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Manufacturing Localisation Potential in

Renewable Energy Value Chains

Solar Photovoltaic 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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2 Acronyms

a-Si	Amorphous silicon
BoP	Balance of Plant
BTM	Behind-the-meter
BIPV	Building-integrated photovoltaic
C&I	Commercial & Industrial
CSP	Concentrated Solar Power
CPV	Concentrator photovoltaic
c-Si	Crystalline silicon
DLC	Designated local content
GW	Gigawatt
IRP	Integrated Resource Plan
kW	Kilowatt
MW	Megawatt
NRCS	National Regulator for Compulsory Specifications
NREL	National Renewable Energy Laboratory
OEM	Original equipment manufacturers
PV	Photovoltaic
RE	Renewable energy
REIPPP	Renewable Energy Independent Power Producer Programme
SAREM	South African Renewable Energy Masterplan
SSEG	Small scale embedded generation
TWh	Terra Watt Hour

3 Executive Summary

3.1 Value chain and technology overview

The solar photovoltaic (PV) value chain comprises several components including solar modules, mounting structures and trackers, as well as inverters, transformers, cables and fasteners. Globally, few countries dominate the manufacturing of solar modules, and these are typically within vertically integrated manufacturing facilities. In countries like South Africa, most sub-components for modules, like cells, are imported, with local capabilities limited to assembly only. The dominant solar technology is crystalline silicon (c-Si) modules, and at least two local assemblers[1] of these modules operate in South Africa.

3.2 Local capacity and capabilities

Figure 1 provides and overview of engaged manufacturers' current capacities and capabilities in the solar energy value chain. The intention is to demonstrate the current key role players in an industry ramp up programme. The figure does not aim to provide an end-to-end list of current and possible manufacturers (as this is already available through REI4P).

[1] Assembly defined as constructing a completed product comprised of components. This is distinguished from manufacturing that involves converting raw materials into finished products.

Figure 1: Current local value chain capacity, capability, and supply based on stakeholder engagements.

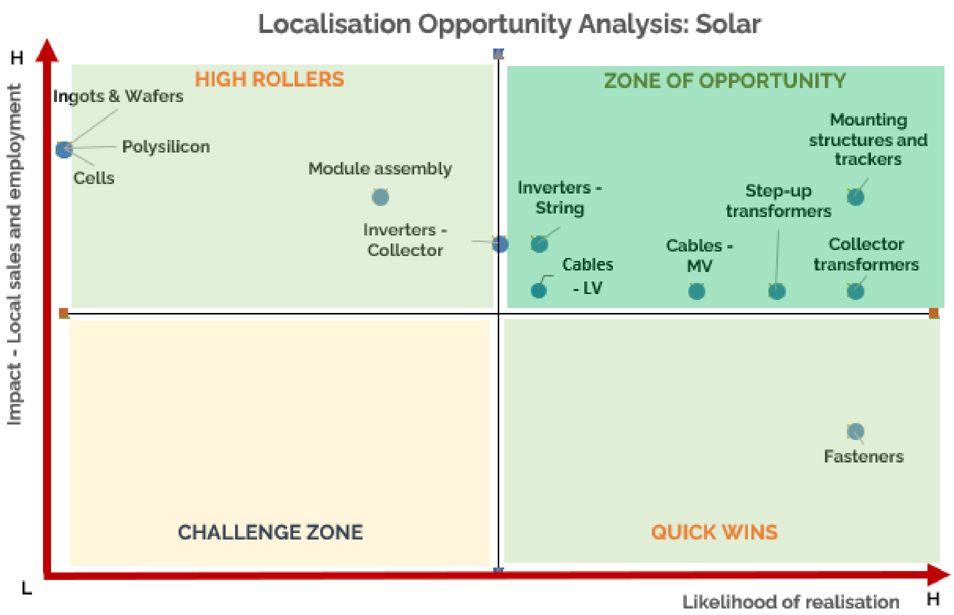
PV module assembly	String Inverters (both grid-tied and off-grid)	Centralised inverters (grid-tied)	Step-up and Collector Transformers	Mounting structures and trackers	Medium voltage cables	Low voltage cables	Fasteners
ArtSolar β Ω Δ	Rubicon (MLT) β Ω Δ	Ario β Ω Δ	Actom β Ω Δ	Modetech β Ω Δ	Aberdare β Ω Δ	Aberdare β Ω Δ	CBC Fasteners β Ω Δ
	Ario β Ω Δ			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

3.3 Prioritisation of localisation potential

Increased module assembly has a medium-low likelihood of realisation as local capabilities exist and manufacturers are already supplying into the local market. However large investments will be required to unlock additional capacities, and policy is required to unlock deeper localisation. Given growing local demand for solar modules, the potential impact in terms of local sales and employment is considered medium-high. For these reasons module assembly is considered a 'high roller'.

Figure 2: Localisation opportunity analysis for components in the solar PV supply chain.



Polysilicon, wafers, and cells are also classified as high rollers with a low likelihood of realisation due to the high investments required to develop local manufacturing capabilities and capacities in fields that are highly technical. Stakeholder engagements indicate that initial modelling of the business case to develop local capabilities for ingot and wafer manufacturing in the short term are positive. If this is successful, it paves the way for cell manufacturing that is heavily dependent on the availability of ingots and wafers. If achieved however, the results would be significant in terms of sales and job creation.

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, however significant investment in capacity is required to realise demand potential. Manufacturing of central inverters consequently has a low likelihood of realisation relative to string inverter manufacturing. 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.

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. Local sales and employment impacts are identified as being medium-high.

Mounting structures and trackers have the highest likelihood of realisation, and represent a major growth opportunity. Local capabilities and surplus capacity exist. As local installations and associated manufacturing grows, the impact on sales and job creation will be very high.

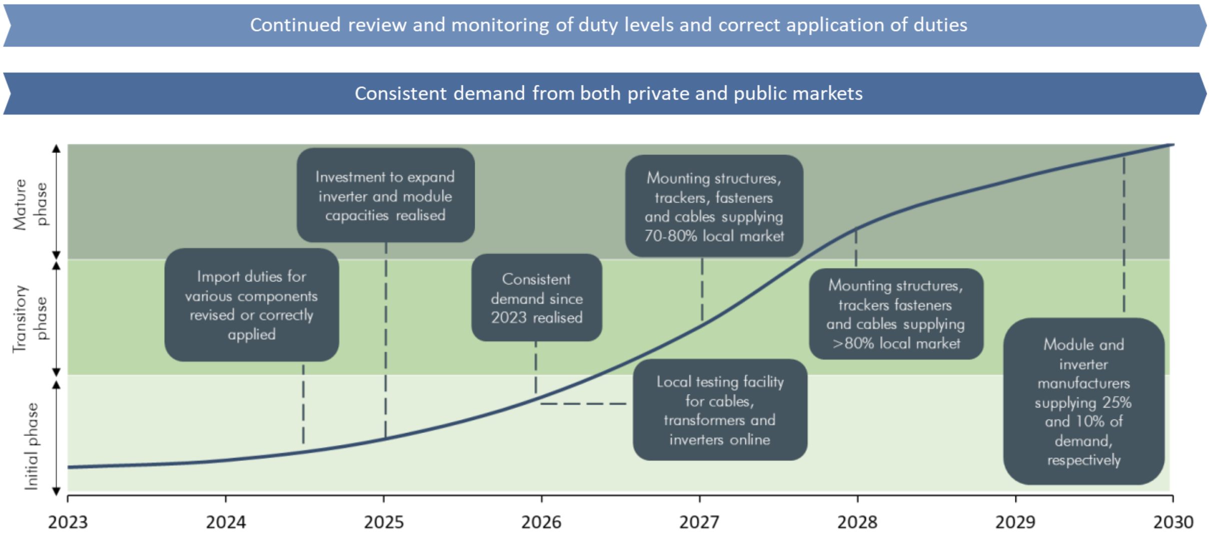
Low and medium voltage cables both fall in the zone of opportunity since local manufacturers are already supplying the market. These firms have excess capacity to ramp up volumes should the demand require it. The main difference between low and medium voltage cables is that there is currently no quality 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 however the sales totals relative to other solar PV components is comparatively small.

