese renewables industry players.** Across several factors, perceived investment attractiveness was favorable for battery refining, due to existing raw materials and stable production infrastructure. Attractiveness for solar PV, though, was low, driven by concerns of the local market potential, supply chain import barriers, a lack of local manufacturing capabilities and security needs.

4 **While Africa already has many tools and mechanisms to encourage renewables manufacturing, several gaps and barriers are working against further growth.** Several strengths—including policies (e.g., fiscal incentives, local content requirements), technical assistance, transaction facilitation, and financing—could spur further investment. However, production factors, supply chain concerns, regulations and lack of incentives, and local market potential are holding back market investment.

5 **Together, we at Sustainable Energy for All, Bloomberg Philanthropies, ClimateWorks Foundation, African Climate Foundation and Chinese Renewable Energy Industries Association have developed an implementation roadmap that details initiatives to be launched over the next 5–8 years.** Potential intervention programs—named Policy, People, Anchor, and Accelerator—aim to bridge the gaps in Africa's renewables manufacturing ecosystem.

[4] *Enerdata*

[5] *IRENA and AfDB, Renewable Energy Market Analysis – Africa and its Regions, 2022*

Renewables manufacturing trends in Africa

Growing power demand across Africa is driven by industrialization and urbanization, with renewables expected to become the primary power source on the continent due to economic and environmental drivers.

The shift toward renewable energy is driven by several factors. First, renewable energy is becoming more affordable—the cost of unsubsidized solar PV levelized cost of electricity (LCOE) has decreased by about 90% from $400/MWh in 2011 to $41/MWh in 2022.[6] Second, rising demand for environment-friendly energy sources has been driven by calls for reducing CO_2 emissions and the depletion of fossil fuels. Third, demand has been driven by the need for energy access: around half the population of sub-Saharan Africa has no access to electricity.[7] This gap in access drives the market for distributed solar generation installations, expanding access.

Estimated energy capacity in Africa by energy type between 2020 and 2050, *GW*

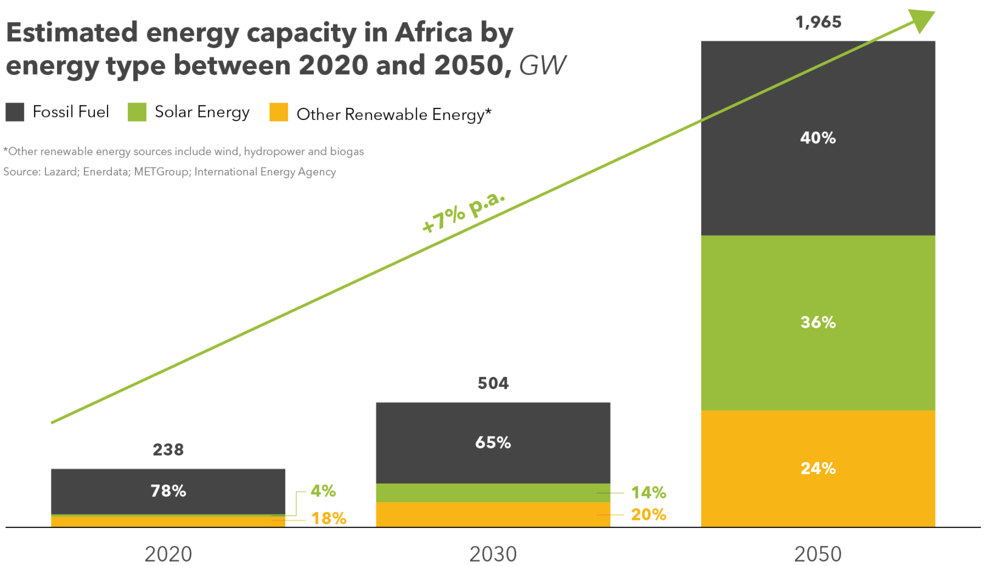

Exhibit 1
Renewables are expected to become the primary power source on the continent.

Economic benefits of African renewables manufacturing

Renewable energy could be crucial to Africa's economic development by stimulating economic growth and job creation while improving trade balance and socioeconomic outcomes.

1 **Economic growth:** On average, Africa could experience a ~6.4% increase in GDP between 2021 and 2050 that is directly attributable to the energy transition[8]. Economic growth is expected to be driven by public investment and expenditure; private investment in energy transition technologies; and net trade differences. Key sectors likely to benefit from this transition include electricity supply—for underserved and low-income areas—public and personal services, basic manufacturing, and business services.

[6] *Lazard, LCOE Analysis, 2021 - LCOE is a measure of the average net present cost of electricity generation over a lifetime. The LCOE average cost provided refers to Crystalline Utility-Scale Solar*

[7] *~570 million people out of SSA's population of 1.17 billion people do not have access to electricity*

[8] *IRENA and AfDB, Renewable Energy Market Analysis – Africa and its Regions, 2022*

2 **Job creation:** Investment in energy transition technologies creates 3x as many jobs as fossil fuels per $1Mn invested[9]. Through 2030, between 8 million and 14 million energy transition jobs could be created in Africa, potentially driven by government spending on public services and investment in transition technologies. Beyond 2030, job creation is estimated to be driven by induced and indirect efforts through increased spending by low-income households. Transitions to clean cooking and electric vehicles will further drive job creation as demand—and its associate supply needs—will drive additional labor opportunities.

3 **Trade balance:** Renewable energy generation could improve Africa's trade balance by lowering spending on fossil fuel imports, which has resulted in negative trade balances for many African countries. Africa is uniquely positioned as a net exporter of crude oil but a net importer of petroleum products, with sub-Saharan Africa's fuel imports equivalent to around 2% of GDP[10]. Homegrown energy sources would offer protection from external shocks and sharp price movements, such as the oil price surge in the first half of 2022. Furthermore, if African countries can build manufacturing capabilities, they could also export the renewable energy components to other countries, creating further positive trade flows.

4 **Socio-economic outcomes:** Renewable energy could play a significant role in closing Africa's energy-access gap and meeting United Nations Sustainable Development Goal 7 (SDG 7) to ensure universal access to energy. Currently, around 60 million people in Africa have electricity access through off-grid solutions, with 15 countries having electrification plans incorporating distributed renewables[11]. Energy access would promote agricultural productivity, modern health services and education, and industrial development.

China's role in Africa's energy transition

China leads the manufacture of renewable energy products. It produces the vast majority of the solar PV supply chain and battery cells; it also globally leads in material processing (e.g., lithium, nickel, cobalt) for critical elements of EV battery production (Exhibit 2).

In addition to being the world's principal manufacturer of renewable energy components, China has also emerged as Africa's largest economic partner, with no other country ranking in the top five for trade, foreign direct investment (FDI) stock, FDI growth, infrastructure financing, and aid. China's leadership extends to renewables development, and solar PV in particular; it garnered 55% share in the supply market for PV modules and 19% in engineering, procurement, and construction (EPC)[12].

