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Manufacturing Localisation Potential in Renewable Energy Value Chains

Renewable Energy Localisation Potential

Prepared by BMA

Authors: Justin Barnes, Meghan King, Mbongeni Ndlovu, Kate Carstens, O'Neill Marais, Sean Ellis, and Dylan Kirsten.

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This research was commissioned by the LSF and was conducted independently by BMA. The lead consultant responsible for this report as well as the overall project was Meghan King. The opinions or recommendations contained in this report represent the views of the authors and do not necessarily reflect the views and opinions of the LSF.

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2 Acronyms

a-Si	Amorphous silicon
BESS	Battery Energy Storage System
BIS	Battery Information System
BMS	Battery Management System
BoP	Balance of Plant
BIPV	Building-integrated photovoltaic
C&I	Commercial & Industrial
CSP	Concentrated Solar Power
CPV	Concentrator photovoltaic
DOE	Department of Energy
DLC	Designated local content
DTIC	Department of Trade Industry and Competition
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement, and Construction
EMM	Electrolyte Manganese Material
EV	Electric Vehicle
GW	Gigawatt
IDC	Industrial Development Corporation of SA
IEA	International Energy Association
IP	Intellectual Property
IRP	Integrated Resource Plan
kW	Kilowatt
LCOE	Levelized Cost of Energy
ITAC	International Trade Administration Commission of South Africa
LAB	Lead Acid Battery
LCO	Lithium Cobalt Oxide
LFP	Lithium Iron Phosphate

LIB	Lithium -ion Battery
LMO	Lithium Manganese Oxide
LSF	Localisation Support Fund
LTO	Lithium Titanate Oxide
MW	Megawatt
NCA	Lithium Nickel Cobalt Aluminium Oxide
NRCS	National Regulator for Compulsory Specifications
NMC	Lithium Nickel Manganese Cobalt Oxide
NREL	National Renewable Energy Laboratory
OEM	Original equipment manufacturers
RE	Renewable Energy
REI4P	Renewable Energy Independent Power Producer Programme
SAREM	South African Renewable Energy Masterplan
SAWEA	South African Wind Energy Association
SA	South Africa
SEZ	Special Economic Zone
SSEG	Small scale embedded generation
TIPS	Trade and Industrial Policy Strategies
Twh	Terawatt-hour
VRB	Vanadium Redox Battery
VRFB	Vanadium Redox Flow Battery
WTO	World Trade Organisation

3 Executive Summary

3.1 South Africa's renewable energy value chains as drivers of manufacturing growth

The creation and development of new industrial value chains linked to renewable energy (RE) (and specifically as delineated in this study in the wind energy, solar photovoltaic (PV) and battery energy storage sectors) can act as a catalyst to support South African economic growth – ultimately providing a growth path out of the country's energy crisis. In addition, expanding productive capacity and enhancing competitiveness in these value chains has significant associated socio-economic and development related benefits for the country. As demand for RE grows, so too must South Africa's ability to localise and expand manufacturing capacity in key components of the RE value chains.

This is not without significant challenges, however. The familiar story of strained public-private relationships and mistrust, a relatively unattractive manufacturing investment environment, a comparatively and historically small local market, weak policy and regulatory frameworks, and poor controls means that the value proposition for localisation is heavily scrutinised by global technology owners and OEMs.

Although not insurmountable, given the positive current market growth outlook, what is clear is that if South Africa wants to re-industrialise behind RE opportunities, substantive changes will be necessary in the policy and regulatory landscape, along with the introduction of globally attractive manufacturing investment incentives. As the private sector increasingly moves into RE, market fundamentals become increasingly important compared to the public sector's procurement based on designation rules.

While daunting, to address the localisation challenge, the appropriate response is through tackling the transversal challenges of policy and regulatory frameworks, and attractive manufacturing investment incentives. Addressing these creates meaningful and significant progress towards localisation in all three RE value chains.

It is worth noting, however, that RE value chains are not a homogeneous group. Although many of the interventions to unlock localisation overlap, there are still significant differences between the value chain dynamics. For example, in the wind energy value chain, the industry is recovering from hugely inconsistent demand in the market, and consequently there is little optimism or appetite for localisation in the industry.

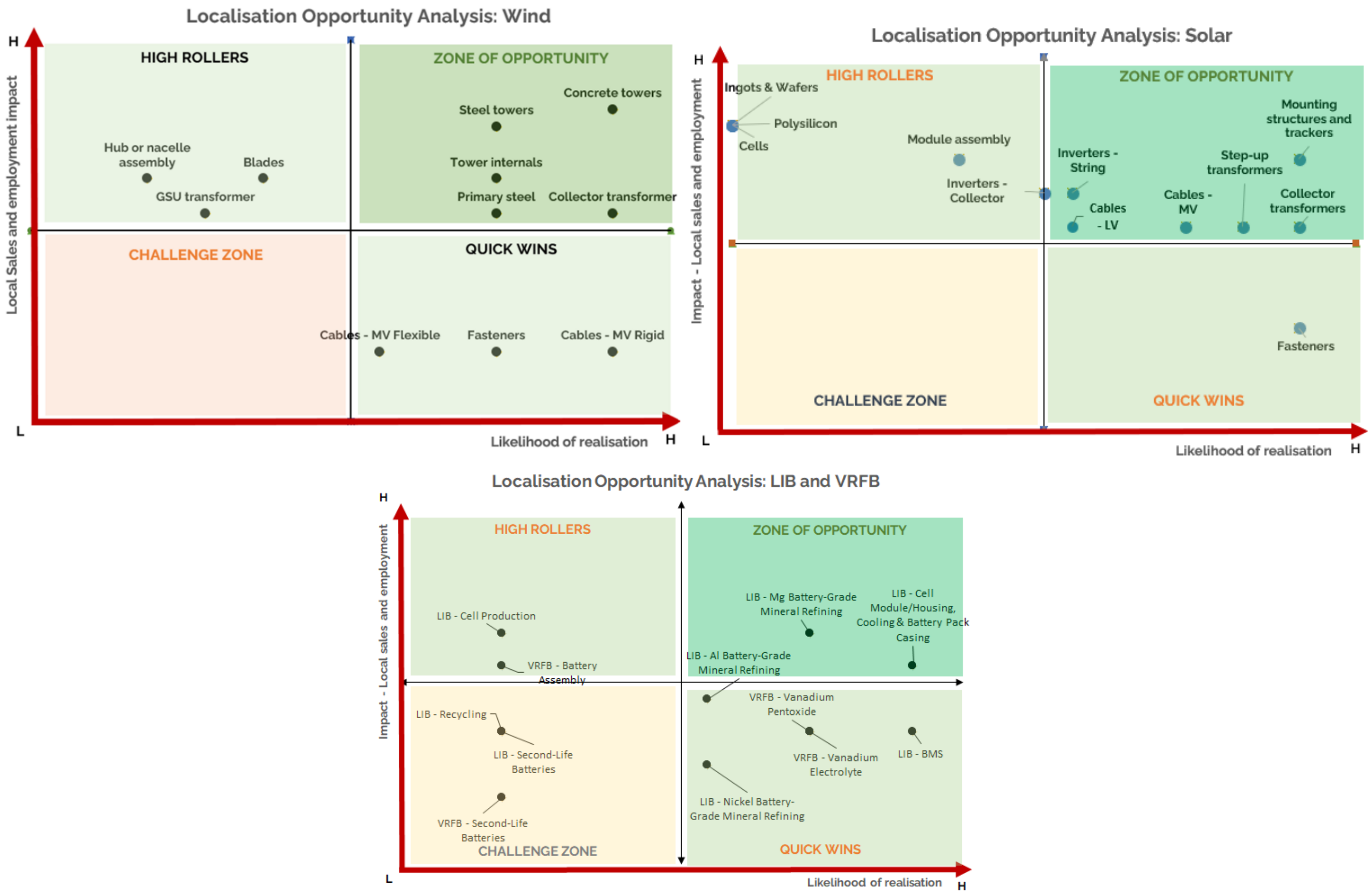
For solar PV, the dramatic surges in demand, juxtaposed with price sensitive customers in residential, commercial & industrial (C&I), and utility scale markets, has led the industry to become flooded with unregulated cheaper imported products. This has set a market price that undermines local production and growth and further erodes the investment business case with the outcome that localisation capacity and capabilities have been undermined.

In battery energy storage, challenges remain in capitalising on high value components with safely guarded intellectual property (IP) in the hands of foreign companies and finding a way to overcome the perpetual African problem – beneficiation of local minerals.

A window of opportunity does show itself in many components across the value chains. With the right supportive policies and partnering with the right firms with potential to expand production in these sectors, potential can be unlocked.

Highest priority components for localisation are presented in the figure below. Those with the highest impact and highest likelihood are prioritised in the *Zone of Opportunity.* Other components show potential through either high likelihood or high impact. Localisation prioritisation in this report focus on the components within the Zone of Opportunity.

Figure 1: Localisation Prioritisation Matrix - Renewable Energy *(scales not comparable)*



3.1.1 Zone of Opportunity Commodity Breakdown

Wind energy localisation

Concrete towers

There is currently excess concrete tower manufacturing capacity in South Africa, with three concrete tower plants in operation. Concrete towers, if located near a nucleus of wind energy demand, are competitive even against imported steel towers. Concrete tower components are highly localised (>99%) and present the highest likelihood and largest potential impact component for growth within the value chain as private demand is unlocked. Capitalising on private demand is essential for the concrete tower industry. The challenge remains that what that private demand is, and how it will behave, is currently unclear.

Steel towers

Currently there is only one steel tower manufacturer in South Africa, GRI Towers. Interviews suggest that domestic steel towers cost up to 60% more than imported steel towers. This renders local steel towers uncompetitive in the private domestic market. It remains a high priority component, but attention is needed to ensure greater levels of price parity with imports. Key interventions include stable demand, implementation and control of import duties, and local access to competitively priced steel.

Tower Internals

Tower internals represent a high priority group of components, especially in the secondary steel components for the steel towers. This includes anchor cages, tower extenders, flanges, door frames, platform brackets the highest impact components. Smaller components relate to the internal platforms, lifting gear, ladders, cable cages, etc. There is already capability and capacity in this space for some components.

Primary steel

Primary steel presents a high impact opportunity. In REI4P steel is designated, leading to the localisation of steel for towers and other tower components. However, local steel is comparatively expensive and in an open market private demand would likely favour imported steel.

Collector transformer

The collector transformer (one or two per wind farm) has a strong local footprint (>90% of collector transformers currently installed on wind farms are sourced from local manufacturers). This component is competitive and of a high quality with several manufacturers locally. Stable demand will ensure that this remains a key part of the local value chain.

Solar PV localisation

Mounting structures and trackers

Mounting structures and trackers represent a major growth opportunity. Local capabilities and surplus capacity exist currently. As local installations and associated manufacturing grows, the impact on sales and job creation could be high. The lack of standards in the industry for installation, however, has allowed for cheaper, inferior product to flood the market, impacting local producers' share of the market.

Transformers

Transformers, both step-up and collector, fall within the zone of opportunity based on high likelihood of realisation given that local manufacturers already dominate local supply. In South Africa, there are multiple large companies that have high quality products to supply into the market. The product is expensive to import and testing, verification, maintenance is crucial for this component, also favouring local supply.