Fasteners were classified as a quick win since existing domestic capabilities exist. Local manufacturers are competitive and already supplying into the renewable energy (RE) value chain. Little to no investment is required to ramp up their capacities to meet local demand requirements, and no changes to policy are required. These factors result in a very high likelihood of realisation. Relative to the larger components in the solar PV value chain, the likely impact on sales and job creation is relatively small.

3.4 Ramp up analysis.

Key milestones to ramp up localisation are firstly the revision and correct application of existing duties for solar modules, mounting structures, cables, and fasteners (see Figure 17). Import competition is a major challenge. 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 enabling local supply. The third milestone is undoubtedly the most significant: the realisation of consistent demand which will boost investment sentiment and provide the stability needed to boost local production capacities. For cables, transformers and inverters, local testing facilities will ensure support for high quality locally manufactured products.

Figure 3: Key milestones to realising increased localisation of the solar PV value chain.



3.5 Conclusion

South Africa has existing capabilities and capacities across a wide range of components for the solar PV value chain. Mounting structures, transformers, cables, and inverters have all been placed in the zone of opportunity based on the high likelihood of realisation and their potentially high impact on job creation and sales. Modules are considered a high roller due to the large investments required to boost existing capacities, but the impact in terms of sales and job creation are substantial. Fasteners fall under quick wins since these manufacturers require little intervention to ramp up to meet local demand.

To realise localisation opportunities, the manufacturing industry requires consistent demand from both the private and public markets. There is also a need to align import duties in a manner that supports the competitiveness of local manufacturers relative to imported components. Local testing capabilities for some components such as cables, transformers, and inverters would also boost the competitiveness of local manufacturers, obviating the need for expensive international testing. If these challenges were addressed, South Africa could see rapidly growing local manufacture across the main solar PV components. Firms would also be better equipped to adequately supply South African demand during the critical period of rapid RE roll-out to 2030.

www.lsf-sa.co.za | 011 269 3736| info@lsf-sa.co.za
Report prepared for the LSF by B & M Analysts (PTY) LTD

4 Introduction

4.1 Value chain localisation opportunity overview

The creation of new industrial value chains linked to renewable energy can act as a catalyst to support South African manufacturing. Key is expanding productive capacity and enhancing competitiveness. Expanding manufacturing capacity in key components of the RE value chains could afford South Africa the opportunity to capitalise on its energy crisis. However, this is not without significant challenges. Strained public-private relationships and mistrust, combined with a comparatively small local market means that the value proposition for localisation is not always clear. Although not insurmountable, what is evident is that meeting global standards and having local tier 1 and 2 suppliers that can compete with imports from a pricing perspective is non-negotiable for localisation.

Positively, South Africa enjoys abundant sunlight, making PV energy a viable option for power generation. Localising the solar PV value chain offers several compelling advantages. By boosting existing or establishing new local manufacturing and assembly facilities for components for solar panels, inverters, and other associated components, South Africa can also accelerate technology and skills transfer, promote research and development, and support economic growth.

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 and determine the ramp-up curve for those components.

4.3 Methodology overview

This project has been 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 then involved a localisation ramp up analysis focusing on the development of a localisation roadmap for various components in the wind energy value chain, as well as the identification of cross cutting opportunities to support localisation.

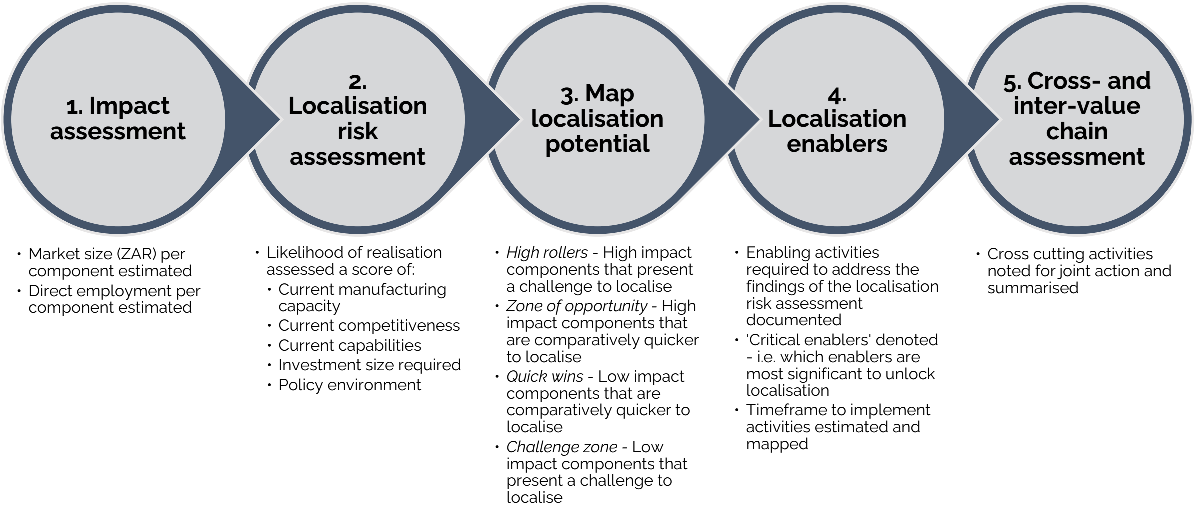
Details of the methodology deployed across both phases is presented below. The process followed for phase 1 is presented in 1. As highlighted, the focus of this phase was on understanding each of the three value chains being focused on (wind, solar, batteries), calculating anchor demand parameters, and engaging with industry on key value chain dynamics.

Table 1: Phase 1 research methodology

Value chain review	» Review 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 the end product side
Anchor demand analysis	» Estimate and forecast anchor demand (end of value chain demand) to be able to reverse project 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 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 presented in the figure below provides and overview of the methodology process for Phase 2 of the project. As highlighted the ramp up analysis required the completion of five activities.

Figure 4: Phase two methodology overview



4.4 Report structure

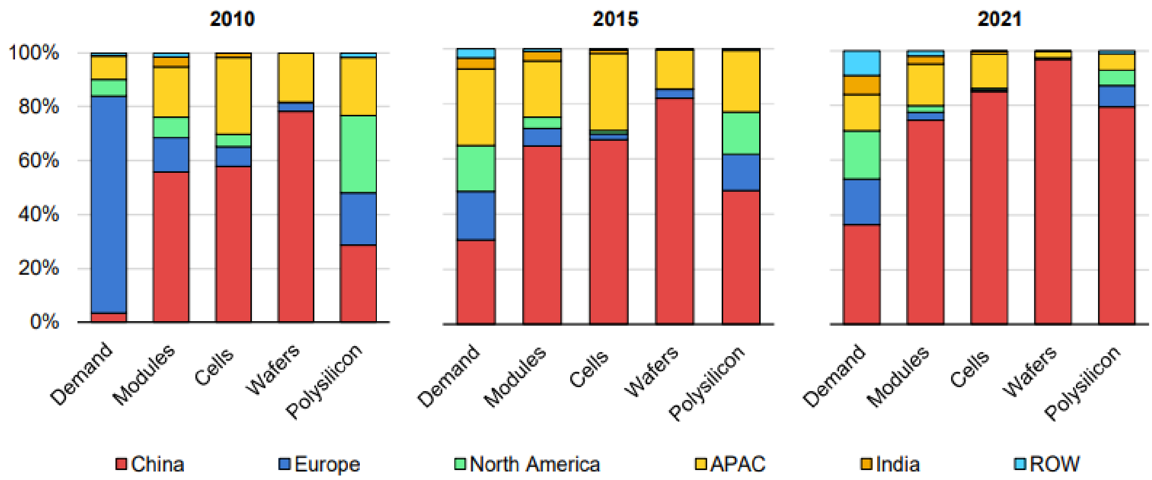
A literature and technology overview of the solar PV value chain follows in section 5. Present and projected demand for solar energy is then provided in section 6. This is obviously a key section and is based on existing data and consultations with the industry reference group mentioned above. Section 7 describes the localisation potential for each main component of the solar PV value chain, highlighting the impact in terms of revenue generation and job creation. Key localisation enablers for each component are also considered. A ramp up analysis then follows in section 8. This section consolidates the key findings from section 7 and attempts to visualise the critical milestones required to significantly ramp up localisation through to 2030 – assuming the enablers identified in section 7 (and based on detailed industry engagements) are realised.