Geographic distribution of renewable products supply chain, %

Source: International Energy Agency

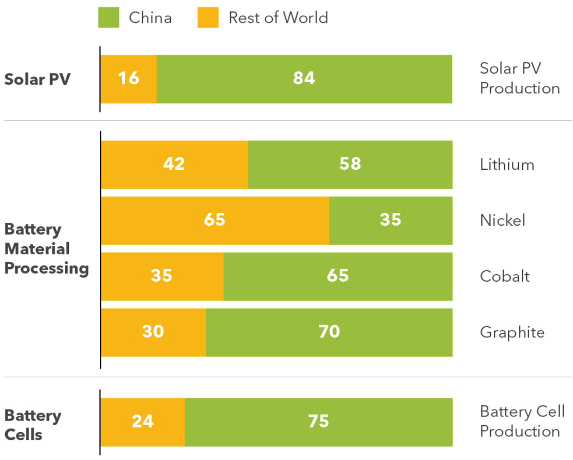

Exhibit 2
China leads the manufacture of renewable energy products globally.

Trade	FDI Stock	FDI Growth	Infrastructure Financing	Aid
$192Bn	**$110Bn**	**$4.2Bn**	**$23Bn**	**45%**
Worth of goods trade in 2019, triple of the next largest trade partner	Estimated 2019 FDI stock (versus ~$80Bn for the US)	Annual FDI flows in 2020, up from $75Mn in 2003	Commmited for infrastructure financing across Africa between 2007-2020	China's foreign aid between 2013 and 2018 that went to Africa

[9] *IRENA and AfDB, Renewable Energy Market Analysis – Africa and its Regions, 2022*

[10] *IEA, Africa Energy Outlook 2022*

[11] *IRENA and AfDB, Renewable Energy Market Analysis – Africa and its Regions, 2022*

[12] *UDI database from S&P Global Market Intelligence (2022)*

Due to its strength in renewables and existing trade ties, China's prominent competitive players and companies are the highest potential partners in scaling up manufacturing in Africa.

Trends affecting China's interest in manufacturing renewable energy products in Africa

Further Chinese investment in the African market for renewable energy products presents an opportunity for mutually beneficial growth for both China and Africa. Several tailwinds and headwinds can aid—or hinder—the potential for China to manufacture renewable energy products in Africa. There are four significant tailwinds:

1. **Increasing usage of renewable energy.** Demand for renewable energy is increasing. This demand growth is happening both at utility scale—driven by the acceleration of large-scale investments in renewable technologies—and at the micro scale—driven by improved economics for distributed renewable energy. This trend is further amplified by an increasing aspiration by countries to reduce dependency on grid infrastructure to solve energy-access challenges.

2. **Africa's push for industrialization and localized manufacturing.** Calls are increasing to localize processes along the manufacturing value chain as recent events such as the COVID-19 pandemic have exposed the overreliance of African countries on global supply chains. The African Development Bank has launched *Industrialize Africa* to support industrialization and manufacturing efforts. The organization approved $300Mn in financing for these efforts.

3. **Africa is resource rich in several raw materials critical for renewable energy products.** The continent has high availability of raw materials with large reserves of inputs such as cobalt, manganese, and lithium. These resources provide an attractive option for companies looking to install renewables manufacturing facilities closer to resource supply chains.

4. **Evolving geopolitical dynamics.** A favorable relationship is developing between Africa and China. Trade between Africa and China was valued at around $192Bn in 2019 and China is Africa's leading individual trade partner, with about 14% of total trade[13].

However, there are also several headwinds. First, **insufficient enabling policies in Africa discourages investment.** China's competitive advantage in producing renewables components includes supportive governmental policies and the ready availability of labor and raw materials. At the same time, many African countries are hamstrung by a lack of action-oriented government policies; manufacturers cite a lack of governmental support that would otherwise encourage innovative and high-value manufacturing investment.

Second, **Africa has a complex business environment**, including high initial costs for setting up renewable energy production plants. Furthermore, renewable energy systems and products attract taxes and tariffs across many African countries, resulting in higher costs.

Third, there is a **lack of legal frameworks and policies that promote renewable energy development** and the substitution of fossil fuels. Many African countries still subsidize fossil fuels in various ways, providing fossil fuel providers with economic advantages that are not available to renewable energy providers and manufacturers.

Finally, **some countries have insufficient power and limited grid development**, which may hinder the scale-up of renewable energy solutions. For example, solar energy PV production requires significant energy inputs, which may not be readily available in parts of the continent.

[13] *ITC Trade Map: UNCTAD*

Feasibility of African countries manufacturing renewables products

We assessed 14 African countries (i.e., our "shortlist") on their feasibility of manufacturing renewable energy products. This assessment spanned seven categories that are critical for success in the sector: renewables demand (to guarantee seamless access to market and offtake of installed capacity, manufacturing maturity (to determine the level of readiness to scale renewables manufacturing in each country), political stability, enabling policies and regulations (to determine the suitability of the business climate), trade relations with China, enabling infrastructure (to determine that necessary production factors are in place to manufacture energy-intensive products and transport them adequately), and ability to export (to determine the country's ability to act as a distribution hub for renewable products within the continent).

Ten countries were identified with medium or high feasibility[14]. It is important to note that these countries represent the "first wave" of countries this report has explored. Other countries will be investigated in future efforts. Further details on methodology are included in the Appendix.

1 **Morocco (7/7).** Morocco has the fourth-highest projected solar energy demand in 2030. The North African country's manufacturing GDP is fifth on our shortlist. Its policies and infrastructure are suited to renewable energy manufacturing and exporting, with its infrastructure scoring second best in our shortlist overall. It also has significant ties to China, with $6.9Bn in imports in 2021.

2 **South Africa (6.5/7).** South Africa ranks first on our shortlist in three categories: projected solar energy demand in 2030, imports from China, and merchandise exports (excluding oil and gas). It is third on our list for manufacturing GDP, at $5Bn in 2021. The country has enabling policies in place for renewable energy and manufacturing.

3 **Egypt (6/7).** Egypt ranks first on our list for manufacturing GDP, third for its imports from China, and fifth in projected solar energy demand in 2030. It has specific laws for renewable energy and manufacturing and is one of the largest exporters in Africa (excluding oil and gas). Its policies and infrastructure also support manufacturing and exporting.

4 **Ghana (5.5/7).** Ghana has a manufacturing GDP of more than $7Bn and merchandise exports (excluding oil and gas) of $11.7Bn. It has specific policies for renewable energy and manufacturing. However, trade with China and infrastructure are on the middle-to-lower end of our shortlist.

[14] *Country specific metrics used in this assessment sourced from DP World, IEA, IRENA, OECD, US International Trade Administration, World Bank and World Mining Data*

5 **Algeria (4.5/7).** Algeria has the second-highest projected solar energy demand. It ranks fourth in both manufacturing GDP and imports from China. It provides policies for renewable energy and manufacturing, but its infrastructure is perceived as average. Its exports, excluding oil and gas, are the second lowest on the shortlist.

6 **Tunisia (4.5/7).** Tunisia provides specific policies for renewable energy and manufacturing. Tunisian manufacturing, although relatively complex, generated $6Bn in 2021. Trade, infrastructure, and exports score toward the middle of our shortlist, while projected solar demand in 2030 is one of the lowest on the shortlist.

7 **Nigeria (4/7).** Nigeria ranks second on our shortlist in manufacturing GDP, projected solar capacity in 2030, and imports from China. It provides a legislative framework for renewable energy and manufacturing, but it scores the lowest on our shortlist in terms of infrastructure, and third lowest for exports, excluding oil and gas.