Cables

Low and medium voltage cables both fall in the zone of opportunity since local manufacturers are already supplying the market. These firms have excess capacity to ramp up volumes should the demand require it. The main difference between low and medium voltage cables is that there is currently no quality standard for low voltage cables, which is the main cable used in solar PV arrays. Policy is thus required to establish and then enforce standards. If localisation is boosted, there is the potential to generate a significant number of jobs although the sales values relative to other solar PV components is comparatively small.

String Inverters

There are many different types of inverters used in the solar PV market, with the two main ones being central and string inverters. Ario is currently the only manufacturer of central inverters in South Africa, and significant investment in capacity is required to meet the demand potential. For string inverters, both established capability and surplus capacity exist. Both types of inverters have the potential to generate substantial sales and unlock medium levels of job creation, but central inverter manufacturing has a low likelihood of realisation relative to string inverter manufacturing.

Lithium-ion battery localisation

Mineral mining

The mining of manganese, aluminium and nickel used in lithium-ion battery cells is being undertaken in South Africa. However, due to the investments required to convert these materials into precursor battery-grade minerals, and with no cell production being in place, the dominant focus for these mined materials is on exports.

Cooling components

The cooling component for the battery packs are made of extruded aluminium. This can be sourced locally from component suppliers and so these components are opportunities for localisation. Access to technology for local suppliers is a key barrier to localisation.

Battery pack casing

A significant opportunity for localisation that has already been somewhat realised but can be expanded, is the design and manufacture of the battery pack casing. The design of these casings is controlled by the firm that assembles the battery pack, and the casing is made from metals such as steel and aluminium, as well as plastics. A range of external suppliers support the battery assembly firms with the base materials to manufacture these battery packs. Casings are therefore a localisation opportunity.

Battery management systems and battery information systems (Quick Win, but significant)

Key elements of all battery packs include the battery management system and the battery information system. These manage the internal and external processes of the battery system. Manufacturers look to own and closely control and manage this aspect of the process in-house. Hardware for BIS and BMS is thus the key opportunity for localisation.

Vanadium Redox Flow Battery Localisation

The vanadium required to produce vanadium redox flow batteries is mined in South Africa, with the production of the vanadium pentoxide also being undertaken domestically. The vanadium electrolyte production is being piloted, although actual battery assembly is currently not taking place. The localisation of the actual vanadium redox flow battery will require a "use-case" to realise its potential as an opportunity, either from private corporate or industry demand or at utility scale.

As with lithium-ion batteries, the reuse and recycling market for this technology is projected to grow as the demand increases. A lag in this market's development (for both LIB and VFRB) is expected given battery life and the resultant demand for recycling.

3.2 Ramping up localisation in renewable energy value chains

3.2.1 Interventions

While noting the value chains as not homogenous in entirety, the fastest and most effective means of ramping up manufacturing localisation in all three simultaneously is through addressing the transversal or collective challenges. These are highlighted in the table below:

Table 1: Key interventions for localisation of RE value chains

Intervention	Wind	Solar	LIB	VRFB
Updated IRP 19	A	A	A	A
Annual REI4P bid windows	A	A	A	A
Transparency for grid availability, grid allocation rules and grid connection timelines	A	A	A	A
Private projects reaching financial close and commencing building at >500MW annually	A	A		
Local content requirements for both private and public sectors established	B			
Import duty level revision or correctly applied	A	A	A	A
Capacitation of custom officials to correctly apply duties	A	A	A	A
Cluster for aligning value chain quality expectations and increasing capability of manufacturers	B		A	
Establish a global-standards aligned testing facility	B	A	A	
Development of a second manufacturer	C			
Access to competitively priced steel	B			
Investment into additional capability	B			
Minerals policy			A	A
R&D support			B	B
Purchase tax incentive			B	
EV offtake agreements			A	
Local content designation			B	

A= High priority; B= medium priority; C = Least priority

3.3 Conclusion

The growing demand for renewable energy, especially in South Africa which is facing an energy crisis, presents a unique opportunity for manufacturing localisation, providing significant benefits to the economy. While fraught with complexity, ramping up localisation in these value chains is most effectively done through prioritisation and addressing transversal interventions that impact the sector in its entirety. These interventions are summarised briefly as:

1. Ensuring Consistent Demand

The paramount objective within the renewable energy sector needs to be establishing reliable demand. To achieve this, several critical interventions are needed. Firstly, an updated Integrated Resource Plan (IRP) must be published. Furthermore, consistent bid windows in the Renewable Independent Power Producer Procurement Programme (REI4P) should be implemented. Ensuring transparency from Eskom regarding grid capacity and expansions is imperative.

Additionally, it is crucial to ensure the successful commissioning and connection of identified private projects to the grid. Private sector demand is an evolving aspect of the market, and understanding its dynamics, financing mechanisms, and investment velocity is essential. Clarity on the rules governing private sector engagement is equally crucial.

2. Protecting the Local Market

The second priority involves conducting a comprehensive examination of duty frameworks, duty levels, and tariff heading definitions across the entire renewable energy value chain. This examination will impact various component opportunities identified in all value chains. It is necessary to investigate the potential redesign of import tariffs.

In the context of batteries, a minerals policy is required to support the local beneficiation of minerals. The development of a beneficiation policy, although not a traditional market protection measure, will aid in reducing the importation of beneficiated products.

Once recommendations are formulated and approved, the focus should shift to effective implementation. Addressing the challenge of improper application of duties across the value chains requires engagement with industry stakeholders, enabling them to understand the methods used to circumvent import duties and enhancing the proficiency of customs officials in classifying and applying tariff headings correctly.

3. Enhancing the Competitiveness of Local Manufacturing

The third key enabler is elevating the competitiveness of local manufacturing. In these producer-driven value chains, standards and expectations are primarily influenced by original equipment manufacturers (OEMs) and intellectual property (IP) holders. These industries in South Africa are still relatively nascent compared to more established sectors like automotive manufacturing, resulting in non-uniform awareness of standards and expectations. A cluster platform that facilitates collaboration between OEMs and local manufacturers is a valuable solution to mitigate this challenge. This initiative can alleviate uncertainties about quality requirements, help local manufacturers meet OEM-mandated manufacturing excellence standards, and enable clear communication of standards. Furthermore, the industry can collectively work towards establishing local testing facilities, reducing the reliance on costly international testing. The cluster serves as not only a communication platform but also a unique mechanism for collective improvement, reducing the cost of supplier development in areas of generic and transversal operational challenges.

In an environment where swift responses to expanding markets are necessary, exploring more robust incentive packages is advisable to stimulate investment and upgrading. These incentives may include greenfield tax incentives, preferential lending rates for green technologies and renewable energy from the Industrial Development Corporation, and a Broad-based Black Economic Development Charter supporting supplier development and sector upgrading. Implementing such incentives will require a thorough examination of their impact and benefits to the industry as a crucial next step.

4 Introduction

South Africa's energy crisis is at a critical point. The South African Reserve Bank (SARB), indicates that each day of load shedding currently costing South Africa $51 million (Proctor 2023). With a forecast of 250 days of loadshedding for 2023, the projected cost to the country this year alone is $13 billion (Protor 2023). It is therefore critical to ensure the successful and rapid roll out of renewable energy in the country.

South Africa's present electricity generation capacity struggles to meet current demand and is only expected to increase at an annualised rate of 1%. South Africa is moreover largely reliant on coal for its supply of electricity (87% of total supply). South Africa's dependence on coal is forecast to decrease to 64% by 2030 as plants reach maturity and are decommissioned (Proctor, 2023). The largest growth is forecasted in the wind and solar energy sectors, although this is subject to transmission and distribution (grid) capacity being available.

Despite abundant natural advantages, South Africa has experienced several challenges with its roll out of wind and solar energy projects. This is evident from the limited successes of the various REI4P bid windows. These challenges have generated important lessons that will hopefully result in a more pragmatic and focussed roll out of RE generation in future.

4.1 This report

This report provides a consolidated overview of the three value chains assessed during the study (namely wind, solar PV and battery energy storage). The report is not exhaustive as its intention is to provide the reader with an overview of the manufacturing potential of renewable energy value chains. The report focuses of collective and cross cutting opportunities and challenges across the three value chains and presents localisation ramp-up recommendations that would secure the greatest impact across all three sectors simultaneously.

For sector-specific nuances and for greater detail on the manufacturing capabilities and capacities within each sector, the reader should refer to the Sector Reports that accompany this document.

4.2 Study objectives

Despite the challenges presented by South Africa's energy crisis, there are a range of RE generation opportunities, and as importantly, related opportunities to develop local manufacturing capability and capacity. The purpose of this study is to unpack the supply chain and existing technologies to evaluate what opportunities may exist to localise the manufacturing of wind energy components in South Africa.

4.3 Report structure and methodology overview

This project was delivered in two phases. Phase one encompassed both desktop and primary research and culminated in a value chain review, anchor demand analysis and an industry engagement summary. Phase two involved a localisation ramp up analysis which presented a roadmap to localisation for various components in the value chain, as well as cross cutting opportunities to support localisation within a value chain or across renewable energy value chains.

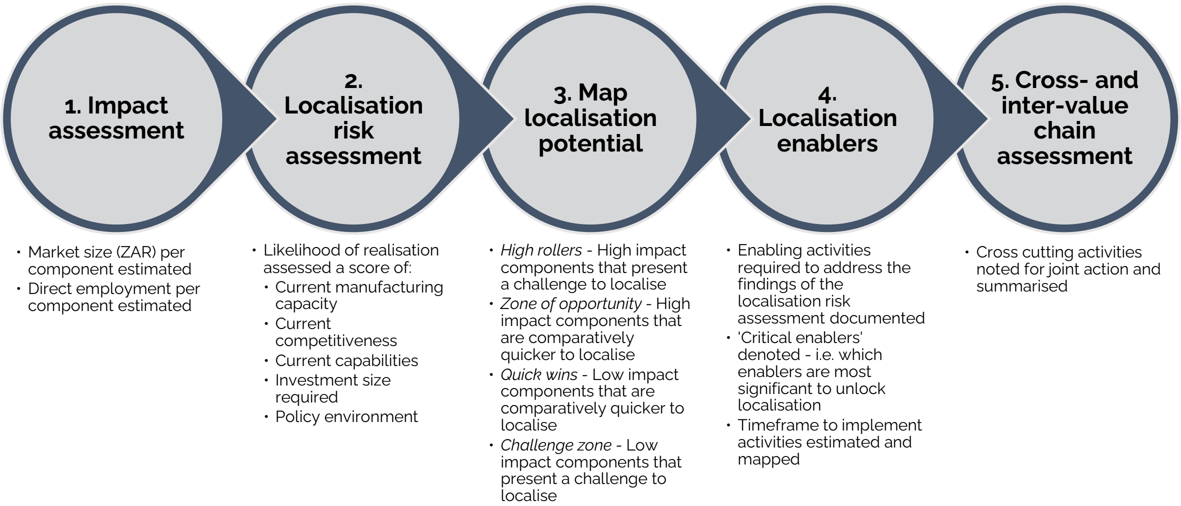
Details of the methodology deployed across both phases is presented below.