5 Literature and technology review

5.1 Overview

China currently dominates the manufacturing of solar PVs and its various core components[i]. Figure 5 shows solar PV manufacturing capacity by country and region for the years 2010, 2015 and 2021. As revealed, China faces little competition in the wafer market, but Southeast Asia, particularly Vietnam, Malaysia, and Thailand, has significant production capability for cells and modules. Germany is a prominent provider of polysilicon to the c-Si PV module market, whereas the US and Japan have large capacity but only in respect of semiconductor-grade goods. China's dominance of solar PV production is anticipated to continue given the manufacturing facilities that are now under construction there as well as those that are planned. According to a report by Wood Mackenzie (2023), China invested $130 billion into its solar industry in 2023 which is predicted to grow by a CAGR of 38% from 2023 to 2026[ii]. By 2026, China is expected to have 1,687 GW production capacity of solar modules which enough to meet annual global demand through 2032[iii].

Figure 5: Solar PV manufacturing capacity by country and region.



Source: IEA analysis based on BNEF (2022a), IEA PVPS, SPV Market Research, RTS Corporation and PV InfoLink.

Notes: APAC = Asia-Pacific region excluding India. ROW = rest of world

This concentration of PV supply chains in a few regions of the world has created vulnerabilities in the supply chain. To de-risk the supply chain, the International Energy Association (IEA) has listed five key policy actions to ensure security of solar PV supply[iv]:

a) diversify manufacturing and raw material supplies,
b) de-risk investment,

c) ensure environmental and social sustainability,
d) continue to foster innovation,
e) develop and strengthen recycling capabilities.

These five policy actions represent a valuable framework, when considering the importance of RE supply chain development in South Africa. Despite the present dominance of Chinese manufacturers, the IEA makes it clear that it is critical for economies such as South Africa to advance their capabilities in the rapidly emerging RE value chain. Doing so, will potentially create substantial value for the domestic economy, especially as the industry expands over time, and the country's energy mix shifts increasingly towards wind and solar energy generation (and by implication increased battery storage with the value chain).

5.2 Global solar PV energy value chains

5.2.1 Value chain governance

Opportunities for localisation need to be explored within the context of the existing governance structures that dominate the global PV value chain. The core technologies that dominate globally are housed within large multinational corporations (MNCs) that work closely with only a few major suppliers and production partners across their global operations. These MNCs consequently operate a follower sourcing model when establishing operations in new locations, with their investments typically locking in subsidiary operations of their core suppliers and production partners. The core technology linkages within the value chain remain locked into these multinational organisations and their global partners, with subsidiary operations undertaking various levels of value addition within the new locations they operate in. These range from low value adding kit assembly of imported systems and sub-systems, to deeper levels of assembly, and local component and materials sourcing.

For the dominant PV technology, c-Si PV, the world's top 10 polysilicon manufacturers supplied 83% of the global market in 2019 (USAID, 2022: 4)[v]. Similar levels of concentration are evident for ingots and wafers. However, a more diverse set of firms manufacture PV cells and PV modules, with PV modular assembly having comparatively low barriers to establishment. This is based on one key proviso – that key materials and components can be sourced from the large multinational suppliers at a competitive price. It is at the modular assembly level of the value chain that key PV components (and their associated software) become important inputs, with these comprising inverters, trackers, mounting structures and two distinctive types of cabling (AC, DC). From a GVC governance perspective this therefore appears to be the point of the value chain from which local content can be organically developed.

As noted by Morris et al (2021: 4), "These manufacturing chain dynamics… resemble that of a producer-driven, vertically specialised, global value chain but this cannot be applied to the entire wind (or solar) energy global value chain". This is because commercial wind and solar farms are managed by energy companies who themselves have substantial decision-making authority within their sphere of operations. As such, Morris et al (2021) use the term "systems integrators" to describe the dual role of powerful manufacturing lead firms and plant developer/management lead firms in the renewable energy value chain[vi]. While a lead manufacturing firm may dominate the entire production chain of a PV farm, it is the developer/management firm that secures long term supply contracts with government entities, secures finance for the project, and then operates the solar PV farm. As argued by Morris et al (2021), given the mutual long-term interests of the lead manufacturer and lead developer in ensuring the successful delivery of solar PV to the client, there are close strategic linkages between the parties.

Clear investment consequences arise from this type of governance structure. Multinational foreign direct investment is key for localising the core technological components of the solar PV value chain, such as polysilicon, ingots, or wafers, with sourcing from local firms only possible in non-core technology areas. According to stakeholder interviews, there is at least one company undertaking a feasibility study regarding local production at this level of the value chain in South Africa. This is the reason for most local content in previous REIPPPP bidding windows emerging from Balance of Plant (BoP) activities, as opposed to higher value, core technologies.

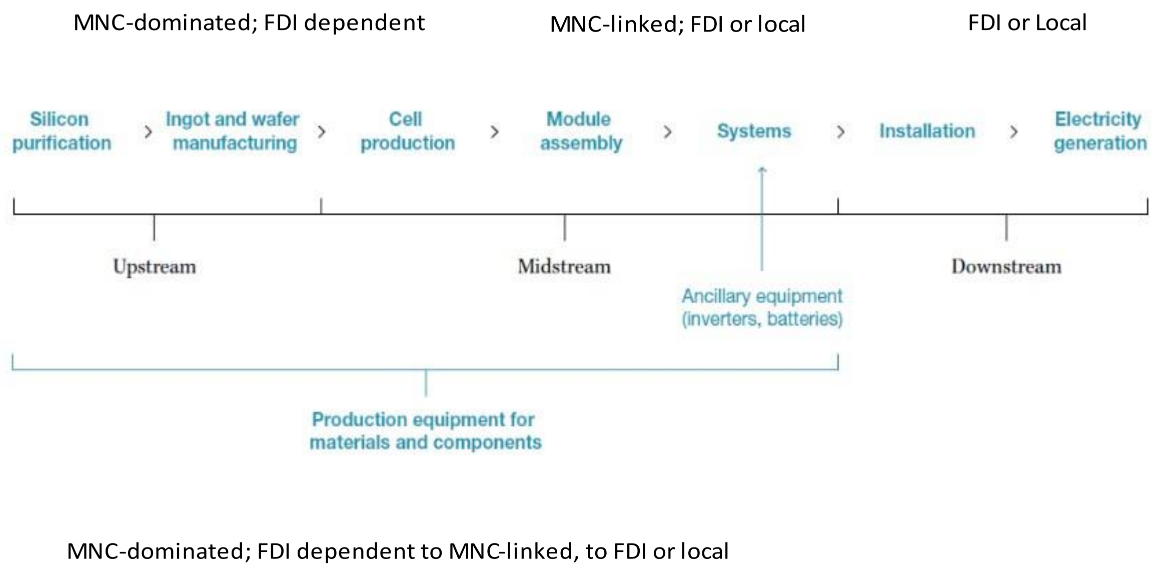
A further localisation challenge that emerges from REIPPPP bidding windows is the scale and concentration of the investments required. Bidding windows create short term surges in domestic demand, and through their local content provisions, in value adding activity.

Large scale plants may be established to meet the requirements of a bid window, but if this is followed by a quiet period, major business continuity problems emerge for the investors. This leads to firms limiting their local investment as much as possible (while still achieving the bid's qualification requirements), and hence focusing on the local purchasing of commodities and components that have low technology barriers and that are expensive to transport over long distances.

Fortunately, this constraint does not appear to exist for solar PV supply to residential and commercial projects sitting behind electricity meters, or within localised energy ecosystems (such as individual municipalities). These SSEG projects are smaller on average than solar farms, but they are not complicated by complex legal renewable energy supply arrangements. In many ways, each installation is akin to the purchase of a vehicle by a customer in a private vehicle market. The individual purchase of a system may not be of huge value, but if many thousands of systems are sold annually, a business case emerges for sustainable, more levelled demand (and by implication supply). Competitiveness between EPCs and installers means that pricing becomes a key differentiator, and given the thin margins in construction, many service providers source the cheapest option that meets the customer's specifications. The complexity of systems integration also falls away, limiting the complexity of global value chain governance to that of the lead manufacturer and its assessment of the domestic market's potential to support levels of supply. If the demand is sufficiently large and has longevity, then investment is likely to follow. However, while REIPPPP processes allow for forced local content, the same does not apply for SSEG (or the large-scale private market), hence the very low levels of local content on PV installations for homes (estimated at only 5% by USAID, 2022).