8 **Namibia (4/7).** Namibia is a politically stable country with strong local projected demand for RE by 2030. It has very high-quality infrastructure, being the highest overall scorer on our shortlist, but has a relatively under-developed manufacturing sector. It had minimal trade with China in 2021.

9 **Kenya (3.5/7).** Kenya provides a specific legislative framework for RE and manufacturing in general. The country is on its way to 100% RE in its electricity mix and has a developing manufacturing sector. However, political instability and a small scale of merchandise exports might challenge its potential to scale.

10 **Tanzania (3/7).** Tanzania is the seventh-highest importer from China on our shortlist. It has policies for renewable energy and manufacturing; manufacturing represented $5Bn of GDP in 2021. Its infrastructure is perceived as average, while its projected solar demand and ability to export are among the lowest on our shortlist.

Value chain and product focus for each African country

Our assessment identified 10 solar photovoltaic (PV) and battery opportunities across the continent—four in solar PV and battery materials refining, three in solar PV assembly, and three in battery materials refining.

Solar PV module manufacturing

The Solar PV module manufacturing value chain comprises four main steps: the production of wafers from polysilicon and chemicals, wafer production, cell manufacturing, and module assembly (Exhibit 3).

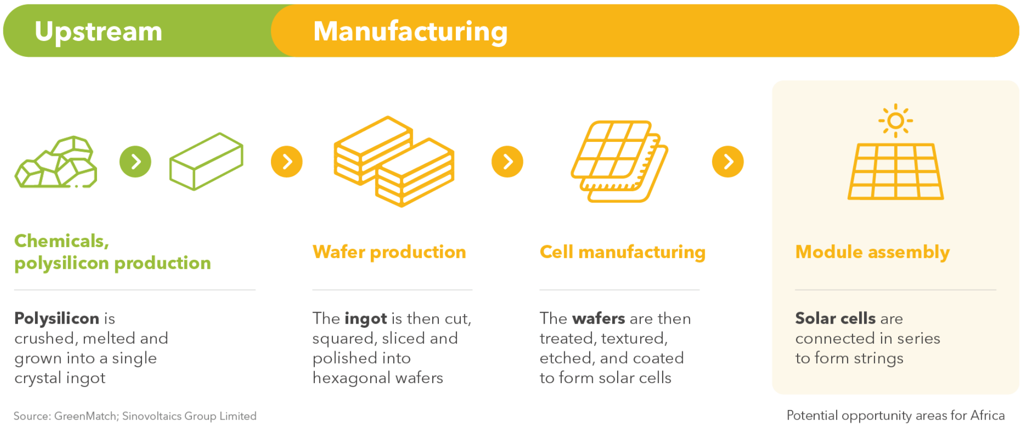

Exhibit 3
The Solar PV module manufacturing value chain has four main steps.

African solar PV manufacturing could start by prioritizing the cell manufacturing and module assembly steps. This is due to less technological and chemical complexity, input-import and product-export opportunities, labor availability, and existing solar panel assembly. Polysilicon and wafer production could be considered when other manufacturing steps scale up, as production of these components is complex and requires high energy availability.

The feasibility, market potential, and competitiveness of solar PV in Africa were assessed across seven metrics: (1) availability of raw materials, (2) human resources capability, (3) infrastructure readiness, (4) capital intensity per industrial unit, (5) enabling policies and regulations, (6) demand dynamics, and (7) production competitiveness.

After assessing the sample countries across these metrics, we identified that solar PV manufacturing is immediately feasible in five countries. These countries are, in order of feasibility:

1. **Egypt:** Egypt's highest feasibility score is driven by high manufacturing value added (MVA), VA infrastructure availability, and labor capabilities; Egypt also has the highest competitiveness score due to existing adjacent industries.

2. **Tunisia:** Much like Egypt, Tunisia's feasibility score is primarily driven by high MVA, availability of manufacturing labor, and competitiveness driven by existing adjacent industries.

3 **South Africa:** South Africa's feasibility is driven by high MVA, infrastructure availability, high competitiveness based on adjacent industries, and low importation costs.

4 **Morocco:** Morocco's feasibility is driven by high MVA, infrastructure availability, labor competitiveness, and competitiveness based on the presence of adjacent industries. However, Morocco faces slightly higher input importation costs from China.

5 **Algeria:** Algeria's overall fifth-place ranking is driven by high estimated additional installed solar power capacity and infrastructure availability.

Nigeria, Namibia, Kenya, Ghana, Côte d'Ivoire and Rwanda would be the next six countries prioritized from a feasibility point of view. Building local solar PV manufacturing is possible in each of these markets as well but will require incremental effort to overcome some of the deterrents to investment. Given political commitment to accelerate local manufacturing in some of these markets, particularly Nigeria and Kenya, we see these as significant opportunities as well.

Estimated module assembly costs in all shortlisted countries are, however, currently higher than average costs in China (Exhibit 4).

Cost-competitiveness of PV module assembly

Production cost*, *$cent/W* *All cost based on stable energy markets (does not include current Poly-Si prices)

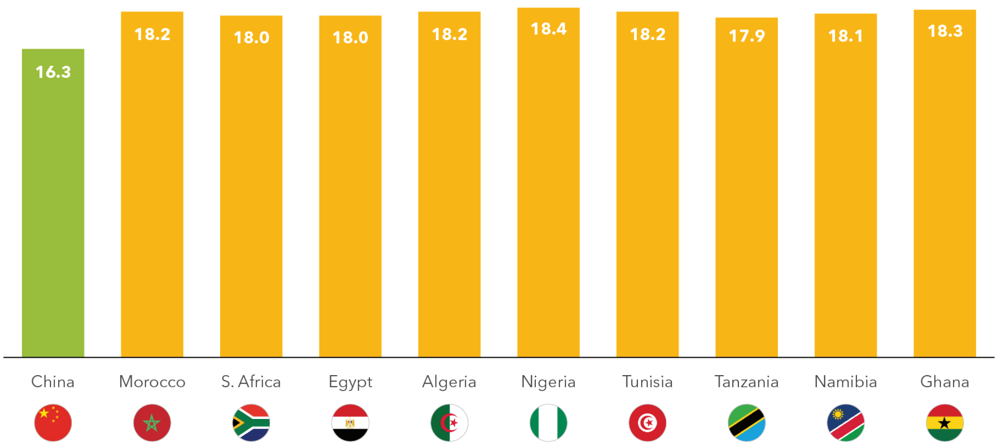

Exhibit 4

African solar PV manufacturing can be cost competitive with China.

Battery manufacturing

The battery manufacturing value chain has six main steps: mining, refining, cell components, cell manufacturing, packaging and integration, and recycling (Exhibit 5). Assessing the specifics of shortlisted countries and the critical success factors for each step shows that the two most feasible industries in Africa are (1) refining and (2) packaging and integration.

Refining includes the refining and processing of materials into usable production. Critical success factors include being close to the source of raw materials, complex technology, process competence to perform safe and cost-effective refining, and ample energy supplies.

BESS production value chain

Exhibit 5

The battery manufacturing production value chain consists of six steps.

Packaging and integration involve assembling cells into modules, modules into packs, and connecting hardware and software into complete packages. Critical success factors include cost-efficient assembly competence; integration of battery management systems and hardware into packs; and minimizing the complexity and cost of a battery pack. However, research indicates there is currently insufficient local demand for building one giga-factory in Africa. This opportunity can be considered once the market has matured.