Table 2: Deployment phases of programme

Value chain review	» Review of current literature available for wind, solar, and battery storage value chains to establish the current technology available and upcoming technological disruptions » Map value chains to understand flow of components from raw materials to end-markets
Anchor demand analysis	» Estimate and forecast anchor demand (end of value chain demand) to be able to estimate demand through the value chain » Include demand and future investments from both public and private sector » Estimate grid capacity and expansion plans as a boundary condition for market growth
Industry engagement	» Engage with industry experts and manufacturers to confirm the breakdown of value chains » Visit current manufacturers of components within the value chain and evaluate the capacity and capability of servicing the demand for the sector (starting with the high priority components) » Engage with manufacturers that can alter their current operation to deliver components into the value chain or who are able to import and distribute components

The schematic diagram below provides and overview of the methodology process for the ramp up analysis.

Figure 2: Phase two methodology overview



5 South African demand for renewable energy

To put RE demand in perspective it is necessary to consider total future demand for electricity in South Africa, the combined installed grid capacity across technologies, and the outlook of these metrics. It is important to note that demand forecasts need to be realistic and motivated solely to give a manufacturing audience a guideline for the outlook of the industry. There are sufficient sources available that can provide an aspirational forecast with ambitious numbers. This forecast is not intended for that purpose.

5.1 RE demand assumptions

To forecast the RE demand through to 2030 a set of key assumptions, which are detailed in the following table, were made.

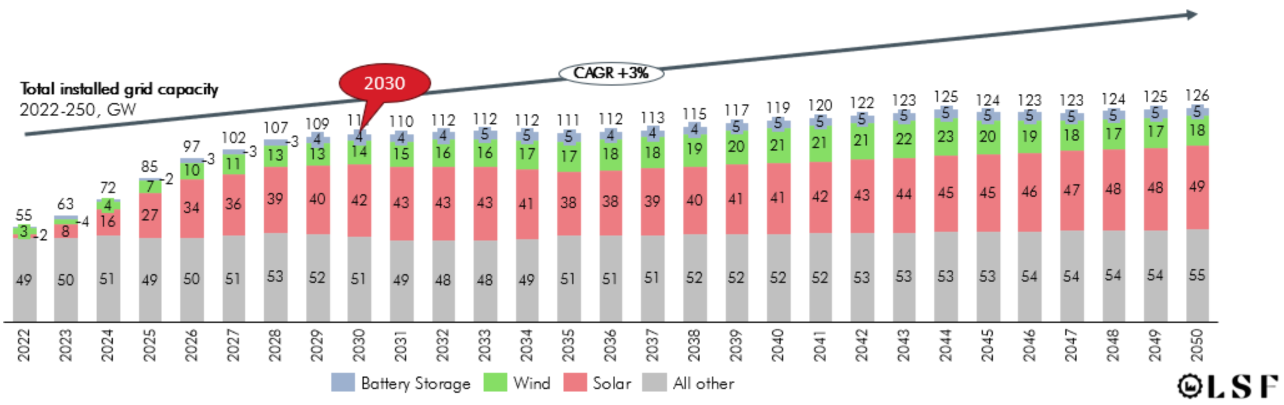
Table 3: Key assumptions for calculating the RE demand forecast to 2030.

	Sector	Key assumptions for BMA's modelling exercise
1	Wind	30% of the annual IRP 19 allocation for wind energy will be realised in alternating years (with gaps between years) by 2030
2		From Eskom TDP 2022 and SAREGS 2023 only 30% of the near term (up to 2025) forecasted capacity will be realized and 20% of the longer-term capacity (2025-2035) likely to be realised
3		Public demand will stabilise at 420 MW per year after 2030 alternating with high and low (30%) years
4		Steady state private demand (after 2035) is assumed to be 600 MW per year
5		The lifespan of a wind farm is assumed to be 20 years
1	Solar PV	The assumption is that public demand will stabilise at 400 MW per year after 2030. This number comes from and was supported by engagements with industry
2		The reported ESKOM numbers are high. An assumption is taken that only 65% of the near term (up to 2025) forecasted capacity will be realized and 40% of the longer-term capacity (2025-2035). This is used for the BMA forecast only. The numbers are used as they are for the high scenario from IRP and ESKOM.

	Sector	Key assumptions for BMA's modelling exercise
3		The steady state private utility demand (after 2035) is taken to be the average of demand 2031-2035 at 216 MW pa.
4		The forecast for SSEG in 2024 was taken as equal to 2023, thereafter declining steadily by 25% per annum until 2030, whereafter a steady state of 150 MW per annum is predicted, based on engagements with industry.
5		The lifespan of a solar farm is taken to be 10 years before re-powering (Levington pers. Comm.)
6		The amount of solar installed as of 2022 is taken to be 2,287 (CSIR report for utility) plus 2143 for SSEG (CSIR 2019 plus Eskom 2023)
1	Battery energy storage	The reported Eskom numbers are high. An assumption is taken that only 65% of the near term (up to 2025) forecasted capacity will be realised and 40% of the longer-term capacity (2025-2030). This is used for the BMA forecast. The numbers are used as they are for the high scenario from IRP and Eskom.
2		The utility scale demand will stabilise at 300 MWh per year
3		The storage duration for behind the meter battery storage is assumed to be 4 hours
4		The lifespan of a battery storage facility is taken to be 10 years

The figure below shows the total installed grid capacity forecast with the relevant technology splits. This is the combined output of the modelling and gives an overall view. In the initial period to 2030 there is some catching up with demand based on existing shortages of generation capacity. The growth in installed grid capacity then slows down as balance is reached between growth in electricity demand and growth in installed grid capacity.

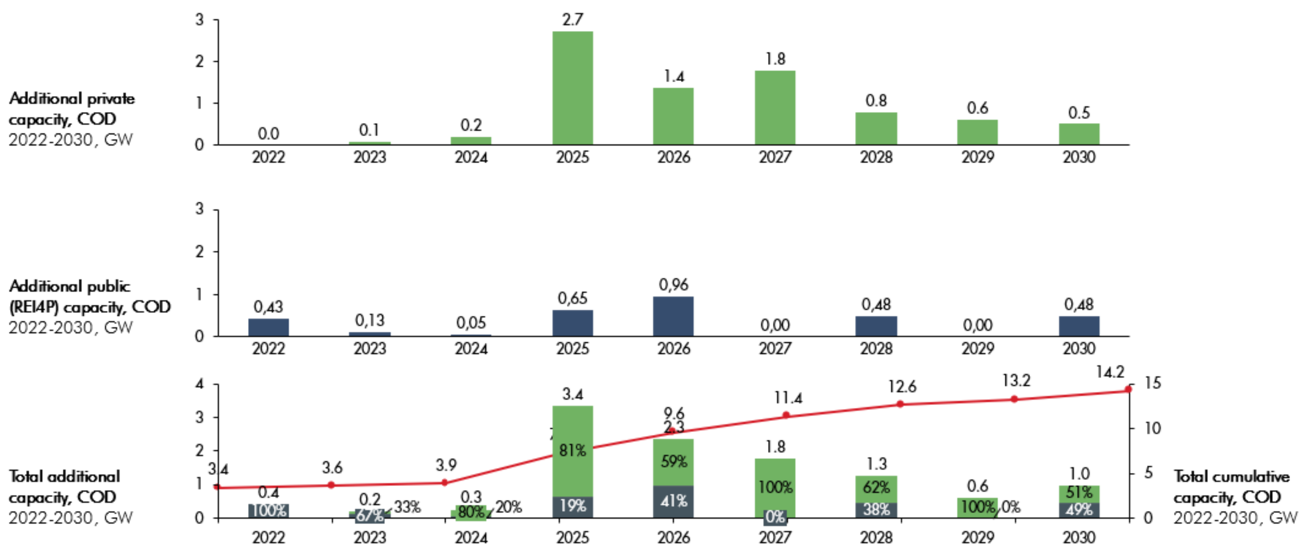
Figure 3: Total installed grid capacity in South Africa.



5.1.1 Wind demand

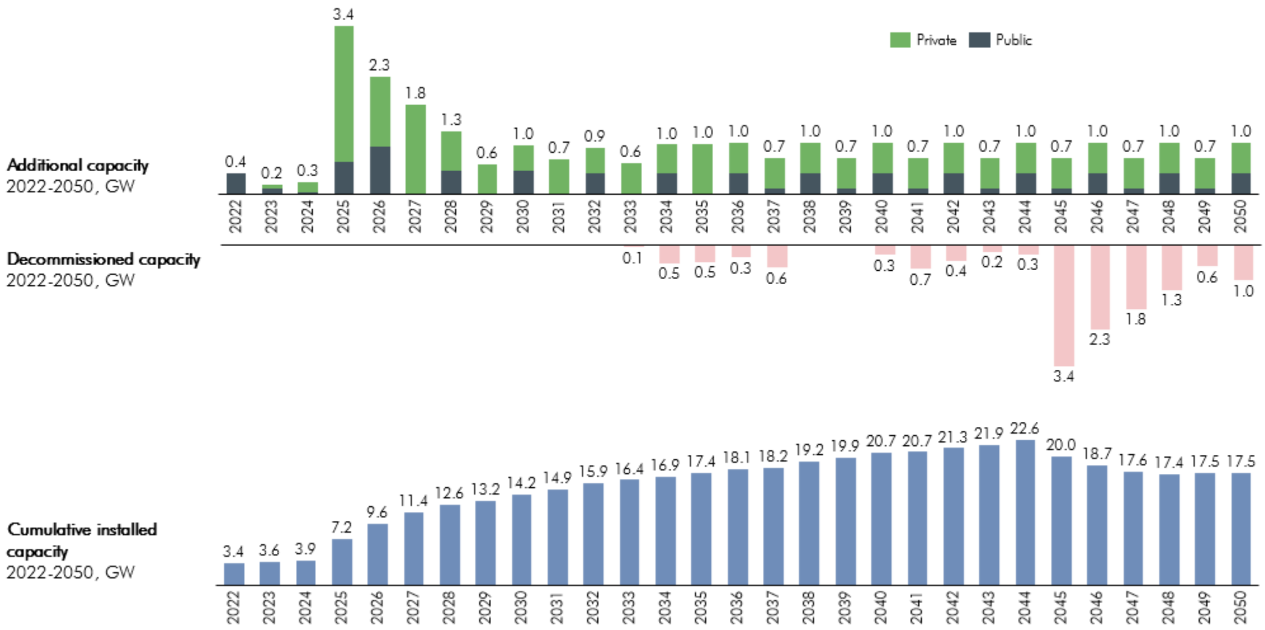
It can be seen from the previous figure that there is little demand for wind energy forecast for the next two years. This is mainly due to bid window 6 of the REI4P not selecting any wind projects; as well as delays in financial closure for wind energy projects from bid window 5 of the REI4P. Private demand is picking up, but it will be a couple of years before the first private projects are connected to the grid. The big spike in wind farms connecting to the grid is forecast to be from 2025. It is important to keep in mind that the demand from the manufacturing base materialises 1-2 years prior to the wind farm being commissioned and connected to the grid.