A summary of the governance considerations shaping solar PV localisation is presented in Figure 6. As highlighted, the upstream portion of the value chain holds little immediate opportunity, unless one of the core multinationals who dominate the key technologies globally chooses South Africa as an investment location. As downstream activity will occur in South Africa in any case, the midstream portion of the value chain appears to hold the most localisation opportunity, provided local capital and/or multinational investors can link competitively with upstream sources of supply. This relates to core PV technologies, as well as the range of components used in production. Competitive inputs are key to the sustainability and localisation potential of any modular assembly process, particularly if exports form a key part of the investment business case.

Figure 6: Governance arrangements within the solar PV value chain



Source: Derived from Morris and Walwyn (2023)[vii]

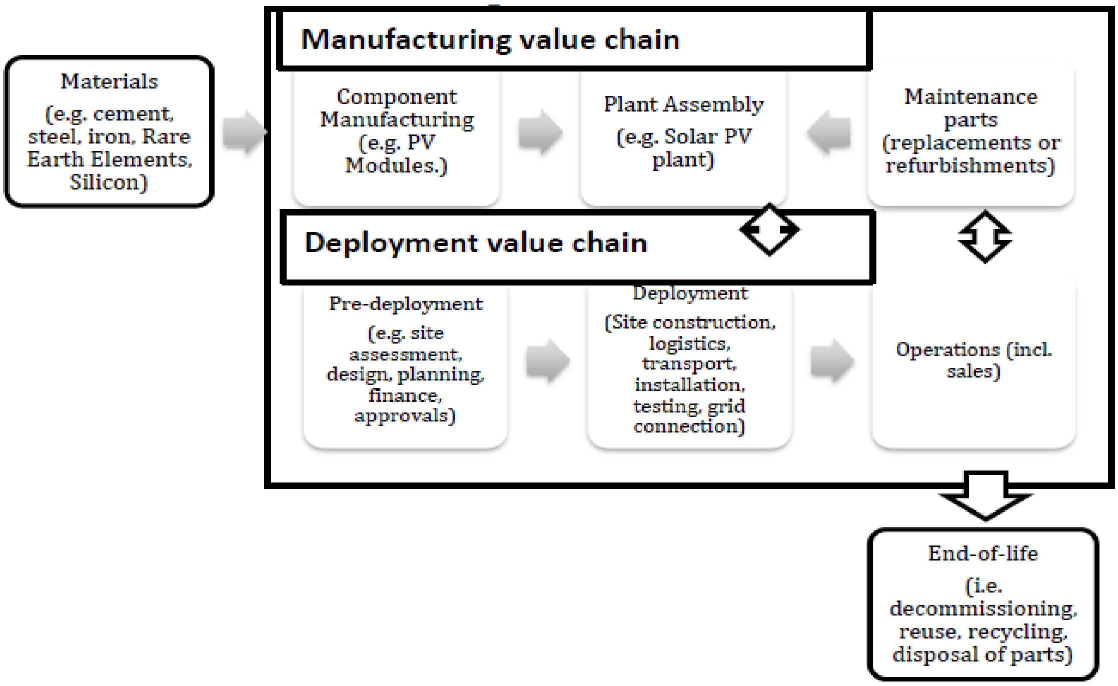
5.2.2 South African Value Chain review

The global value chain for the c-Si PV modules that are most common in South Africa is described in this section. There are two value chains in the solar PV industry. The first is the manufacturing value chain (including the materials, production, assembly, and delivery of the primary equipment, as well as its upkeep or replacement)[viii]. The second is the deployment value chain (which include the conception, delivery, operation, end-of-life, and decommissioning of solar PV projects). Figure 7 depicts these two value chains and how they interact, including the forward links to end-of-life for renewable energy materials and the backward links to materials for the manufacturing chain.

Even without government subsidies in South Africa, solar energy is already successfully competing with other energy generation sources. This is being driven by the declining cost of PV production. Nevertheless, securing investment flows, assisting local solar producers, and expanding the solar sector all depend on a stable and well-defined policy framework. This is particularly true in emerging nations, where private investors and project developers perceive a higher level of investment risk. For investors evaluating local risk, a solid set of measures targeted at boosting the scale and predictability of demand are essential.

A clear and significant installed capacity objective that offers solar developers and regional manufacturers a long-term vision of the market is one important strategy[ix].

Figure 7: The solar value chain.



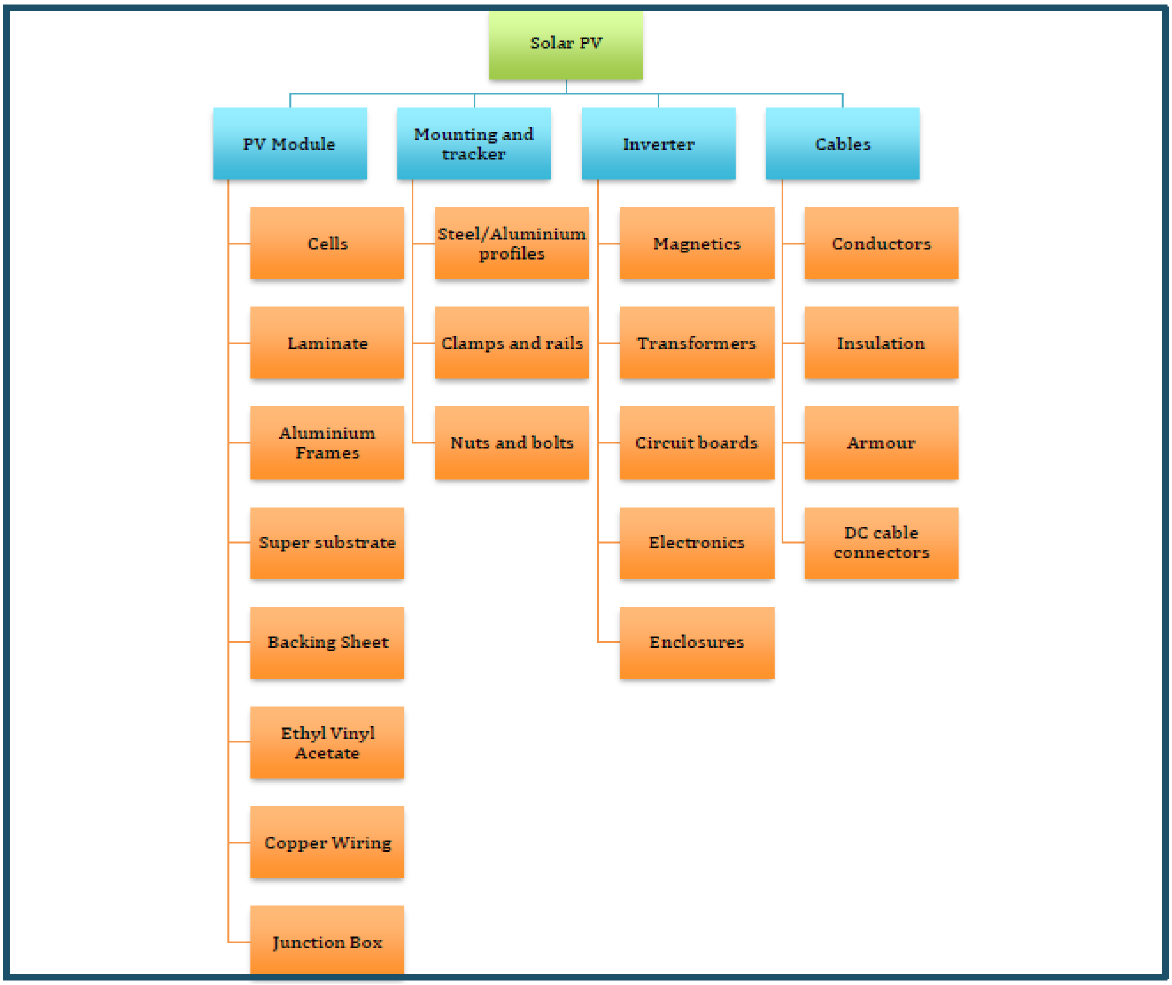
Source: Rivett-Carnac (2022).