The assessment used ten indicators to assess the feasibility, market potential, and competitiveness of mineral refining in Africa: (1) availability of raw materials, (2) labor productivity, (3) skill availability, (4) infrastructure readiness, (5) available power, (6) maturity of complex manufacturing, (7) enabling policies and regulations, (8) ability to export, (9) demand dynamics, and (10) production competitiveness.

Our assessment shows that battery manufacturing can begin with mineral refining in five shortlisted countries:

1. **Ghana:** Ghana actively mines lithium and scores highly on feasibility, which means it could refine both local and imported lithium.

2. **Morocco:** Morocco actively mines cobalt reserves and is already engaged in primary and secondary refining. The country could expand its refining capacity by importing more raw materials.

3. **Namibia:** Namibia actively mines lithium and scores highly on feasibility, which means it could refine both local and imported lithium.

4. **South Africa:** South Africa has the largest manganese reserves in the world and scores highly on feasibility, indicating a high likelihood of success for refining manganese. South Africa emerges as the only country with a credible battery-energy-storage-system (BESS) packaging opportunity, given that its projected demand is the highest on the continent. However, the near- and intermediate-term opportunity remains limited given the scale of demand in the next 5-10 years.

5. **Tanzania:** Tanzania has large nickel reserves with a high nickel ratio has has a high potential to start mining in the coming years. Therefore, Tanzania offers the top nickel-refining opportunity in Africa.

An analysis of battery-material refining shows that African countries can be cost-competitive with China for various minerals (Exhibit 6).

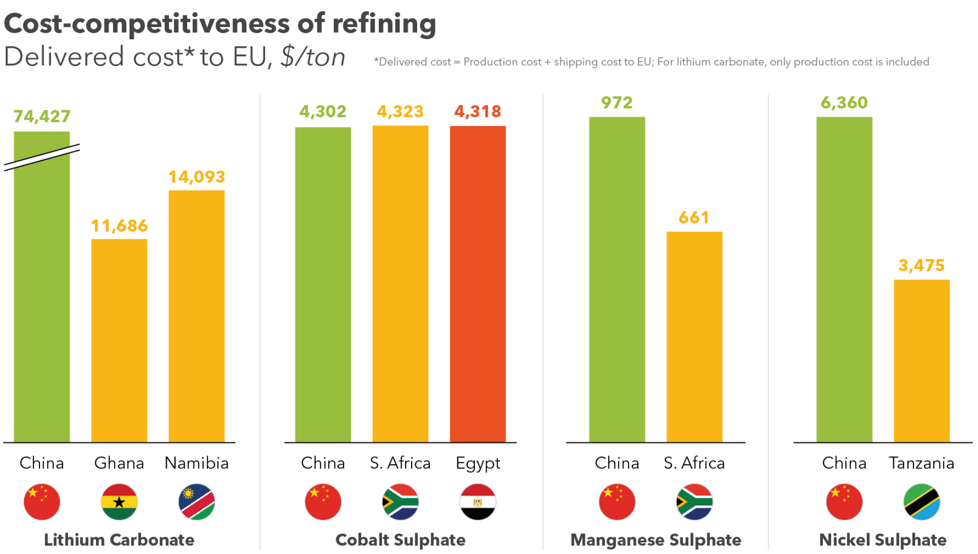

Exhibit 6

African battery material refining can be cost-competitive with Chinese refining.

Africa renewables manufacturing from a Chinese renewables energy industry perspective

China pursues active foreign direct investment (FDI) across Africa and has prevalent bilateral agreements in place based on South-South cooperation and the "Belt and Road Initiative." The top recipients of China FDI in Africa are estimated to be Kenya, South Africa, Nigeria, Senegal, and Tanzania[15].

In manufacturing industries, Chinese companies have built factories in several sectors, including automotive, cement, and appliances However, at the time of this report, the only three projects in the renewables space are facilities in South Africa operated separately by Jinko, Seraphim and Talesun—all for solar module assembly.

In solar PV, Chinese companies lead PV module supplies in Africa (55%) and are active in engineering, procurement, and construction (EPC) in solar products (19%) but only represent 5% of owners/operators.[16]

We looked at 15 Chinese solar PV manufacturers and 15 battery manufacturers based on multiple criteria, including footprint in Africa, overseas capacity, exposure to the US and Europe, and recommendations from Chinese industry. We conducted interviews with these manufacturers to (1) identify opportunities for solar module assembly and battery material refining and (2) determine the main "pull" factors and perceived drawbacks of such investments Their assessment of the opportunities is shown in Exhibit 7.

Where are the opportunities situated on the continent?

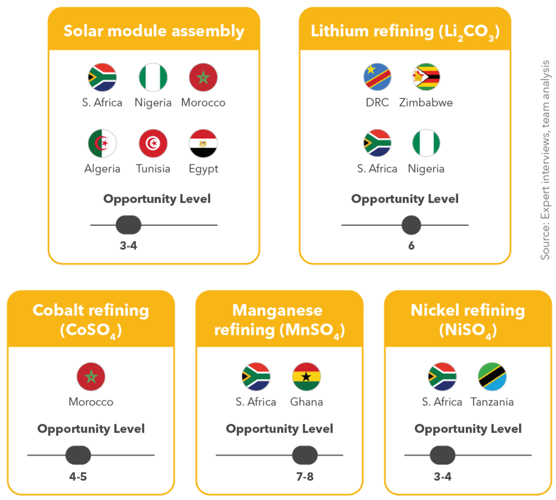

Exhibit 7
Industry players ranked the opportunity level of renewables manufacturing on the continent.

Catalysts for investing in Africa's solar PV manufacturing

Chinese solar PV manufacturers suggested several factors should provide a catalyst for investment in PV manufacturing in Africa.

1 **Increased local market potential:**
A large, growing, and profitable solar market is a prerequisite for Chinese manufacturers to build factories in Africa, as it is the safest way to ensure revenue, given the export uncertainties. Chinese players would like to see Africa's solar demand boosted by national plans for solar capacity, continuous solar feed-in-tariff schemes, and regular solar tenders. Investments could also be attracted by secured offtake, either by prioritizing procurement or assigning development rights to solar stations.

[15] *Johns Hopkins University's School of Advanced International Studies - China Africa Research Initiative*

[16] *UDI database from S&P Global Market Intelligence (2022)*

2 **Enhanced production factors:** Cost competitiveness of solar PV products can only be achieved if there are strong local production factors, including labor force, utility, and infrastructure. To attract Chinese manufacturers' investment, Africa should consider incentives for local manufacturing, labor force improvements, infrastructure support, a secured supply of low-cost green electricity, and preferential financing packages.

3 **Strengthened local supply chains:** Local capacity of solar PV assembly materials is largely missing in Africa, including solar PV glass, which is costly to ship. Chinese manufacturers would like to see local supply chains strengthened by reducing import barriers (e.g., low tariffs or tax waivers for material imports) and cultivating adjacent industries (e.g., building local capacity and creating industrial zones to gather value chain partners).

4 **Improved enabling environment:** Also crucial is a stable macro/micro environment with low sovereign risks, few public security issues, and good bilateral relations. Chinese manufacturers would like enhanced security levels for factory sites and societies.