Figure 4: Forecasted demand for wind power up to 2030



The next figure completes the picture with a forecast up to 2050. It includes the decommissioning of wind farms after their expected 20-year lifespan. Finally, it also looks likely that private demand will be greater than public demand. Even with an updated IRP, the trust in public procurement is low and is likely to remain that way in future.

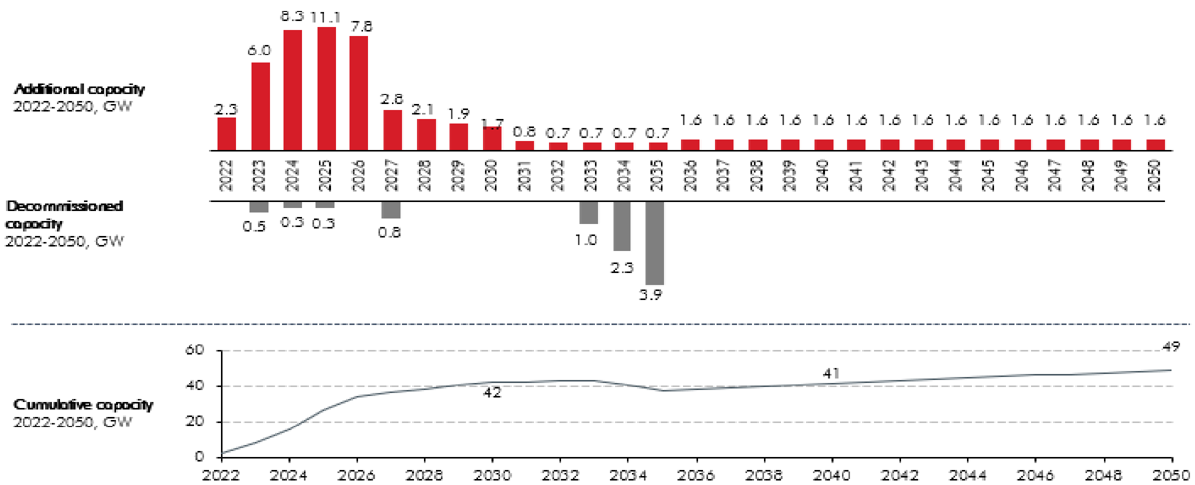
Figure 5: Wind energy forecasted demand up to 2050



5.1.2 Solar demand

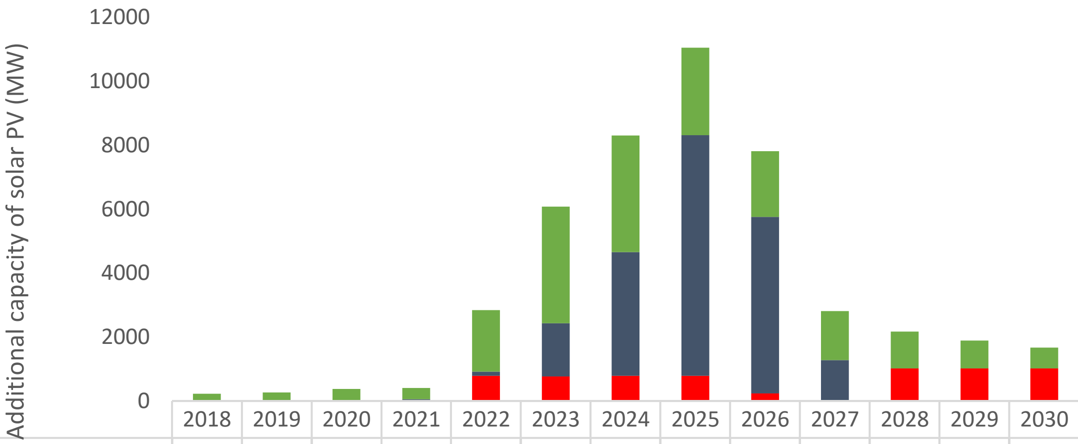
It is important to note that cumulative solar capacity is forecast to reach 42GW by 2030 (from the current base of 8GW in 2023, Figure 7). Solar demand is forecast to increase substantially to 34GW in the 2023-2026 period and then to remain between 30GW-40GW between 2026-2038. Total cumulative capacity is expected to reach 49GW by 2050 and takes into account decommissioning of some solar projects between 2022-2035 (see Figure 6 below).

Figure 6: Demand for solar PV during 2022-2050 showing detail on additional capacity, decommissioned capacity and cumulative capacity.



Solar energy demand is forecast to increase rapidly to a peak of 11GW of newly installed capacity in 2025, thereafter declining to 1.7GW by 2030 (see Figure 7). This rapid increase is as a result of loadshedding as companies and private households plan to alleviate the problem of lack of electricity brought about by the current energy crisis in the country in the short term. Stakeholder engagements indicated that demand should peak by 2025, and then fall to a stable base thereafter.

Figure 7: Newly installed solar PV capacity in South Africa during 2018-2030.



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Embedded Total	225	240	350	351	1 924	3 651	3 651	2 738	2 054	1 540	1 155	866	650
Private Utility Total	0	25	23	53	134	1 663	3 870	7 530	5 525	1 274	0	0	0
Public Utility Total					784	764	784	784	235	0	1 019	1 019	1 019

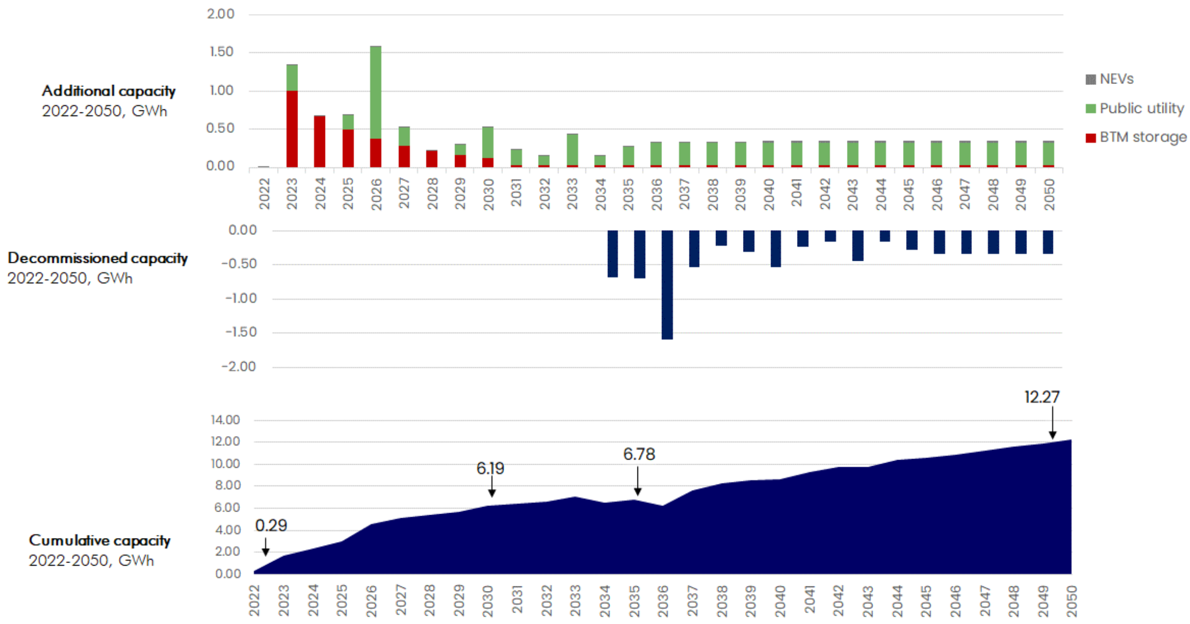
5.1.3 Battery demand

As is outlined previously, and based on the assumptions, the installed local battery capacity in 2023 for South Africa is 1.6GWh and is forecast to reach 6.19GWh by 2030. It is forecast to grow at an aggressive rate of about 0.68GWh per year on average until 2030 due to the instability of the grid and prevalence of load shedding, then steady demand growth of between 0.3 to 0.4GWh thereafter.

By 2035, capacity is forecast to reach 6.78GWh, and 12.27GWh by 2050. The forecast is primarily driven by increased private demand in the short- to medium-term to 2030 but then driven by public utility demand thereafter.

This is a conservative forecast which is attempting to quantify the long-term trend of demand, rather than accounting for monthly or quarterly spikes. It only measures the size of South African energy demand for BESS and does not include demand based on a rapid BEV transition or South Africa operating as a base for African regional or global supply. The localisation opportunities would be enhanced if these opportunities were realised but this is not included in the scope of this study.

Figure 8: Total battery capacity in South Africa through to 2050



6 Localisation potential of renewable energy components

6.1 Industry engagement summary

Through the industry engagements, five cross cutting themes, present in all three value chains, emerged that sets the landscape for future interventions. These five themes are explained the figure below.

Figure 9: Localisation themes from industry engagements

Inconsistent demand and demand economies of scale

The single most significant recurring theme is the impact of inconsistent demand on the wind energy value chain.

Market demand needs to reach sufficient scale to warrant investment.

"The history book of REI4P reads like a horror story for investors"

Certification challenges

Certifications for many components are difficult to obtain, and typically requires sending products overseas for certification at great cost. This is hampering the possibility of substitution of imported parts with local due to lengthy and costly certification process if components are changed.

Skills shortages

Skilled technicians will be critical to conduct manufacturing, maintenance and refurbishment work as component warranties and lifespans expire. Trained artisans and technical specialists find better opportunities overseas, and it is becoming increasing challenging to find and retain staff in SA a challenge to retain skilled staff in SA.

High quality levels are a barrier and lack of supplier development

The quality levels required are high, companies are deterred by the steep learning curve. There are currently no supplier development platforms in collaboration with OEMs.

"It can easily take three years to get a part approved to supply an OEM and cost upward of R1M"

Import regulation is not good enough

Tariff heading definitions are not sufficient, custom officials are not trained to differentiate correctly. Import duties are being dodged by bringing in components under equipment tariff codes.

"We make quality components that have to compete with sub-par components coming in duty free"

6.2 Existing RE manufacturing capabilities in South Africa

The figures below provides an overview of current capacities and capabilities in the renewable energy value chain. The figures demonstrate potential stakeholders in an industry ramp up programme. The figure does not aim to provide an end-to-end list of current and possible manufacturers (this is already available through REI4P). Further detail justifying their capacity, capability and supply scoring is found in the individual value chain reports.

Figure 10: Current local wind value chain capacity, capability, and supply

Turbines	Steel towers	Concrete towers	Primary steel	Tower internals	Secondary steel for towers	GSU transformer	Collector transformer	Fasteners	Rigid medium voltage cables	Flexible medium voltage cables
Vestas Δ	GRI Towers β Ω Δ	Concrete Units β Ω Δ	ArcelorMittal β Ω Δ	Modetech β Ω Δ	Modetech β Ω Δ	Actom β Ω Δ	Actom β Ω Δ	SA Bolts β Ω	CBI African Cables β Ω Δ	Aberdare β
Nordex Δ		Copperton Concrete β Ω Δ	Columbus Steel X		Naledi Engineering X		Powertech β Ω Δ		M-tech β Ω Δ	CBI African Cables β
Siemens Gamesa Δ		Colossus β Ω			K5 Engineering X		Matlakse β		Aberdare β Ω Δ	
Gold Wind Δ										

X	In development to enter value chain
β	Local capacity
Ω	Local capability
Δ	Currently supplying

Figure 11: Current local solar value chain capacity, capability, and supply; engaged with as part of this study.