The PV module, inverter, mounting system, tracker, and cabling make up much of a solar-powered system. Mounting structures and trackers are frequently purchased as part of the same design process, or as pre-manufactured items. Investments in the BoP are also necessary for large solar PV installations. This refers to the system components that require capital investment but excluding the PV module. The BoP is typically divided into three categories: components, civil and electrical services, and logistics and installation. Raw materials, such as silicon, glass, and aluminium, are required to produce the components. Intermediary items, such as semiconductors, are also important. About 76% of the weight of c-Si modules that are installed in South Africa is made up of glass, with minor amounts of polymers, aluminium, silicon, copper, silver, and other metals. A solar inverter's size, type, and enclosure all affect the materials needed for its manufacture. For instance, a 500 W inverter of one kind comprises 78 grams of steel, 216 grams of polymers, and 682 grams of aluminium. Depending on the installation method, a solar mounting structure's material requirements change[x].

Compared to CPV and thin film modules, which are made in a single stage, the manufacture of c-Si PV modules is more fractured, providing more localisation possibilities. The PV module's output is converted by inverters into alternating current that may be sent into the electrical grid. Inverters frequently provide additional services, such as data monitoring.

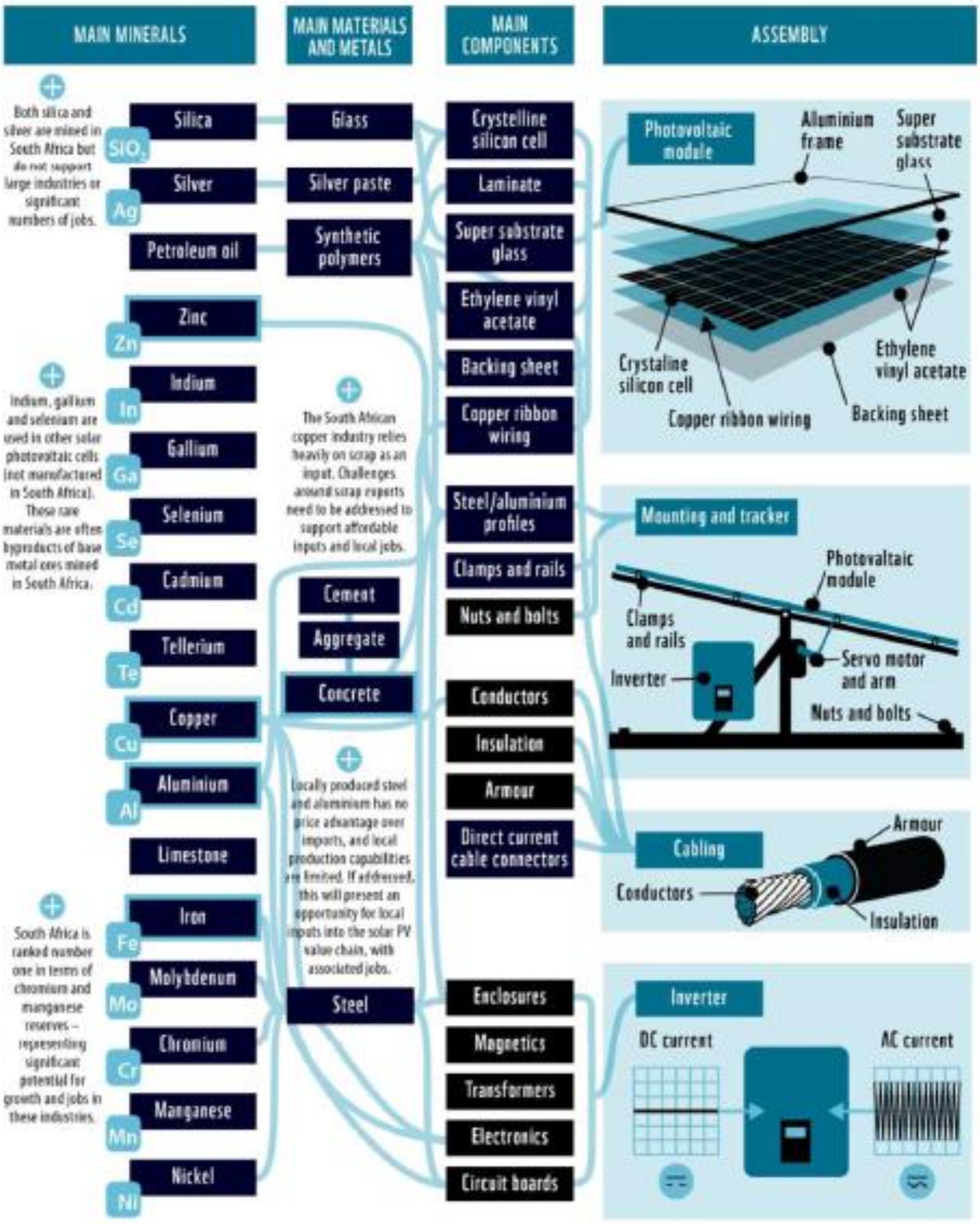
There is substantial technical diversity in the inverter industry. Inverters can either be large, centralized inverters or smaller string inverters like those used in residential projects or solar strings in utility-scale solar PV plants. While centralised inverters are big, solitary inverters that often convert more electricity per unit, string inverters are smaller and connected to individual modules or solar arrays (through recombiners). Indeed, there is more diversity in the form of microinverters that connect to the back of single modules, and hybrid inverters that can supply the energy from the panels to both the grid and battery strings. But the focus of this report will be on centralised and string inverters. With consideration for each site and location, mounting and tracking structures maintain PV modules pointed in the appropriate direction to the sun. PV systems are either fixed or tracking (where they follow the sun), and they can be pole mounted, land mounted, rooftop or façade installed, etc[xi]. An overview of the main components and sub-components of the solar value chain are shown in Figure *8* and Figure 9.

Figure 8: Components and sub-components for solar PV



Source: Rivett-Carnac (2022)

Figure 9: Materials and manufacturing value chain for the solar PV value chain.



Source: Rivett-Carnac (2022)

5.3 Solar PV technology review

5.3.1 Conventional solar PV technology

Solar panels are made up of individual photovoltaic cells that are connected to form modules (also known as panels). A collection of more than one module is called an array. The installation market in South Africa is dominated by c-Si modules and this report therefore focusses on this form of module. C-Si modules come in two forms: monocrystalline and polycrystalline that differ in their structure and efficiencies. Monocrystalline cells consist of solid silicon crystals sliced into thin discs and cut in the form of octagons[xii]. These modules are the most efficient type of PV cells, ranging from 15% to 20% efficiency[xiii]. Unlike monocrystalline cells, polycrystalline cells contain several fragmented silicon crystals that have been formed into cubes and cut into thin wafer squares. This form of PV module is cheaper to produce but is less efficient at converting sunlight into electricity, with an average energy efficiency of 13% to 16%[xiv]. Consequently, polycrystalline panels require more space to produce the same energy as monocrystalline panels.

5.3.2 Concentrator photovoltaic technology (CPV)

CPVs operate by concentrating sunlight using mirrors and lenses onto a central large photovoltaic cell to generate electricity[xv]. This form of energy generation increases the efficiency of the collector PV through the concentration of solar radiation up to 500 times, thereby reducing the area required for solar PVs[xvi]. Due the concentrator effect, CPVs are twice as efficient as conventional PVs in converting solar radiation to electricity, reaching efficiency levels >30%[xvii]. CPVs are not to be confused with Concentrated Solar Power (CSP); a technology that converts the sun's energy into high-temperature heat using concentrator reflectors, with the heat then being used to generate electricity[xviii]. South Africa has one operational CPV Solar Project located near the town of Touwsrivier in the Western Cape. In 2019, this project was the second largest operating CPV facility in the world[xix], with an electrical power production capability of 44 MW[xx].