Catalysts for investing in Africa's battery refining industry

Input provided regarding battery refining revealed many similarities with solar PV manufacturing needs, albeit with a stronger focus on securing raw materials

1 **Secured raw material through access to mines:** Close proximity to mines—and the associated reduction in potential shipping costs—is the top motivation for Chinese manufacturers to build refineries overseas. Given that Africa has rich mineral resources, it could be highly attractive to Chinese manufacturers. This advantage, though, could be further enhanced by accelerating the administrative process for mining and refining and by supporting partnerships between refiners and miners.

2 **Enhanced production factors:** Similar to solar PV, strong production factors are needed, including a specific emphasis on stable power and water supplies to ensure continuous operation. Chinese manufacturers would appreciate utility support on captive power plant investment and administrative processes for surface-water abstraction certificates. Improved labor force and tax benefits would also be attractive factors.

3 **Strengthened local supply chains:** Investments in adjacent industries and lower import barriers are required to strengthen Africa's supply chain for battery refineries. For example, sulfuric acid is required in most refinery processes, and it is challenging for logistics and warehousing to manage. Further restricting manufacturing interest is the lack of production capacity for sulfuric acid and other key input materials.

4 **Improved enabling environment:** It will be crucial to offer Chinese players a stable macro/micro-environment with low sovereign risks, free flow of foreign capital, and good bilateral relations. Chinese manufacturers also voiced support for lower currency control in the host countries used for mining operations.

Existing tools and mechanisms to encourage renewables manufacturing, although several gaps and barriers work against further growth.

Africa already has several enablers to attract potential investments in renewables manufacturing. They fall into three main categories: fiscal incentives, local content requirements (LCR), and capability building.

1. **Fiscal incentives:** Fiscal incentives have been a driver of market growth for renewable energy product manufacturing. They include VAT and import duty exemptions, reduced corporate income tax, accelerated depreciation on equipment, and tax holidays for investors.

2. **Local content requirements (LCRs):** Local authorities have encouraged manufacturers to derive a certain percentage of the final value of renewable energy products from domestic firms. These policies were enacted to develop local industries using tender requirements, targets, and commitments.

3. **Capability building:** In some cases, the local workforce is trained with technical expertise for renewable energy product manufacturing. This capability growth was achieved through joint ventures with international renewable energy companies, through academic institutions, and investment in R&D within the renewable energy space.

Tools and incentives have driven some success across the continent

Fiscal incentives have helped the growth of solar PV module manufacturing companies in South Africa, Egypt, and Tunisia. They have also facilitated the emergence of an assembly sector for solar energy products in sub-Saharan African countries, including Nigeria, Ghana, and Kenya.

LCR has aided the inclusion of local supply chains in developing renewable energy products and components. For example, 50% of the CSP solar field in the Kuraymat project in Egypt was manufactured locally[17].

Capability building has been driven by the development of training programs and the emergence of renewable-energy-focused learning centers and research institutions (e.g., the Regional Center for Renewable Energy and Energy Efficiency in Egypt, Research Institute for Solar Energy and Renewable Energies (IRESEN) in Morocco and National Agency for Energy Management in Tunisia). Moreover, the strengthening of local engineering, procurement and construction companies through technological transfer is enabled by joint ventures with international companies.

[17] *IRENA, Evaluating Renewable Energy Manufacturing Potential in the Mediterranean Partner Countries, 2015*

Other potential tools, such as transaction facilitation and funding of renewable energy manufacturing, have already been deployed in Africa. To date, though, these efforts have generated little noticeable impact in capability building.

While several enabling factors are in place, there are also numerous gaps and barriers to the success of renewable energy manufacturing in Africa. Stakeholder conversations consistently revealed opportunities were diminished by four aspects:

1. **Absence of necessary production factors:** Inadequate technical capabilities—such as a dearth of local expertise in high-value manufacturing, and a low number of renewable-energy-related educational programs—contribute to the perception that Africa lacks the necessary labor pool for production operations; "labor productivity is low for assembly, let alone (for) more complex products," one stakeholder commented. Africa is also seen as having constrained infrastructure and utility support. For example, the high cost of electricity is further compounded by unreliable supply in some cases, and less developed transport infrastructure in others (e.g., roads and ports), which may adversely impact opportunities for intra-Africa trade of renewable energy products. "Power/water is generally in short supply," and this lack of "bottom-line criteria" limits investment.

2. **Weak local supply chains:** Import barriers, including high tariffs and taxes on equipment and components, cause a competitive disadvantage, while many African countries lack adjacent industries such as glass, aluminum, and sulfuric acid. "Africa has (an) absence of local supply chain for not only core materials (e.g., PV cells), but also (for) the auxiliary materials (e.g., glass, back sheet, EVA)." This weakness requires additional time and investment for manufacturers to secure the necessary supply chain to enable production.

3. **Constrained regulatory development and incentive structures:** There are limited existing regulations to encourage manufacturing localization, and many countries lack a comprehensive regulatory framework for designing and implementing renewable energy manufacturing programs. Additionally, there is an absence of incentives to attract renewable energy manufacturers and encourage local value creation. "We will consider building solar factory if governments approach us with attractive incentive packages, but that's missing in Africa," said one stakeholder. Other stakeholders mentioned a lack of "clear planning" and the stability and consistency of policies that impact investment.

4. **Absence of incentives to boost local demand:** Most African countries lack adequate incentives to promote local and regional demand for renewable energy products. For example, many countries lack clear solar plans and feed-in-tariff programs to encourage solar panel manufacturing at scale. This lack of local demand was seen as "a critical factor hindering development" by stakeholders, who cited the need for local demand to drive further investments throughout the value chain—including further development in the supply chain.

Other countries have used successful tactics to facilitate the manufacturing of renewable energy products

Countries outside Africa have facilitated renewable energy product manufacturing by implementing favorable regulations, offering capital benefits, and investing in R&D.

1 **Regulatory environment:** The successful growth of a country's renewable energy product manufacturing sector can be enabled by comprehensive strategy development and policy implementation to strengthen supply chains, spur local demand, and exploit export opportunities. Malaysia, for example, created a 10% sales tax exemption on locally manufactured solar PV modules. China offered a reduced corporate income tax to clean energy manufacturers. Beneficial regulatory actions include:

- **Fiscal incentives (e.g., lower corporate income tax, VAT, and import duty exemptions for inputs)**
- **Import tariffs imposed on imported components**
- **Ban on dumping of materials from other markets**
- **Execution of local content requirements**

2 **Capital benefits:** Manufacturers of renewable energy products are further incentivized by capital benefits. For example, Indonesia established a Sustainable Energy Fund (SEF) grant to encourage rooftop solar systems, incentivizing local demand and attracting investors; Maharashtra, India, allocated government land to solar panel manufacturers. Capital incentives can include:

- **Access to low-cost capital**
- **Provision of guarantees for long-term assets and equipment**
- **Availability of land (at affordable prices) to set up manufacturing plants**
- **Accelerated depreciation on equipment**

3 **R&D:** Long-term sustainability and competitiveness of the renewable energy manufacturing sector can be facilitated through innovation and technology development. In Germany, for example, the government funded R&D on lower-cost solar PV under the Photovoltaics Innovation Alliance. R&D has been facilitated in various countries by:

- **Running competitive innovation programs**
- **Direct funding to manufacturing companies**
- **Financial support to research and academic institutions**

Learnings from these global examples are being incorporated into the approach that philanthropies and other stakeholders can adopt in scaling renewable energy manufacturing in Africa.