PV module assembly	String Inverters (both grid-tied and off-grid)	Centralised inverters (grid-tied)	Step-up and Collector Transformers	Mounting structures and trackers	Medium voltage cables	Low voltage cables	Fasteners
ArtSolar β Ω Δ	Rubicon (MLT) β Ω Δ	Ario β Ω Δ	Actom β Ω Δ	Modetech β Ω Δ	Aberdare β Ω Δ	Aberdare β Ω Δ	CBC Fasteners β Ω Δ
	Ario β Ω Δ	Santerno* Δ		Caracal Engineering β Ω Δ	CBI African Cables β Ω Δ	CBI African Cables β Ω Δ	Impala Bolts & Nuts β Ω Δ
				K2 Systems β Ω Δ	SOEW β Ω Δ	SOEW β Ω Δ	
				PVH β Ω Δ			
				Barnes Tubing β Ω Δ			

β	Local capacity
Ω	Local capability
Δ	Currently supplying

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Figure 12: Current local value chain capacity, capability, and supply for Lithium-Ion Batteries (LIBs)

Mineral Refining				Cell Production				Casings, Modules, & Cooling				BMS / BIMS				Battery Manufacturers				Recyling				Second-Life			
MMC (EMM & MSM)	β	Ω	Δ					Casings - Steel, Aluminium & Plastics Suppliers	β	Ω	Δ	Balancell	β	Ω	Δ	Balancell	β	Ω	Δ	Circular Energy	β	Ω	Δ	Revov	β	Ω	Δ
Thakuda (Nickel Sulphate)	β	Ω						Modules - Machining operations	β	Ω	Δ	Blue Nova	β	Ω	Δ	Blue Nova	β	Ω	Δ								
Hulamin - Aluminium Foil	β							Cooling - Aluminium Exrusion (e.g. Wispeco)	β	Ω	Δ	Freedom Won	β	Ω	Δ	Freedom Won	β	Ω	Δ								
												Hubble Lithium	β	Ω	Δ	Hubble Lithium	β	Ω	Δ								
												Maxwell & Spark	β	Ω	Δ	Maxwell & Spark	β	Ω	Δ								
												Polarium	β	Ω	Δ	Polarium	β	Ω	Δ								
												Rubicon	β	Ω	Δ	Rubicon	β	Ω	Δ								
												Solar MD	β	Ω	Δ	Solar MD	β	Ω	Δ								

Figure 13: Current local value chain capacity, capability, and supply for VRFBs

Mineral Refining				Electrolyte Prouction				Battery Assembly				Recyling				Second-Life			
Bushveld Vanadium (Vanadium Pentoxide)	β	Ω	Δ	Bushveld Energy	β	Ω		Bushveld Energy		Ω									

β	Local capacity
Ω	Local capability
Δ	Currently supplying

6.3 Localisation potential of RE value chains in South Africa

6.3.1 Localisation potential matrix

It is essential to recognise that the dynamics of renewable energy (RE) value chains are not uniform. While there are commonalities, there are specific factors governing the success of manufacturing localisation in each value chain that are unique. For instance, the wind energy sector has faced the serious consequences of inconsistent market demand, bid window delays and shock reductions in wind allocation - resulting in a scepticism and a lack of enthusiasm for localisation.

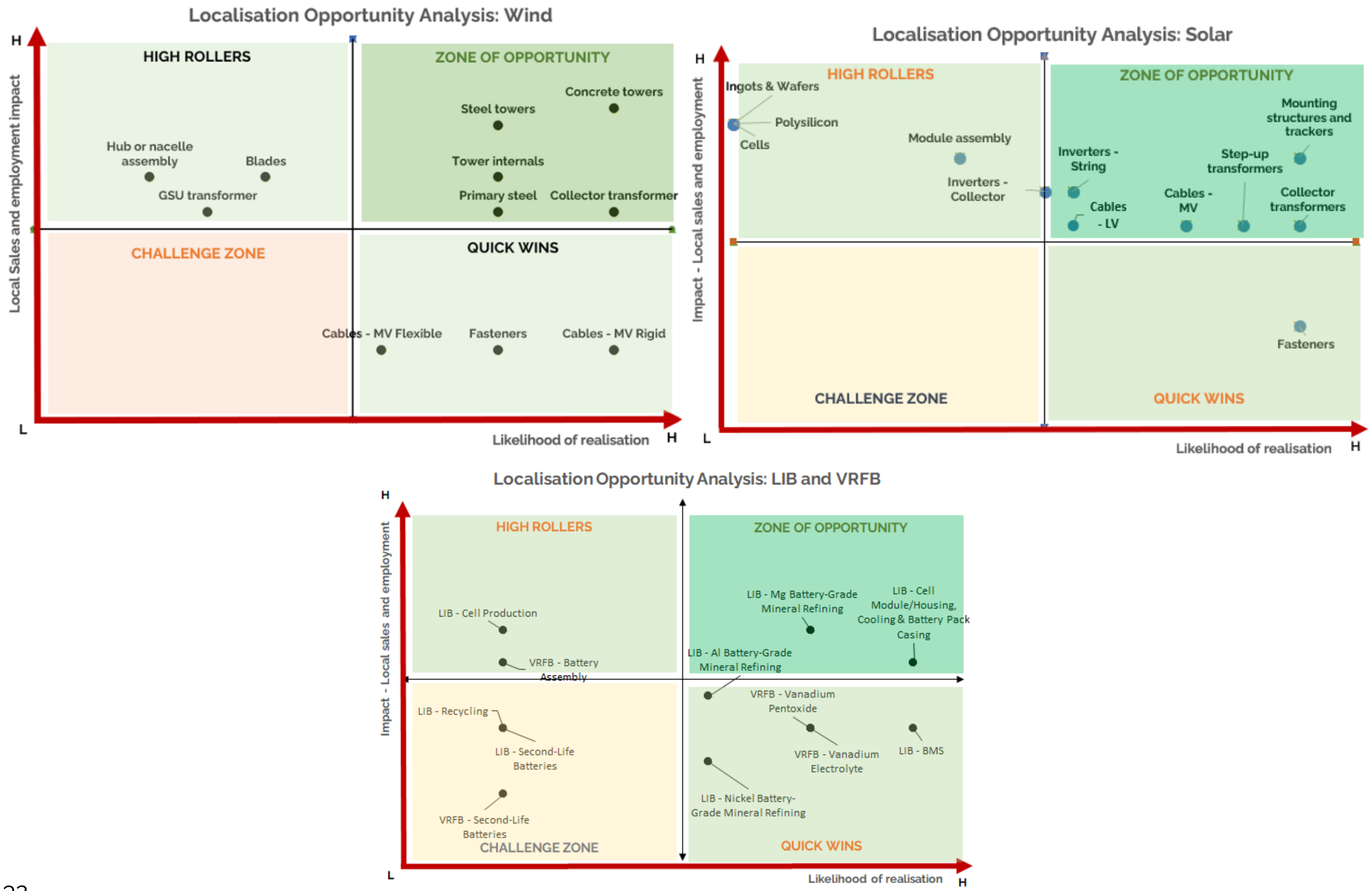
In the case of solar photovoltaics (PV), fluctuating demand and price-sensitive customers across residential, commercial, industrial, and utility-scale markets have led to an influx of unregulated, inexpensive imported products. This situation has established a market price that hampers local production and growth, undermining the business case for localisation efforts.

Battery energy storage presents its own set of challenges, including difficulties in localising high-value components protected by intellectual property owned by foreign companies. Additionally, addressing the longstanding issue of local mineral beneficiation in Africa is an ongoing concern.

Nevertheless, opportunities do exist within various components of these value chains. By implementing supportive policies and collaborating with firms capable of expanding production in these sectors, the potential for unlocking local capabilities and capacity remains promising.

Highest priority components for localisation are presented in the Figure 15 below. Within the timeframe of the South African Renewable Energy Masterplan (SAREM 2030), those with the highest impact and highest likelihood of realisation (lowest risk to localisation realisation) are prioritised in the *Zone of Opportunity.* Other components show potential through either high likelihood or high impact. Localisation prioritisation in this consolidation report focus on the components within the Zone of Opportunity.

Figure 14: Localisation opportunity analysis for RE *(scales not comparable)*



Wind energy localisation

The outcome of the wind energy value chain localisation potential matrix does not contain many surprises. The industry is recovering from hugely inconsistent demand in the domestic market, and the supply chain is waiting for the market to stabilise and become more reliable and consistent before making any major investment decisions.

Local tower production is crucial to maintain as this is the only key component that has been successfully localised through the local content and designation procurement levers under the REI4P programme. The prioritisation matrix recognises this, with prioritised components all being components of the towers value chain.

The only exception to this is the inclusion of blades and hub/nacelle assembly localisation opportunities. These key components fall in the 'high roller' quadrant, meaning that they are potentially high impact components but that are likely to be challenging to unlock. Blades are viewed as slightly more likely than hub/nacelle assembly because of the global strategy of OEMs to localise towers and blades, and the fact that blades were close to being localised in the earlier rounds of the REI4P. This is before the interruption of the bid windows shattered investor confidence.

Components that are in the Zone of Opportunity are towers, tower internals, primary steel, and transformers. For towers the likelihood of concrete towers is slightly higher than that of steel, primarily due to the higher cost of steel produced towers. For the transformers the collector transformers are deemed to be in the zone of opportunity and not the medium voltage transformers. These components represent the opportunities that have the highest impact and likelihood of realization. These components should sit at the core of the wind value chain localisation drive.

While cables and fasteners have a high likelihood of realisation and can be considered as potential Quick Wins given their low barriers to localisation, they will have a relatively low impact on the value chain. The rigid medium voltage cables more so than the flexible cables that are used inside of the wind tower. Success can be achieved with the localisation of these components without excessive and intensive interventions being necessary.