5.3.3 Thin-film solar photovoltaics

Thin-film solar panels consist of three components: the PV material which is deposited on a thin layer of substrate such as metal or glass and coated with a protective layer to prolong the life span of the solar module. There are three types of thin-film solar PVs: cadmium telluride, amorphous silicon (a-Si) and copper indium gallium selenide. This type of PV technology has an efficiency of 7% to 18%, and a lifespan of 10-20 years[xxi]. Their physical flexibility facilitates their applications on surfaces where traditional solar PV modules cannot be fitted, such as on curved surfaces or on glass panels in building-integrated photovoltaic projects (BIPVs). This is considered the fastest growing segment of the global solar industry[xxii]. Africa's largest thin film solar farm was completed in 2014 in South Africa near the town of De Aar and is known as the Solar Capital De Aar Project. It is 75 MW in size[xxiii].

Box 1. Potential and disruptive global solar PV technologies

There are several potential and emerging solar PV technologies that have been identified as potential disrupters to the current mainstream solar PV technologies. These include:

Perovskite Solar Cells

Perovskite solar cells have been identified as having several benefits over silicon-based solar cells. These benefits include better light absorption and longer lifespans leading to greater module efficiencies[xxiv]. This recent technology may realize lower costs and be more scalable, but improvements are needed in the stability of the cells and the currently high, negative environmental impacts of manufacturing[xxv].

Organic PVs

Using organic electronics[xxvi], organic PVs are made up of thin films of organic semiconductor materials, such as carbon-based material, rather than silicon. This makes organic PVs lightweight, flexible, and extremely thin. Organic solar cells are third generation solar technology: low in cost and high in energy efficiency[xxvii]. Organic solar cells are emerging as a low-cost PV generation technology, with the prospect of serving as an alternative to silicon PV in the future[xxviii]. They offer 18% power conversion efficiency and a 12-year lifespan[xxix].

Off-shore solar projects

Floating solar farms have previously been designed for use in still-water applications such as dams and lakes. Installing solar farms on rough water such as at sea has been hampered by damage to modules caused by waves. In 2019, the first offshore solar project was initiated in The Netherlands which is expected to be operational in 2025 and produce 759 MW[xxx].

Solar roof tiles

Also known as solar roof shingles, these tiles contain a thin sheet of PV film that generate electricity. These have been identified as being sleeker and offering a more attractive aesthetic than traditional solar PV modules. They are also easier to maintain, and more cost effective[xxxi]. There are no documented examples of this technology being applied yet in South Africa.

5.3.4 Technology Utilisation by Geography

The most widely installed solar PV technology in South Africa is the c-Si module[xxxii]. c-Si modules have been installed in all three market segments across South Africa: residential, industrial and utility-scale. CPV technology in South Africa is currently only used at the utility scale, with South Africa's only plant located in Touwsrivier in the Western Cape[xxxiii]. Similarly, thin film technology has been implemented at only a single utility scale project in South Africa, near the town of De Aar in the Northern Cape[xxxiv]. We were unable to identify any literature that describes residential and commercial applications of CPV or thin film technology in South Africa, or any references to installations.

5.3.5 Technology Utilisation by Market Segment

Residential projects (also sometimes referred to as distributed solar PV systems) are typically 5-20 kW in size with PV panels mounted onto the sloping roof of homes[xxxv]. Commercial and Industrial (C&I) projects are typically much larger, ranging from 1 MW in size, primarily serving corporate organisations and industrial plants[xxxvi]. Panels can either be ground-mounted or rooftop-based. Utility-scale projects tend to be >10MW in size and serve utility companies and larger energy consumers such as mines[xxxvii]. They are situated on large tracts of land where modules are attached to mounting systems on the ground with trackers to rotate the panels to maximise sunlight absorption. In South Africa, conventional PV solar farms dominate[xxxviii].

Residential and C&I projects typically use c-Si PVs. Residential and C&I installation projects are also typically simpler in their design and implementation than utility-scale projects. Residential and C&I installations involve fewer players, and installations are typically carried out by a single service provider whose services range from technical assessments through to installation[xxxix].

Utility scale projects involve many more stakeholders, including investors and financiers, Original Equipment Manufacturers (OEMs), and power producers and distributors, among others[xl].

Another important distinguishing feature concerns the materials required for ground mounted systems (as is often the case in utility-scale projects) versus roof mounted systems (typical of residential and C&I installations). The former requires double the amount of steel per MW project than roof mounted systems to adequately support the free-standing, tilted solar panels and their components such as tracking systems[xli]. Residential and C&I systems on the other hand require more copper as they rely on micro-inverters and not centralised inverters used in utility-scale projects[xlii].

5.4 South African solar PV market

There is an extant literature describing opportunities for the localisation of solar PV component manufacturing in South Africa. One of these is the South African Renewable Energy Masterplan (SAREM). The draft 2022 SAREM provides the highest level of detail for each component of the solar PV value chain and identifies the highest potential for localisation existing for mounting structures, trackers, and cabling as of 2022. In addition, the updated SAREM describes cell manufacturing as one of the short-medium term opportunities, identifying the production of ingots and wafers as the next frontier for manufacturing opportunities in South Africa[xliii].

For mounting structures and cables, three of the four subcomponents for each component were already supplying into the RE value chain in the country in 2022 (see Table 2). For trackers, the draft 2022 SAREM indicated that it might require a ramp up period to re-establish manufacturing capabilities for this component but that the potential is high. For PV modules, lamination and aluminium frames are already produced locally and therefore, with cells, super-substrate, copper wiring and junction boxes, have been identified as medium potential for localisation (see Table 2). For inverters, the magnetics, enclosures, and transformers were already locally produced, with circuit boards showing medium potential (see Table 2).

Table 2: The potential for localisation of the sub-components in solar PV.

Component	Existing related industry in SA?	Supplying to RE in SA?	Potential (Low/Med/High)	Required conditions to localise
Modules				
Cells	No	No	Med	Highly competitive industry with current oversupply globally. Tier 1 companies forward integrated (only supply to companies making own PV modules). Min of 300MW/year/facility required for 5 years
Lamination	Yes	Yes	High	Already localised
Aluminum Frames	Yes	Yes	High	Already produced locally, but not competitively. Local producers need economies of scale (increased demand) to reduce cost.
Super-substrate (glass)	Yes	No	Med	SA production potential for rolled glass high but considered uncompetitive by manufacturers especially against Asian producers with large economies of scale. High iron content of SA silicon will require large demand/economies of scale to produce low iron solar glass
Backing sheet	Yes	No	Low	Concentrated supply chain limiting opportunity for local manufacturing
Ethylene Vinyl Acetate (EVA)	Yes	No	Low	Concentrated supply chain limiting opportunity for local manufacturing. Some potential if large demand/economies of scale
Copper wiring	Yes	No	Med	Some potential for manufacturing of wiring with imported copper. Local copper uncompetitive (quality and cost due to economies of scale)
Junction box	Yes	Yes	Med	Some smaller scale manufacturing established. Requires about 300 MW/year demand to justify investment in local production
Inverters				
Magnetics	Yes	Yes	High	Additional mill equipment is required to enable production of magnetics locally, but economies of scale are required to be competitive. (Magnetics for small scale inverters can be made locally.)
Enclosures	Yes	Yes	High	Scaling of local production likely to be enabled by local assembly of utility scale inverters where reduced shipping cost of local production can give a competitive advantage to locally produced enclosures. (Some small scale inverter manufacturers source enclosures locally.)
Transformers	Yes	No	Med-High	It takes 3-4 years for local suppliers of critical renewable energy components to be able to deliver at the expected quality. / Requires some development of local transformer manufacturing capability to adapt to requirements and standards of renewable energy industry.
Power Stage and Power Electronics	Yes	Yes	Low	Limited manufacturing using imported components (70% of value). Requires some development of local power electronics manufacturing capability to adapt to requirements and standards of renewable energy industry.
Circuit boards	Yes	Yes	Low-Med	Some locally assembled printed circuit boards (PCB) are made from imported materials (30% of value), but not produced competitively. It may be difficult to produce competitively locally due to economies of scale of international manufacturers.
Mounting structures				
Steel profiles	Yes	Yes	High	Local producers need economies of scale (increased demand) to reduce cost / Existing capability for production of flat, rolled, and stainless steel. Where required to be local, these are currently sourced locally at some premium.
Aluminium profiles	Yes	Yes	High	Requires dedicated extrusion capacity to respond to needs of renewable energy industry in terms of scale and timing of demand (currently primarily using imported aluminium billets, see materials section; in facilities that produce for multiple sectors).
Nuts & bolts	Yes	Yes	High	Well established local producers that produce for multiple sectors.
Clamps and rails	Yes	No	High	Fixed axis use clamps, single axis trackers use bent steel rail. Capability exists in South Africa, not predominantly utilised at present. Design needs to be approved by PV module supplier.
Cables				
Conductors (copper rods, aluminium rods)	Yes	Yes	High	Relatively good backward integration (i.e. sourcing components locally). Aluminium imported; establishing local aluminium rod production would boost localisation potential of cables. Copper imported when local supply inadequate
Insulation (polymers)	Yes	Yes	High	Challenging to remain globally competitive due to technology development (requires investment in manufacturing).
Armour (steel)	Yes	Yes	High	Some local production (primarily using imported steel, see materials section). Local producers also need economies of scale (increased demand) to reduce cost / be competitive with imported armour
DC cable connectors	Yes	No	Med	Highly specialised component. Innovation required to enable competitive advantage. -Design and quality for minimum losses, design for tool-free assembly