Potential interventions and proposed pathway forward

Stakeholders, especially philanthropies, could deploy these levers to scale renewable energy manufacturing in Africa.

Capability building: Help organizations strengthen their capabilities through technical assistance, training, and tools

Knowledge: Discover, develop, interpret, and share knowledge throughout the sector

Advocacy: Support decision-making institutions in crafting and implementing policies that provide conducive business climates

Convening: Establish forums for ideas and exchange

Pilot: Support small-scale experiments or pilots for innovation and first-of-their-kind projects

To bridge gaps in Africa renewable energy manufacturing through a combination of these levers, this report proposes four potential overarching program types, each with a different approach to driving growth.

1 **Policy: Enable the set-up of a best-in-class business environment.** Inform, train, and support African government officials to accelerate and bolster their policymaking for "Africa for Africa" renewable energy manufacturing. Four levers could be used: capability building (e.g., develop policy awareness programs and policy master classes); knowledge (e.g., research on country-specific policy pathway and policymaking toolkits); advocacy (e.g., sponsor advocacy organizations to articulate the Africa renewable energy manufacturing policy needs); and convening (e.g., support policy forums and high-level dialogues).

2 **People: Build Africa's future renewable energy manufacturing workforce**. Sponsor the training, employment, and career development of renewable energy engineers and technicians in Africa, focusing on solar PV, battery refinery, and key adjacent industries. Three levers would be used: capability building (e.g., develop renewable energy technician schools, online education programs for renewable energy manufacturing, and renewable energy scholarship programs); knowledge (e.g., workforce best practices, online library for renewable energy manufacturing technology); and convening (e.g., career centers, labor information exchange platforms).

3 **Anchor: Attract mature renewable energy manufacturers at scale in Africa.** Provide mature renewable energy manufacturers with better access to consulting and financing services and cultivate a robust renewable energy manufacturing ecosystem in Africa. Four levers would be used: knowledge (e.g., business model support, legal and tax consulting services, national playbooks for renewable energy factory financing); advocacy (e.g., tailored advocacy and policy negotiations for renewable energy factory projects); pilot (e.g., grant support for scaled renewable energy factories); and convening (e.g., a global alliance for Africa renewable energy manufacturing).

4 **Accelerator:** Incubate Africa's renewable energy manufacturing projects. Provide end-to-end grant support for renewable energy and adjacent manufacturing projects in Africa, from planning and financing to operations and sales of end products. Four levers would be used: knowledge (e.g., business model support, market intelligence reports); capability building (e.g., renewable energy manufacturing boot camps, renewable energy factory twinning visit programs); convening (e.g., innovative financing hubs); and pilot (e.g., grant support for pilot renewable energy/adjacent factories, power solutions).

Four overarching programs are proposed to bridge the gaps

	Policy: Enable the setup of a best-in-class business environment *Inform, train, and support African government officials to accelerate and bolster their policy making for "Africa for Africa" RE manufacturing*	**People: Build Africa's future RE manufacturing workforce** *Sponsor the training, employment, and career development of RE engineers and technicians in Africa*	**Anchor: Attract mature RE manufacturers at scale to Africa** *Provide mature RE manufacturers with better access to consulting and financing services, and cultivate a robust RE manufacturing ecosystem*	**Accelerator: Incubate Africa RE manufacturing projects** *Provide end-to-end grant support for RE and adjacent manufacturing projects in Africa, from planning, financing to operations and sales*
Capability building	*RE manufacturing policy awareness* *RE policy master class* *RE leadership development*	*RE technician school* *RE manufacturing online education* *RE scholars* *RE worker exchange*	*N.A.*	*RE manufacturing boot camp* *RE factory twinning program*
Knowledge	*RE manufacturing online platform – policy module* *Country-specific policy pathway* *Policymaking toolkits*	*RE manufacturing online platform – tech module* *Workforce best practices*	*Business model support* *Legal and tax consulting services* *Financing playbook*	*Business model support* *Market intelligence reports* *RE manufacturing online platform – project and product info module*
Advocacy	*RE manufacturing policy advocacy*	*N.A.*	*RE factory incentive package negotiation*	*N.A.*
Convening	*RE manufacturing policy forum* *High-level dialogue on Africa RE manufacturing*	*Career center* *Labor info exchange* *High-level dialogue on RE workforce*	*Global alliance of africa RE manufacturing*	*Innovative financing hub*
Pilot	*N.A.*	*N.A.*	*Grant for scaled RE capacity investment*	*Grant for pilot RE/ adjacent factories* *Grant for power solutions*

With adequate investments in these four programs, there is a potential to achieve 10 scaled renewable energy factories; ten pilot renewable energy/adjacent factories; 3,000 trained renewable energy technicians; and 500 qualified future leaders, all supported by a best-in-class business environment (Exhibit 9).

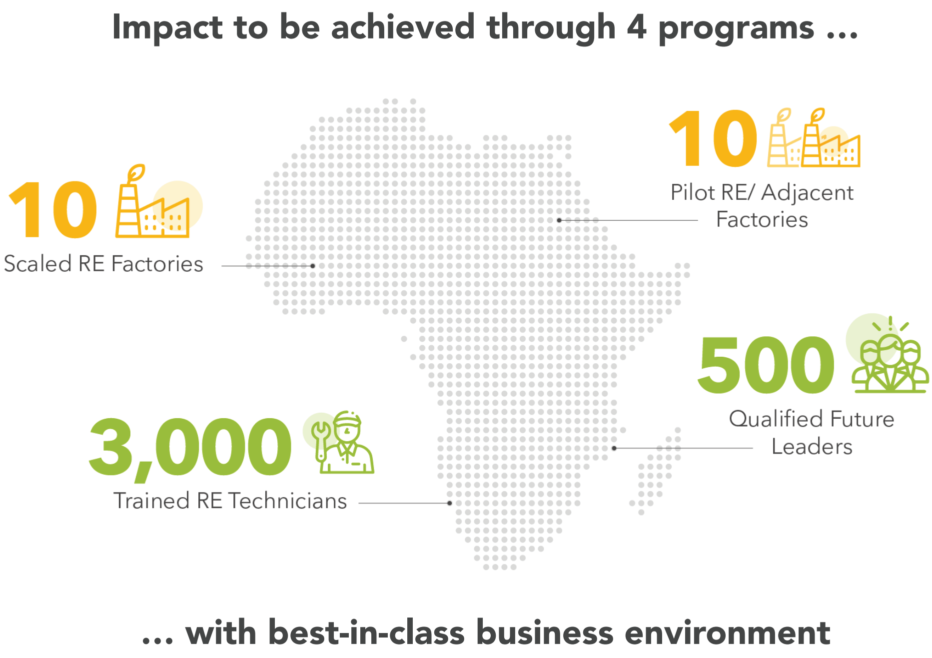

Exhibit 9
Significant impact in renewables energy manufacturing in Africa could be achieved through four programs.