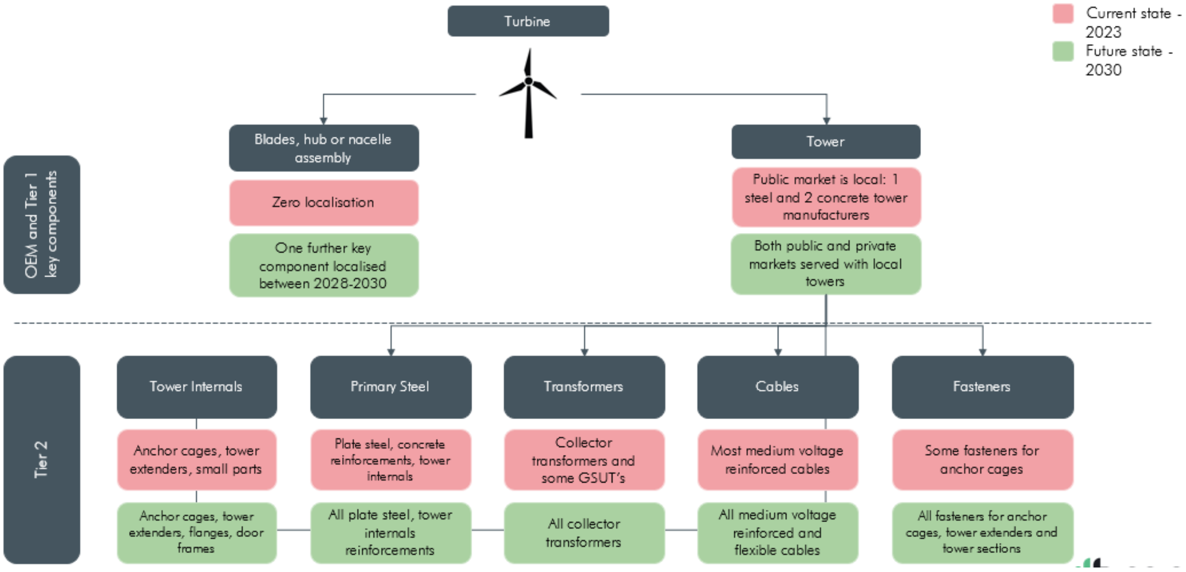
The local wind value chain currently comprises only one steel and two concrete tower producers (a third plant, Colossus, is currently mothballed) who exclusively service public demand. Tower internals, such as anchor cages, tower extenders, lifting gear, and platform brackets are made locally by one company that supplies an estimated half of public demand. Primary steel was designated in round 5 of the REI4P and subsequently the steel was sourced locally for most of the tower mass.

Local transformers dominate the market in the collector transformer space but are not supplied for medium voltage transformers. The medium voltage reinforced cables that run from the tower to the collector transformer enjoy a high local market share due to designation in REI4P, but no flexible rubber cables are provided locally. Fasteners are supplied in small volumes as second tier components into the anchor cages and tower extenders value chains but are not used for the tower sections.

The likely target state for the wind value chain by 2030 is to have both public and private demand serviced by local tower manufacturers. Additionally, the local industry could add the capability to produce the flanges and door frames on top of what is currently produced for the tower internals. Also, the primary steel for tower plates and steel tower internals can be made and supplied locally. All collector transformers are made locally. Both reinforced and flexible cables are supplied locally and all fasteners for anchor cages, tower extenders, and tower sections are manufactured locally.

A major achievement for the wind value chain would be to have one additional key component (blades, hub, or nacelle assembly) localised in the latter part of the decade.

Figure 15: Current and future states of the 6 key components in the wind value chain



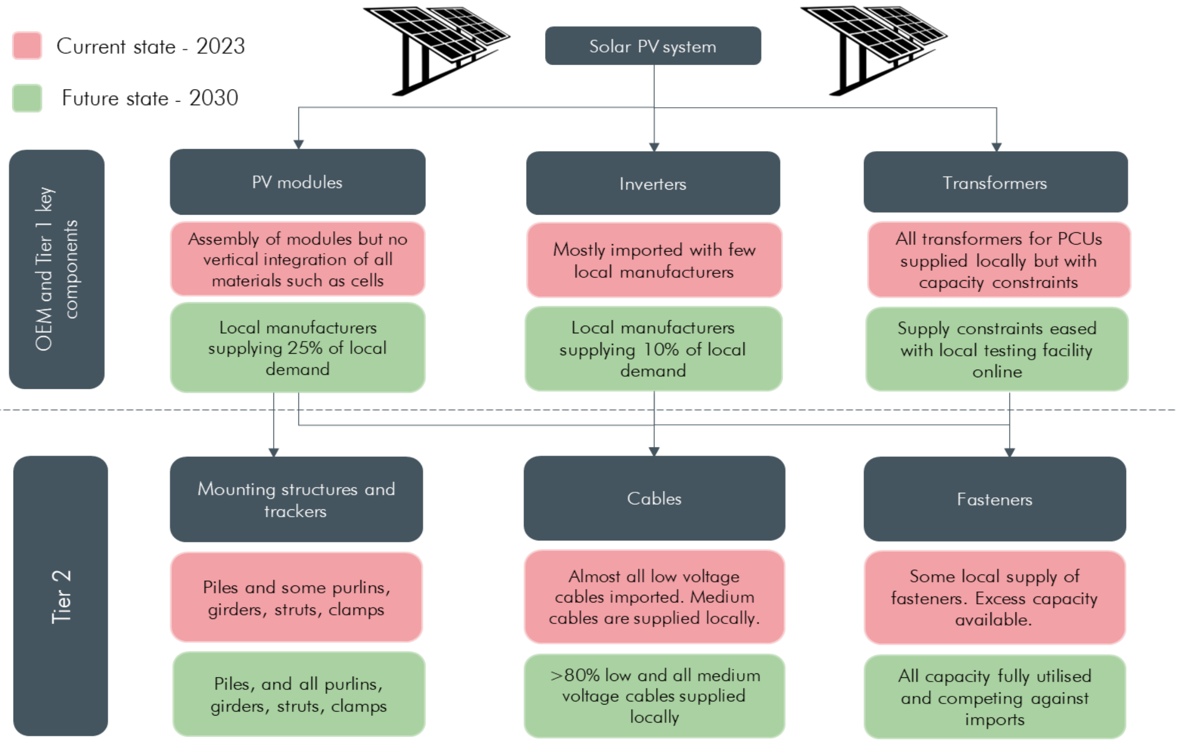
Solar PV localisation

Most of the solar photovoltaic (PV) components reviewed fall within the Zone of Opportunity, with fasteners considered a 'quick win' and solar modules (assembled) as High Rollers (see Figure 15). Polysilicon, ingots and wafers, and cells are deemed high rollers with a very low likelihood of localisation. These subcomponents of the solar module are all highly capital intensive and have technical barriers to entry. In contrast, solar module assembly is less capital intensive, with lower technical barriers to entry (USAID, 2022). These sub-components of a solar PV module are included in the matrix for noting but are not discussed further as industry engagements were focussed on module assembly and components of a higher likelihood of realisation.

Module assembly is a High Roller, requiring investment to grow capacity and policy revision to level the playing field against imports. Inverters (string inverters such as those made by Ario, as well as smaller types for the residential market such as those made by Rubicon) show promise with local capacity and capabilities present and substantial room for growth if designated for localisation and local testing facilities are realised. Engagement with additional manufacturers and suppliers however is recommended to evaluate the potential of the full suite of inverter types that are manufactured locally, or that could potentially be localised. Transformers are already localised and designated with local manufacturers dominating supply. Excess capacity exists for mounting structures and trackers, but consistent demand is crucial to grow localisation. For cables, local capacity and capabilities exist, but standards and import duty enforcement is required to grow local supply. Fasteners are considered a low hanging fruit because spare capacity already exists. However, employment opportunities are relatively small given the capital-intensive nature of these manufacturing processes.

Given the right economic environment, the solar PV value chain could see considerable growth to meet demand forecasts by 2030 and beyond. The projected market share of solar modules and inverters by 2030 has been conservatively computed and is realistic if identified enablers and interventions are implemented to support and expand on the country's existing manufacturing base (see Figure 16). Transformers are already highly localised, but enablers could see bottlenecks in the supply of these products being eased by 2030 (see Figure 16). Firms manufacturing mounting structures, trackers, cables, and fasteners all have excess capacity that could be supplied into the solar PV chain. This is highlighted in Figure 16.

Figure 16: Current and future states of the six key components in the solar PV value chain.



Battery energy storage localisation

Battery cell manufacturing and VRFB are both in the High Rollers zone as they potentially have a high impact but require significant incentives and policy to realise.

The review of the LIB value chain identified that the most feasible opportunities exist for battery assembly, and manufacturing modules, casings, cooling components. These are in the 'zone of opportunity'. This is linked to a high likelihood of realisation due to capacity and capabilities existing, and the sector viewed as being competitive. This is linked to several supplies currently operating in various sectors (e.g., automotive, and white goods), with limited investment required and no policy needed to support growth.

For Battery Management Systems (BMS), a competence that many firms manage in-house. The likelihood of localisation is high, although the impact is viewed as being moderate due to the low market size and job creation factor.

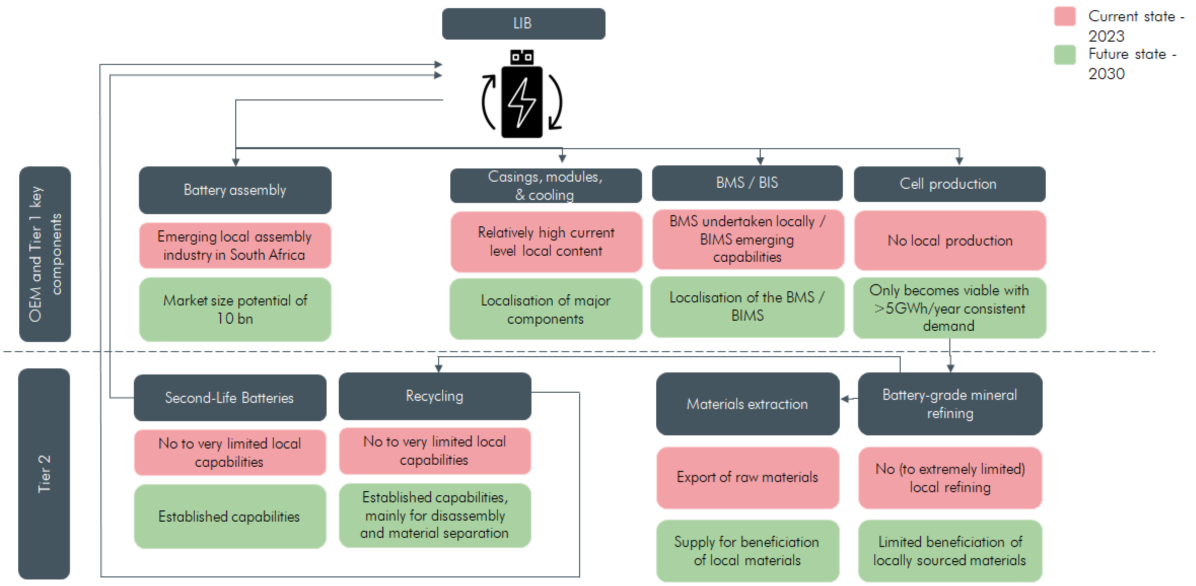
The production of aluminium and nickel battery-grade minerals as well as BMS for LIBs, are in the Quick Wins zone, as well as is vanadium pentoxide and electrolyte for VRFBs. The investment required to unlock these opportunities is a factor for these areas, as well as the low level of job creation opportunities. Producing precursor manganese battery-grade minerals is also positioned in 'zone of opportunity', mainly due to raw materials being currently mined. The biggest challenge here relates to the required investment being large.

For the VRFB value chain, localisation opportunities are evident within the upstream elements of the value chain, especially in the production of vanadium pentoxide and the vanadium electrolyte. Developing a vanadium redox flow battery itself requires policy measures for energy procurement to unlock as the battery is only commercially viable at a utility scale.