Source: SAREM (2022)

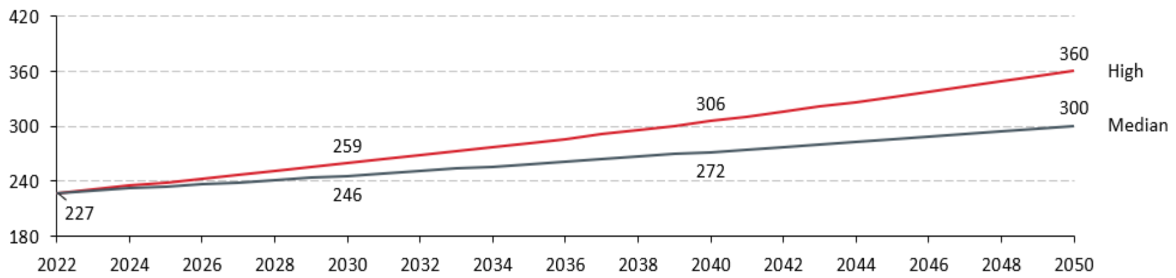
6 South African demand for solar energy

6.1 Solar energy demand

To put solar PV energy 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.

The figure below shows the total forecast demand for electricity. The forecast considers the historical compound annual growth rate (CAGR) of -0.55% and the established publications from the Integrated Resource Plan (IRP), Eskom, CSIR, and the International Energy Agency (IEA). Demand is growing and is forecast to increase steadily at between 1% (median scenario) and 1.66% (high scenario) in future.

Figure 10: Total electricity demand (Twh) forecast for South Africa



When calculating demand for solar PV to 2030, six assumptions were made, as listed in Table 3.

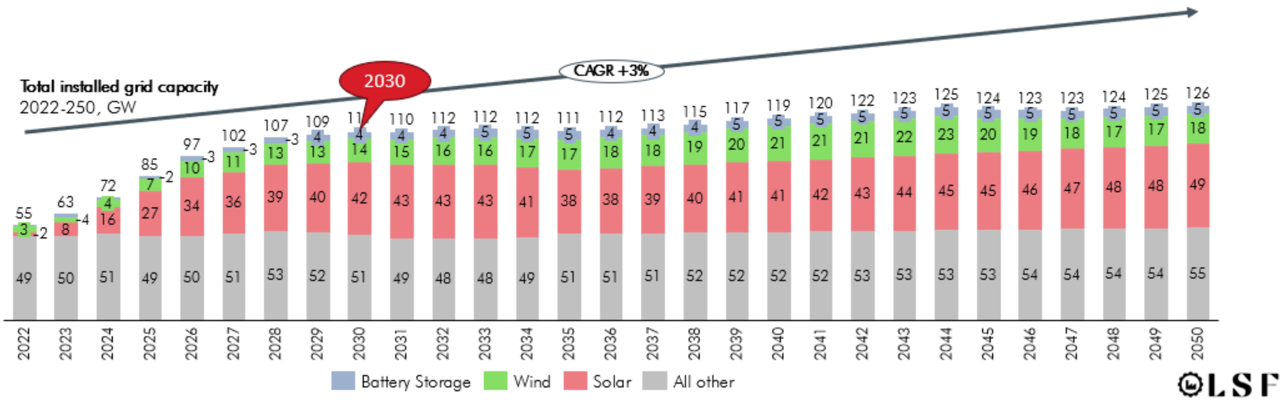
Table 3: Key assumptions made when calculating the solar PV demand forecast to 2030.

Key assumptions
The assumption is that public demand will stabilize at 400 MW per year after 2030. This number comes from and was supported by engagements with industry
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.
The steady state private utility demand (after 2035) is taken to be the average of demand 2031-2035 at 216 MW pa.

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.
The lifespan of a solar farm is taken to be 10 years before re-powering (Levington pers. Comm.)
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)

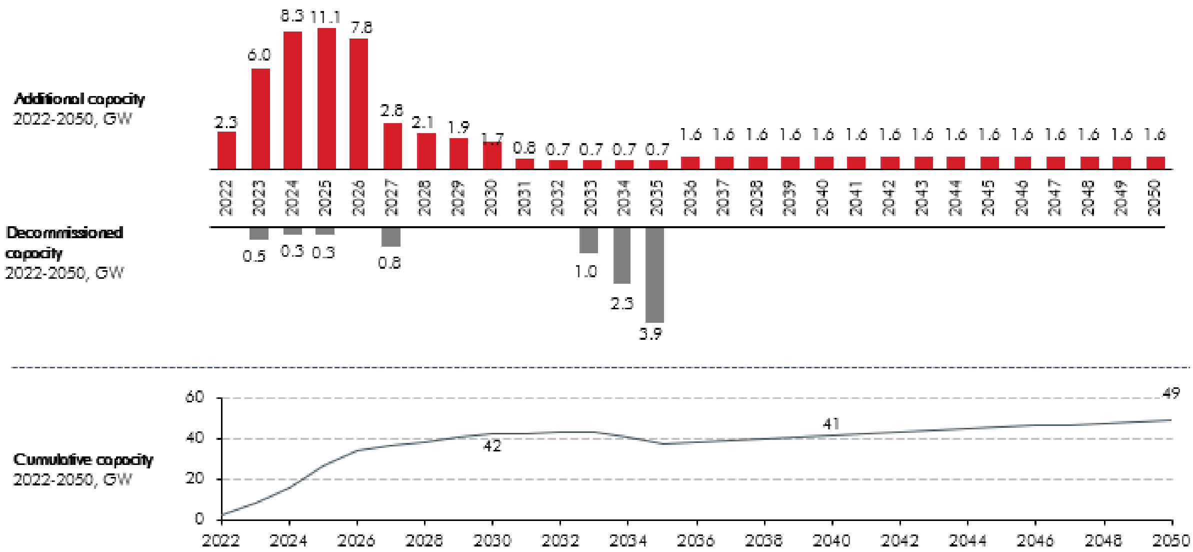
The figure below shows the total installed grid capacity forecast with the relevant technology splits. This is the combined output of the modelling and gives an overall view. In the initial period to 2030 there is some catching up with demand based on existing shortages of generation capacity. The growth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

Figure 11: Total installed grid capacity in South Africa.