Africa can seize the opportunity to build a leading, world-class renewables industry

Africa has many of the right ingredients to build a globally-competitive renewable energy ecosystem—it has the demand, the natural resources, the trade partnerships, and many supporting tools and incentives. With the right approach, several African countries could emerge by 2030 as significant players in the sector, benefitting the entire continent.

By identifying the most feasible entry-points in the renewable energy value chain, the best locations to create opportunities, and the right partners, Africa can start to attract investment and expertise to build a competitive edge. The strong growth outlook for African economies, coupled with the drive for a global transition to cleaner energy, make this the right time to start building Africa's renewable energy future. We believe this could be the first step in a long and successful journey for African renewables.

Appendix

Investment attractiveness and readiness methodology

We assessed 14 African countries on their feasibility of manufacturing RE products, across seven categories: renewables demand, manufacturing scale, political stability, enabling policies and restrictions, trade relations with China, enabling infrastructure, and ability to export (Exhibit 10).

Renewable energy demand: Review of the current electricity mix in the country and projections for future mix. This analysis assumed ambitious climate policies, such as alignment to the Science-Based Target initiative (SBTi) of keeping a global temperature increase below 2 degrees Celsius. A high ranking indicated a projected solar capacity in 2030 equal two or beyond 2GW, while a low ranking indicated less than 1GW of solar capacity.

Manufacturing scale: Manufacturing value added (MVA) is calculated as a contribution to GDP by manufacturing. MVA includes a share of low tech and medium/high tech and included a qualitative review of complex and adjacent industries and country ambitions. High scores in the category indicated a generated value exceeding $10Bn, while a low score indicated a value below $5Bn in generated value.

Political stability: Scores were determined by using Worldwide Governance Indicators defined by the World Bank. High scores were considered to have an aggregate value greater than or equal to 150 from four select components. Low scores were given for values less than 125.

Enabling policies and regulations: This category ranks the ease of doing business with a country and includes a review of policies for stimulating renewable energy demand, manufacturing, and overall policy/regulatory effectiveness. Scores were compiled as an aggregate of select RISE indicators and/or the presence of specific policies that incentivize renewable energy manufacturing. High scores required a 200 threshold, while low scores were given to totals less than 100 or countries that did not have specific incentives for renewable energy manufacturing.

Trade relations with China: Figures are directly linked to total imports from China, with high scores requiring at least $6Bn in exports while low scores were given to export totals below $500Mn.

Enabling infrastructure: This category scores the overall quality of electricity supply, ports and roads, and other manufacturing enablers. High scores met or exceeded a 14 on the World Economic Forum's executive survey of electricity/ports/roads; low scores fell below 7.

Ability to export: This category reviews existing and relevant trade agreements and export volumes, both to other countries in Africa and globally. High scores totalled merchanded exports, excluding oil and gas, of at least $10Bn; low scores fell below $5Bn.

Exhibit 10

Countries were evaluated across seven dimensions and ranked high, medium or low on feasibility.

	HIGH	MEDIUM	LOW
RE demand assuming stringent climate policies	*Projected solar energy capacity in 2030 >= 2 GW*	*Projected solar energy capacity in 2030 < 2 GW and >= 1 GW*	*Projected solar energy capacity in 2030 < 1 GW*
Manufacturing scale	*Manufacturing GDP >= USD 10Bn*	*Manufacturing GDP < USD 10Bn and >= USD 5Bn*	*Manufacturing GDP < USD 5Bn*
Political stability	*Aggregate of 4 select components of World Bank Governance Indicators >= 150*	*Aggregate of 4 select components of World Bank Governance Indicators < 150 and >= 125*	*Aggregate of 4 select components of World Bank Governance Indicators < 125*
Enabling policies and regulations	*Aggregate select RISE indicators >= 200 and/or specific policies to incentivize manufacturing*	*Aggregate select RISE indicators < 200 and >= 100 and/or specific policies to incentivize manufacturing*	*Aggregate select RISE indicators < 100*
Trade relations with China	*Total imports from China >= USD 5Bn*	*Total imports from China < USD 5Bn and >= USD 500Mn*	*Total imports from China < USD 500Mn*
Enabling infrastructure	*Aggregate score on quality of electricity/ports/roads on the WEF executive survey >= 14*	*Aggregate score on quality of electricity/ports/roads on the WEF executive survey < 14 and >= 7*	*Aggregate score on quality of electricity/ports/roads on the WEF executive survey < 7*
Ability to export	*Merchandise exports globally (excluding O&G) >= USD 10Bn*	*Merchandise exports globally (excluding O&G) < USD 10Bn and >= USD 5Bn*	*Merchandise exports globally (excluding O&G) < USD 5Bn*

Ten countries were identified with medium or high feasibility. It is important to note that these countries represent a “first wave” of countries this report has explored. Other countries will be investigated in future efforts. The chart below (Exhibit 11) shows the first 14 countries examined, in order of highest to lowest assessment ranking.

High performance received a score of 1; medium performance a score of .5; low performance a score of 0.

Exhibit 11

Fourteen countries were evaluated across seven dimensions to assess feasibility of manufacturing renewables energy products in each country.

HIGH Performance	MEDIUM Performance	LOW Performance

	RE demand	Manufacturing maturity	Political stability	Policies and regulations	Trade relations with China	Enabling infrastructure	Ability to export	Overall assessment (out of 7)
1. Morocco	High	High	High	High	High	High	High	7
2. South Africa	High	High	High	High	High	Medium	High	6.5
3. Egypt	High	High	Low	High	High	High	High	6
4. Ghana	High	Medium	High	High	Medium	Medium	High	5.5
5. Algeria[1]	High	High	Low	High	High	Medium	Low	4.5
6. Tunisia[1]	Low	Medium	High	High	Medium	Medium	High	4.5
7. Nigeria[1]	High	High	Low	High	High	Low	Low	4
8. Namibia[1]	High	Low	High	Medium	Low	High	Medium	4
9. Kenya[1]	Medium	Medium	Low	High	Medium	Medium	Low	3.5
10. Côte d'Ivoire[1]	Low	Medium	Low	High	Medium	Medium	High	3.5
11. Rwanda[1]	Medium	Low	High	High	Medium	Medium	Low	3.5
12. Tanzania[1]	Low	Medium	Medium	Medium	Low	Low	Low	3
13. Senegal[1]	High	Low	High	Medium	Low	Medium	Low	3
14. Botswana	Low	Low	High	Medium	Low	Medium	Medium	2.5

[1] Countries with equal overall scores are ranked in decreasing order of GDP

Solar PV assessment methodology

Africa's solar PV manufacturing sector was assessed across seven metrics to determine feasibility, market potential and competitiveness with China (Exhibit 12).