In the long-term, after 2030, opportunities do exist for both LIBs and VRFBs with regards to recycling and re-use. The focus on this aspect of the value chain is projected to start gaining momentum only 5-10 years' time, when this will become a major requirement due to products coming to the end of their initial life.

The next figure depicts the LIB value chain with a description of the current state and 2030 possibilities of each value chain segment. Upstream activities include the mining and refining of battery minerals, while the minerals refining stage produces refined materials to the required battery qualities and purities. The manufacturing and assembly stage of the value chain includes manufacturing of battery cells and modules, and design and assembly of the battery pack. The battery cells are assembled into a module (usually 12 cells per module) containing electronic management components. The LIB pack is built from multiple battery modules that can be integrated into a metal or carbon-fibre enclosure. Additional key components in a battery pack include the battery management system (BMS), cooling systems, fuses and a pre-charge circuit, safety vents and a current interrupt device (USAID, 2022).

Figure 17. Current and future states of the LIB value chain.



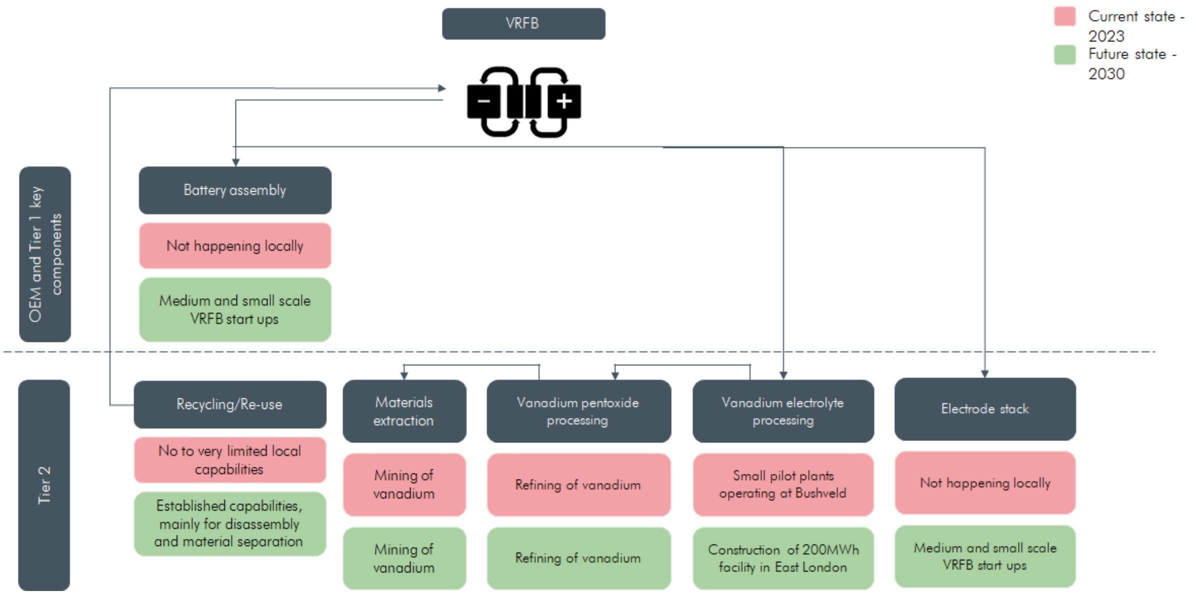
For the VRFB value chain, the following aspects are considered in the manufacturing process:

- Vanadium Pentoxide
- Vanadium Electrolyte
- Battery Assembly (including the electrode stack)
- Re-use or recycling of batteries

While not as substantial as for LIBs, VRFBs present an encouraging opportunity for localisation. This is due to the vanadium being mined locally, and the necessary capabilities for supporting downstream activities taking place (pentoxide processing) and being established (electrolyte processing). Realising the full potential of VRFBs, including assembly, depends on targeted policy interventions to support and nurture the sector, especially the key upstream activities.

A simplified VRFB value chain is shown in Figure 18 with a description of the current state and 2030 possibilities of each value chain segment. On the upstream side, primary vanadium is mined from titaniferous magnetite ore. This involves multiple steps of crushing-milling-roasting-leaching-precipitation and calcination to produce only vanadium in the form of vanadium pentoxide (V_2O_5) flakes. Vanadium electrolyte is produced by dissolving high purity vanadium pentoxide in sulphuric acid. The purity and composition of the electrolyte are key in determining electrolyte performance. The construction of the electrochemical cell is like that of a fuel cell.

Figure 18. Current and future states of the VRFB value chain



6.4 Transversal interventions and next steps

The growing demand for renewable energy, especially in South Africa facing an energy crisis, presents a unique opportunity for manufacturing localisation, providing significant benefits to the economy. While fraught with complexity, ramping up localisation in these value chains is most effectively done through prioritisation and addressing cross cutting interventions that impact the sector in its entirety. Based on the stakeholder feedback, and the components of highest priority, if we holistically consider all three of the value chains, a clear picture starts to form on the cross-cutting interventions necessary for deeper localisation within the South African RE industry.

While noting the RE value chains as not homogenous in entirety, the fastest and most effective means of ramping up manufacturing localisation in all three simultaneously is through addressing the collective challenges. Interventions to do so are highlighted in the table below:

Table 4: Key interventions for localisation of RE value chains

Intervention	Wind	Solar	LIB	VRFB
Updated IRP 19	A	A	A	A
Annual REI4P bid windows	A	A	A	A
Transparency for grid availability, grid allocation rules and grid connection timelines	A	A	A	A
Private projects reaching financial close and commencing building at >500MW annually	A	A		
Local content requirements for both private and public sectors established	B			
Import duty level revision or correctly applied	A	A	A	A
Capacitation of custom officials to correctly apply duties	A	A	A	A
Cluster for aligning value chain quality expectations and increasing capability of manufacturers	B		A	
Establish a global-standards aligned testing facility	B	A	A	
Development of a second manufacturer	C			
Access to competitively priced steel	B			
Investment into additional capability	B			
Minerals policy			A	A
R&D support			B	B
Purchase tax incentive			B	
EV offtake agreements			A	
Local content designation			B	

A= High priority; B= medium priority; C = Least priority

These interventions are summarised briefly as:

1. Creating demand certainty

Interventions that enable consistent demand are the highest-level priority for the entire renewable energy market. This includes the publication of an updated Integrated Resource Plan (IRP), establish consistent bid windows in the Renewable Independent Power Producer Procurement Programme (REI4P), secure transparency from Eskom on grid capacity and expansions, and ensure identified private projects close, commission, and connect to the grid.

As private demand comes online, an additional layer of complexity to demand certainty is added. This is considered to be a significant driver of RE demand moving forward, however the dynamics of this, how it will be financed and the speed of investment is unclear. Understanding this private demand and providing transparency and certainty around the rules of engagement to manufacturing is required.

2. Protecting the local market

Secondly, a RE value chain-wide investigation of the duty frameworks, duty levels, and tariff heading definitions should be completed. This impacts most of the component opportunities identified across all the value chains. A detailed investigation is required, and the potential re-design of import tariffs considered.

Specifically for batteries, a minerals policy is required to support the beneficiation of local minerals and while not market protection in the traditional sense, a beneficiation policy will support a reduction in imported beneficiated product.

Once recommendations are drafted and approved, focus should shift to implementation as the correct application of duties was noted as a challenge across the value chains. Engaging with industry is especially critical to understand the mechanisms being used to bypass import duties; and to capacitate customs officials to correctly classify and apply tariff headings.

3. Enhancing competitiveness of local manufacturing

The last transversal enabler is enhancing the competitiveness of local manufacturing. As producer-driven value chains, these sectors are governed by the standards of the original equipment manufacturers (OEMs) and the IP holders. Their decisions set the expectations for all upstream manufacturing. As these industries in South Africa are still in their infancy (relatively speaking and in comparison, to more established sectors like the automotive industry), these standards and expectations are not always widely and uniformly known. The existing and potential players in these industries are also not necessarily well known to lead enterprises. The establishment of a cluster platform to link OEMs and local manufacturers is a useful mechanism to overcome this challenge. Such an initiative will help remove the uncertainty in quality requirements and assist local manufacturers to reach OEM required levels of manufacturing excellence. In addition, standards can be clearly communicated, and collectively the industry can work towards the establishment of local testing facilities or creating the capability to test to the lead firm standards locally (reducing the need for costly international testing).

In an environment that requires urgent response to growing markets, bolder incentive packages should also be explored to stimulate investment and upgrading. Greenfield tax incentives, preferential lending rates for green technologies and renewable energy from the Industrial Development Corporation, and a Broad-based Black Economic Development Charter that supports supplier development and upgrading in the sector are examples of such incentive packages. The implementation of such would require further investigation on the impact and benefits of these incentives to the industry as an immediate next step.

7 Ramp up analysis

7.1 Renewable energy ramp up analysis

Wind energy

If the interventions highlighted in the report are not implemented it is unlikely that current levels of local content will be maintained for private sector demand in the wind sector. Existing levels of local content have been derived from public procurement policy. Industry engagements suggest that if pure market competitiveness determined procurement, which will likely be the case in the private sector, local content will reduce. Therefore, the short-term interventions to ensure consistent demand are the most important elements and will lead to the localisation of components like the towers, tower internals, cables, fasteners, transformers, and steel. If summarised into the top 3 interventions, these would be:

1. Consistent demand from both the private and the public sector
2. Revised duties on the towers, tower internals, cables, and primary steel
3. Establishment of a cluster to upgrade the capability of manufacturers in the component industry

If the duty landscape revision is implemented and the cluster platform established, the value chain will move into the transitory phase with significant further localisation occurring. At this point it is likely that additional manufacturers will enter the industry. The biggest opportunity appears to be in steel towers and specialised steel for tower internals. This could push the local industry into a more mature phase: one where a well-established and sustainable local industry supplies a local market with consistent demand.

The keystone achievement that will signal the mature phase is the localisation of the second key component, most likely blades but also potentially hub or nacelle assembly.

Solar PV

The top three actions to realise increased local participation by the manufacturers in the solar PV value chain are:

1. The revision and correct application of existing duties for solar modules, mounting structures, cables, and fasteners - These components specifically highlight competition against imports as being a major challenge.
2. The next milestone is undoubtedly the most significant: the realisation of consistent demand which will boost investment sentiment and provide the stability needed to develop business cases in support of boosting local production capacities. For cables,

transformers and inverters, local testing facilities will ensure the support for existing high quality manufactured products.

3. Investment and access to capital to grow capacity for inverter manufacturing and module assembly - Given that local manufacturers of modules and inverters currently capture only a small percentage of the domestic market, investment to realise expansion projects or the development of new manufacturing facilities would be key to enable increasing local supply.