Availability of raw materials: This metric evaluated the availability of quarts sand to produce silicon, a key component of solar PV manufacturing. *Score weight: 5%*

Human resource capability: This metric evaluated labor productivity and the percentage of the labor pool that is in manufacturing. Productivity greater than $15 and manufacturing workforce exceeding 10% scored high; low scores were given to workforces with productivity less than $10 and workforces with less than 5% in manufacturing. *Score weight: 15%*

Infrastructure readiness: Score given to the quality of electricity, ports and roads according to the World Economic Forum's executive survey. High rankings met or exceeded a score of 4.5; low rankings received a score of less than 3 on the survey. *Score weight: 15%*

Capital intensity per industrial unit: A measurement of the capital investment required, based on a project. Lower capital investments per unit (i.e., intensity) show a greater potential return for manufacturers. High scores were given to investments lower than $50Mn; low scores were given to projects that exceeded $150Mn. *Score weight: 10%*

Enabling policies and regulations: This category ranks the ease of doing business and includes a review of policies for stimulating Solar PV manufacturing and overall policy/regulatory effectiveness. Scores were compiled as an aggregate of select RISE indicators and/or the presence of specific policies that incentivize renewable energy manufacturing. High scores required a 75 threshold, while low scores were given to totals less than 50. *Score weight: 5%*

Demand dynamics: Measures the annual additional installed solar power capacity High ranks were given to capacity of at least 400 MW, while low ranks were given to additional installed capacities less than 50 MW. *Score weight: 25%*

Production competitiveness: Evaluates the cost competitiveness of production when compared to Chinese manufacturing. High rankings reflect African manufacturing within 20% of Chinese costs; low rankings reflect African manufacturing costs more than 40% than Chinese counterparts. *Score weight: 25%*

Exhibit 12

The feasibility, market potential and competitiveness of solar PV manufacturing was assessed across 7 metrics and ranked high, medium or low.

Feasibility and competitiveness assessment framework

		HIGH	MEDIUM	LOW
FEASIBILITY	**Availability of raw materials**[2] Weight = 10%	Availability of quartz sand to produce silicon	Partial availability of quartz sand silicon	Absence of quartz sand
	Human resource capability Weight = 30%	Labour productivity of >= $15; >= 10% of workforce in manufacturing	Labour productivity of < $15 and >= $10; < 10% and >= 5% of workforce in manufacturing	Labour productivity of < $10; < 5% of workforce in manufacturing
	Infrastructure readiness Weight = 30%	Score on quality of electricity/ports/ roads on the WEF executive survey >= 4.5	Total score on quality of electricity/ports/ roads on the WEF executive survey < 4.5 and >= 3	Total score on quality of electricity/ports/ roads on the WEF executive survey < 3
	Capital intensity per industrial unit Weight = 20%	Capital investment of USD 50Mn required based on project	Capital investment of between USD 50Mn and 150Mn required based on project	Capital investment of > USD 150Mn required based on project
	Enabling policies and regulations Weight = 10%	Score on select RISE indicators >= 75	Total select RISE indicators < 75 and >= 50	Total select RISE indicators < 50
COMPETITIVE-NESS	**Demand dynamics** Weight = 50%	Annual additional installed solar power capacity (MW) >= 400 MW	Annual additional installed solar power capacity (MW) < 400 and >=50 MW	Annual additional installed solar power capacity (MW) < 50 MW
	Production competitiveness Weight = 50%	=< 20% estimated increase in the cost of production when compared to China	>= 20% to =< 40% estimated increase in the cost of production when compared to China	> 40% estimated increase in the cost of production when compared to China

[2] *Polysilicon used in production of Solar PV cells is produced using metallurgical grade silicone, which is produced by reacting high grade pure silicon, wood and charcoal then used in the production of polysilicon*

Battery refining assessment methodology

Refining of individual battery metals in Africa was assessed across 10 metrics to determine feasibility, market potential and competitiveness with China (Exhibit 13).

Availability of raw materials: Countries with local, accessible reserves received a high score; a lack of reserves as given a low ranking, while the lack of data was given a neutral "medium" rank. *Score weight: 10%*

Labor productivity: Measured as a dollar value. High scores had productivity of at least $15; low scores were given to values under $10. *Score weight: 10%*

Skill availability: Measures the percentage of the workforce that is employed in manufacturing. High scores were given to countries with at least 10% of their workforce employed in manufacturing; low scores were given to those with less than 5%. *Score weight: 10%*

Infrastructure readiness: Score given to the quality of electricity, ports and roads according to the World Economic Forum's executive survey. High rankings met or exceeded a score of 4.5; low rankings received a score of less than 3 on the survey. *Score weight: 7.5%*

Available power: Measures the electrical grid capacity in the host country. High scores were given to countries that produced at least 40,000 MW of capacity; low scores were given for less than 10,000 MW of capacity. *Score weight: 2.5%*

Maturity of complex manufacturing: Measures the percentage of GDP attributable to manufacturing. High scores were given to countries with at least 20% of GDP derived from manufacturing; low scores were given to those with less than 10%. *Score weight: 2.5%*

Enabling policies and regulations: This category ranks the ease of doing business and overall policy/regulatory effectiveness. Scores were compiled as an aggregate of select RISE. High scores required a 75 threshold, while low scores were given to totals less than 50. *Score weight 2.5%*

Ability to export: Measures the countries current value of its exports, both globally and to other African nations. High scores were given to countries with at least $10Bn in exports; low scores for those with less than $5Bn in exports. *Score weight 5%*

Demand dynamics: This metric measures solar and wind capacity in GW and operates as a corollary for potential battery-energy-storage-system (BESS) capacity. High scores were given to countries with combined generating capacity of at least 10 GW; low scores were given for those with less than 5 GW. *Score weight 25%*

Production competitiveness: Evaluates the cost competitiveness of production when compared to Chinese manufacturing. High rankings reflect African manufacturing within 20% of Chinese costs; low rankings reflect African manufacturing costs more than 40% than Chinese counterparts. *Score weight 25%*

Exhibit 13

The feasibility, market potential and competitiveness of refining individual battery metals was assessed across 10 metrics and ranked high, medium or low.

Feasibility and competitiveness assessment framework

		HIGH	MEDIUM	LOW
FEASIBILITY	**Availability of raw materials** Weight = 20%	Local accessible reserves	N.A.	No reserves
	Labour productivity Weight = 20%	Labour productivity of >= $15	Labour productivity of < $15 and >= $10	Labour productivity of < $10
	Skill availability Weight = 20%	>=10% of workforce in manufacturing	< 10% and >= 5% of workforce in manufacturing	< 5% of workforce in manufacturing
	Infrastructure readiness Weight = 15%	Score on quality of electricity/ports/ roads on the WEF executive survey >= 4.5	Total score on quality of electricity/ports/ roads on the WEF executive survey < 4.5 and >= 3	Total score on quality of electricity/ports/ roads on the WEF executive survey < 3
	Available power Weight = 5%	>= 40,000 MW capacity	< 40,000 and >= 10,000 MW capacity	< 10,000 MW capacity
	Maturity of complex manufacturing Weight = 5%	Manufacturing GDP >= 20%	Manufacturing GDP < 20% and >= 10%	Manufacturing GDP < 10%
	Enabling policies and regulations Weight = 5%	Score on select RISE indicators >= 75	Total select RISE indicators < 75 and >= 50	Total select RISE indicators < 50
	Ability to export Weight = 10%	Merchandise exports >= USD 10Bn	Merchandise exports < USD 10Bn and >= USD 5Bn	Merchandise exports < USD 5Bn
COMPETITIVE-NESS	**Demand dynamics (BESS Focus)** Weight = 50%	Solar + Wind capacity in GW >= 10	Solar + Wind capacity in GW < 10 and >= 5	Solar + Wind capacity in GW < 5
	Production competitiveness Weight = 50%	=< 20% estimated increase in production cost compared to China	>= 20% to =< 40% estimated increase in production cost compared to China	> 40% estimated increase in production cost compared to China