Under the scenario of a lack of action to realise key enablers, then the industry will exist under these conditions based on stakeholder engagements:

1. Module assembly will continue to supply but at low volumes and will continue to struggle to compete with cheaper imports. Due to the lack of stable demand, expansion plans are unlikely to be realised due to lack of investor confidence.
2. Manufacturers of string inverters and centralised inverters will supply a small portion of the local market, unable to increase capacity to meet the rapidly growing demand. Without a local testing facility, the manufacturer's ability to localise certain components will be hindered unless manufacturers can cover the high cost of sending unit away for testing overseas each time a local component gets tested for addition to the bill of materials.
3. Transformers already supply a large quantity of the local market. But without a local testing station to test the entire power conversion unit, the local industry will lose out to imported PCUs that have already been tested overseas and arrive as a single complete unit of centralised inverter, transformer and switchgear.
4. Manufacturers of mounting structures will have no visualisation of expected market demand and consequently opportunity to plan for anticipated demand will hinder market participation. A lack of enforced standards in roof-top installations leads to premature breakages and failures of installed units in the near future, despite warnings from trusted local manufacturers who see the industry flooded by installers who lack training and experience, and who use below standard components.
5. Manufacturers of cables continue to manufacture but excess capacity gets bought by other countries such as Ghana where manufacturers note current interest lies. Solar installations suffer with the use of low quality, imported low-voltage cables, leading to technical failures of installations and other risks to the end user down the line.
6. Fastener manufacturers continue to operate but below maximum capacity as the local market seeks out cheaper imported fasteners.

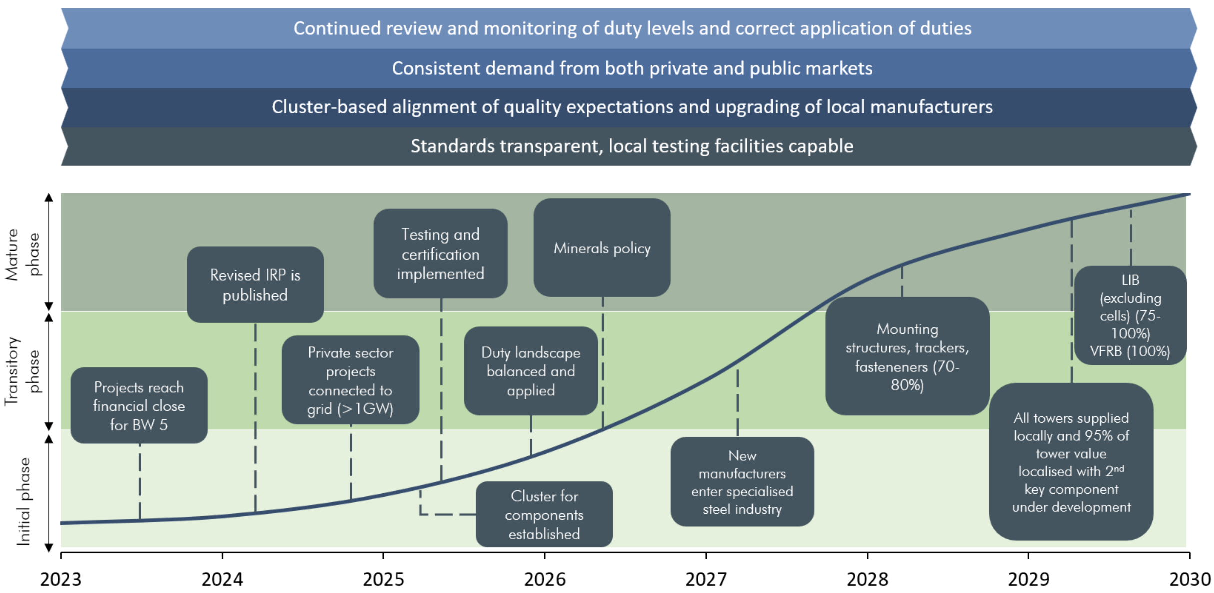
Battery energy storage

The successful adoption of the interventions for batteries, as outlined, will result in increased levels of localisation being supported to take place.

Localisation firstly requires support and development of a local component supply base for energy storage batteries. A cluster-based platform to support buyer-supplier linkages, supplier upgrading and standards clarity and testing is recommended.

Secondly, a revision of the IRP which includes sensible local content designation thresholds and clear renewable energy and battery storage technology allocations. A revised IRP that is consistently adhered to by a public utility should stimulate domestic investment by 2026 by providing a credible map of utility scale demand over the next few decades.

Introducing additional tax, mineral beneficiation incentives, and investment support measures by 2026 will also assist to enhance the capacity of domestic battery energy storage capacity and capabilities. Developing a set of domestic standards for battery cells and modules will ensure that the market is rationalised to avoid dumping of imported battery cells and modules. If these interventions are undertaken it is anticipated that the lithium-ion battery market will achieve VRFB will achieve a localisation of 90%-100%., respectively by 2030.



7.2 Stakeholder actions and next steps

Implementing the three most pertinent recommendations (namely, creating demand certainty, protecting the local market and enhancing the competitiveness of local manufacturing) requires a programmatic response. The following table outlines the next steps required to address the three greatest challenges facing all three value chains, who the relevant stakeholders are and what specific actions are required to unlock the opportunity. It is worth re-emphasising that the single greatest intervention of the three is creating the demand certainty. The industry is recovering from tumultuous peaks and troughs, neither of which is conducive to create business cases for investment. Without this clear outlook, the shroud of uncertainty will continue to plague the industry and limit localisation potential.

Table 5: Stakeholder actions and next steps

Programme	Project	Key stakeholder	Other stakeholders	Timeframe	Actions and interventions
Creating demand certainty	Updated IRP	DOE	SAWEA, SAPVIA, SAESA, SAREM, the dtic,	1 year	1. Industry and stakeholder lobbying (interest groups united – i.e. all industry associations with a collective voice of pressure). 2. The Department of Trade Industry & Competition (the dtic) to provide pressure on the update. 3. Forum with regular industry updates on progress shared with transparent timelines and accountability.
	Annual bid windows with consistent allocation volumes	DOE	SAWEA, SAPVIA, SAESA, SAREM, the dtic,	3 years	1. Forum with regular industry updates on status and potential changes shared with transparent timelines and accountability to keep shock allocation changes to a minimum and inform decision-making.
	Grid availability and connection transparency	ESKOM	SAWEA, SAPVIA, SAESA, SAREM, DOE, the dtic,	3 years	1. Forum with regular industry updates on progress shared with transparent timelines and accountability.

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Programme	Project	Key stakeholder	Other stakeholders	Timeframe	Actions and interventions
	Transparency in private demand	Industrial cluster	SAWEA, SAPVIA, SAESA, DOE, Finance institutions, LSF	1 year	1. Unpack private demand constraints and procurement behaviours (i.e. financing 2. Create clarity on private demand, constraints and behaviours
Protecting the local market	Import duty level revision	ITAC	Firms, LSF, the dtic	0.5 years	1. Investigate the maximum allowed import duty for components and assess and model value chain and associated value chain impacts if applied. 2. Recommend changes to duties as per results of the study. 3. Develop an official training programme to support customs officials to correctly apply duties
	Duty changes	ITAC	Firms, LSF	2 years	1. Implement duty change recommendations
	Capacitation of customs officials to correctly apply duties	ITAC		0.25 years	1. Train customs officials to correctly apply duty codes

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Programme	Project	Key stakeholder	Other stakeholders	Timeframe	Actions and interventions
	Minerals policy	DMR	The dtic, DOE	1.5 years	1. Development and introduction of a well-defined minerals policy, to preserve critical minerals and support cell production for LIB and VRFBs, is imperative.
Enhancing the competitiveness of local manufacturing	Cluster-based support programme	OEMs	SAREM, The dtic, suppliers, LSF,	2 years	1. Private sector participation in OEM-led cluster to communicate specifications/expectations and enhance quality and technical capability. 2. Initiation, funding, and setting strategy of the cluster. 3. Management and facilitation of cluster to ensure that goals are achieved.
	Testing capabilities understood	LSF	SABS, OEMs and industrial clusters	0.5 years	1. In collaboration with OEMs, document specific testing requirements and standards per component 2. Review of current testing capabilities and gaps locally 3. Understand investment (ZAR and skills) requirements to implement local testing 4. Create a business case to support the creation of local testing facilities and partner with key stakeholders to implement
	Implementation of local testing	SABS / other		2 years	1. Implement as per recommendation

Programme	Project	Key stakeholder	Other stakeholders	Timeframe	Actions and interventions
	Favourable incentives for improved competitiveness and supplier development	the dtic	SAREM, IDC,	0.5 years	1. Review potential incentive frameworks (i.e. favourable investment, B-BBEE Charters for supplier development, green / renewable energy tax incentives) and model fiscal implications, competitiveness improvement and socio-economic benefits 2. Provide recommendations to appropriate stakeholders on the implementation of investment incentives off the basis of a business case to stimulate market development and competitiveness 3. Secure interest and commitment from relevant stakeholders for the implementation of investment incentives

8 Conclusion

In conclusion, there is clear potential for localisation of components in all three RE value chains. This is based on existing capacities and capabilities within the domestic manufacturing sector. However, there are also fundamental challenges that if not addressed could not just stagnate current local content but decrease it, especially with the opening of private sector generation projects.

Wind energy

The dynamics of the value chain suggest that specific components hold the key to any further localisation opportunities: blades, nacelle, hub, and towers. If the economics of importing towers are favoured over locally produced towers for the private sector it would remove most local opportunities for the value chain. It is not clear yet what the private market will do because it is too early to identify preferences. However, there is a fundamental difference between public and private markets, and the impact of this could well be the loss of more local components. What would be left is the balance of plant components; the collector transformer, medium voltage rigid cables, and some other small fabrications.

Conversely, if the interventions are successfully implemented through an organised and effective vehicle,, the wind energy industry could become a major industrial success story in South Africa. This success would likely be a strong local market for towers and all affiliated components, such as steel plates, secondary steel components (anchor cages, flanges, door frames, etc), tower internals (platforms, cables, lifts, ladders, etc.), and fasteners. In the balance of plant, local supply would be secured for the collector transformers and the medium voltage cables.

Solar PV

The demand for solar PV is expected to grow to a peak of 11 GW per annum in 2025, and thereafter decline to 2030. Therefore, a sense of urgency is required to enable local manufacturer participation in the solar 'boom'. The latest draft of the SAREM highlighted the assembly of mounting structures and trackers (and fasteners), AC/DC cables, and centralised inverters (and transformers) as showing high growth potential. The findings from this study support these findings. These components have substantial local demand, base production requirements that can be met locally, and as such have high potential for localisation.

Battery energy storage

The dynamics of the LIB value chain suggest that the specific components that hold the key to any further localisation opportunities are LIB modules, casings, and cooling components. The evidence suggests that despite the increase in imports and the likelihood of the domestic market reaching the economies of scale for cell manufacturing by 2030, it is not expected that the country will be able to capitalise on this opportunity without significant policy support in minerals beneficiation and energy procurement. The study has elucidated the policies required for this but a more detailed study on the business case for such policies and interventions would be required.

For VRFBs, there is an opportunity to leverage the mineral endowment of vanadium in South Africa, but it requires similar levels of incentive and policy support and the procurement challenges associated with concentration in the value chain need to be acknowledged.

Final note

The RE demand growth and the specific needs of the South African market provide a unique opportunity to drive industrialisation in RE value chains. Interventions should be targeted to create consistency in market demand, protecting the market and enhancing the competitiveness of local manufacturing. If implemented correctly, this provides significant economic value and job creation opportunities.

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