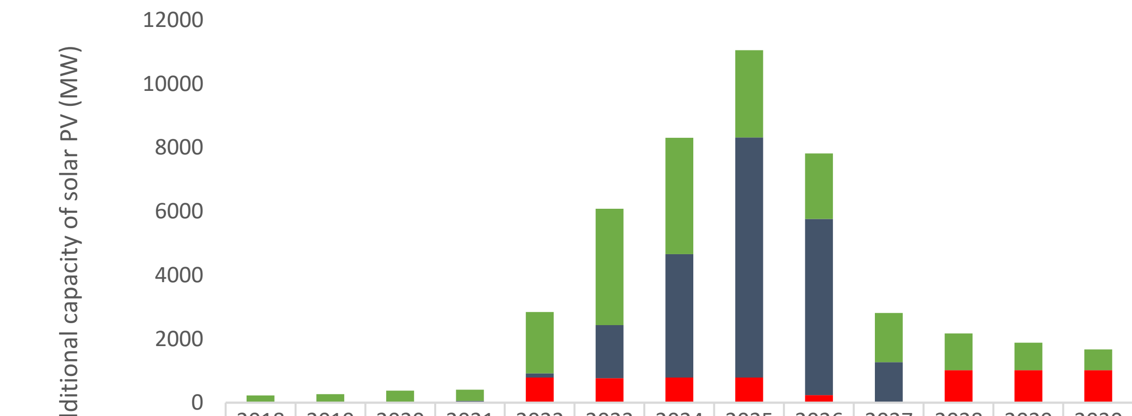
It is important to note that cumulative solar capacity is forecast to reach 42GW by 2030 (from the current base of 8GW in 2023, Figure 13). Solar demand is forecast to increase substantially to 34GW in the 2023-2026 period and then to remain between 30GW-40GW between 2026-2038. Total cumulative capacity is expected to reach 49GW by 2050 and takes into account decommissioning of some solar projects between 2022-2035 (see Figure 12 below).

Figure 12: 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 13). 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 13: 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

7 Localisation potential of solar energy components

7.1 Industry engagement

7.1.1 Existing solar energy component manufacturing capabilities in South Africa

The table demonstrates potential stakeholders in an industry ramp up programme. The manufacturers and suppliers engaged as part of the study are included. The figure does not aim to provide an end-to-end list of current and possible manufacturers (this is already available through REIPPP)

Table 4: Manufacturers of components of the solar PV value chain who were 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			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

7.1.1.1 Solar modules

The speed of technological advancements being made by a few global manufacturers of solar modules has increased their market dominance. These global manufacturers have large, well-resourced research and development (R&D) teams that have ensured a widening gulf between their capabilities and smaller competitors.

There are at least three local manufacturers of solar panels in the country: ArtSolar (engaged), Seraphim and Ener G Africa. Assembled modules comprise mostly (~90%) imported materials. Some efforts to localise components have been made but most are imported through the local manufacturers' technology partners. Materials that are already localised include packaging, flux, alcohol, and soldering wire. Some R&D is taking place locally and aspirations of expansion suggest increasing local supply capacities in the short-medium term.

7.1.1.2 Inverters

The supply of all types of inverters in South Africa is dominated by imported units with most of the local manufacturing value add coming from distribution and maintenance. There is one manufacturer of string (grid-tied and off-grid) and centralised inverters but is not yet fully operational (Ario is awaiting certification). This facility has a current capacity of two 180 kVA units per week, with aspirations to expand and develop a production line to ramp this up to five units per day by 2030. The second manufacturer, Rubicon (who acquired MLT) is an established manufacturer of residential grid-tied (bi-directional) string inverters and manufactures 10kW inverters for the residential market. Their current capacity is 50 units a month and they are currently establishing capabilities to manufacture hybrid inverters. It is understood that Microcare also operate in this segment though there was no direct engagement with the manufacturer.

Most (if not all) electrical components are imported. Metal work is largely localised, although the raw materials are claimed to be mostly imported due to local raw material quality concerns. Local content is estimated to be ~60%.

Inverter manufacturers and suppliers at the utility scale supply power conversion units (PCUs) for utility projects. These units contain an inverter, a transformer, and a switchgear. These three components are distributed to site where they are placed on a locally manufactured concrete skid and assembled by a team of technicians usually associated with the inverter and transformer manufacturers. The unit is then connected to the solar strings by cables, with this work carried out by the Engineering, Construction and Procurement contractors (EPCs). The transformers and switchgears are largely supplied locally, meaning that even if the inverter is imported, the PCU will still have a high local content (45%). This then provide little incentive for the localisation of the inverters themselves.

7.1.1.3 Transformers

There is already a high degree of localisation for transformers since these are designated for public procurement through REIPPP. Local manufacturing capabilities include Generator Step Up Transformers (GSUT) and collector transformers. GSUT sizes range from 2-5 MVA and can take between 0.6 KV to 33 KV. Collector transformer sizes range from 80 KVA to 180 KVA and can transform between 33 KV and 132 KV. For collector transformers, one manufacturer dominates with the lion's share of the market. Capacity to supply GSUT transformers is ~500 units per annum, while for collector transformers it is ~3000 MVA per annum. The domestic industry has spare capacity of around 30%.

Solar PV transformers are completely different to those dealing with power distribution. Transformers for solar PV projects need to handle fluctuations in energy (purely because the sun goes up and down) versus the constancy of coal. There is also an element of design which takes place for each project; and this can take up to three years to be completed. Transformers have consequently been identified as a bottleneck to supply power conversion units.

In the manufacturing process, 40% is value addition and 60% raw materials. Of the raw materials, 60% is imported, including copper and core steel, while 40% is local, including some locally supplied steel.

Additional local capabilities include an on-site testing facility at Actom. There are also local capabilities to install and maintain transformers, with local manufacturers who can supply these value adding services holding a competitive advantage with EPCs and OEMs.

7.1.1.4 Mounting structures and trackers

Mounting structure suppliers are either teams of engineers who have their designs sent to fabricators for manufacturing or are purely wholesalers of imported mounting structure components. These companies also have installation technicians who carry out the assembly of the structures as per design specifications, but they are typically not involved in the maintenance of structures. This task is left to the EPCs or other private companies.

Local manufacturers such as Caracal Engineering can supply the market with high-quality bespoke mounting solutions comprising piles, purlins, girders, struts, and clamps (depending on project specifications, such as whether rooftop or ground mounted). Aluminium extrusion and steel fabrication capabilities exist to manufacture mounting structure designs. It is understood that Hulamin and Wispeco have capabilities to supply clamps for this industry. For larger and international projects, local suppliers' source most of their materials (up to 70% - mainly girders, purlins, and fasteners) from countries such as China and Turkey.

By way of example, one engineering company, K2 Systems, has significantly increased its supply of solar panel framing systems. The firm does not supply tracking systems - only fixed or ballasted systems. The firm supplies the market with advanced solar support systems (comprising brackets, clamps, clips, and bolts) that are manufactured in Europe (although most Aluminium is from China or elsewhere in Europe).

7.1.1.5 Cables

Medium and low voltage cables are required by the solar PV value chain. Both can be made in South Africa, although almost all low voltage cables are imported. There is excess domestic production capacity for both cable types, but this capacity remains under-utilised due to the high price of local cables relative to often lower quality imports.

Local manufactures (CBI, Aberdare, SOEW, Tulisa, and M-tech) can supply roughly 8,400 tons per month of medium and low voltage cables (proportion for each not specified). For low voltage cables, Aberdare and CBI can supply 1,200 and 2,400 km per annum, respectively. For medium voltage cables, these two manufacturers can supply 180 and 2,600 km per annum, respectively.

For medium voltage cables there is a compulsory safety standard (SANS 97 or 1339), and all local manufacturers adhere to this. For low voltage PV cables there is no compulsory safety standard. The Association of Electrical Cable Manufacturers of South Africa (AECMSA) has developed the standard (IEC 62930), and it has been submitted to the Department of Trade, Industry and Competition (dtic) and the National Regulator for Compulsory Specifications (NRCS) for adoption. There are at least two local manufacturers (SOEW, Aberdare) currently capable of producing the PV cable to the standard.

Almost all (~90%) of the materials needed for cable manufacturing are being imported, including aluminium, cross-linked polyethylene and copper. There is a small supply of copper from a local mine, and all polyvinyl chloride is supplied locally.

7.1.1.6 Fasteners

Local manufacturers make a wide variety of nut and bolt sizes (6-24 mm). Workers are typically trained in-house and thus skills are not a critical issue in this industry. In terms of quality, most fasteners are made to an ISO specification. Manufacturers are required to issue a 3.2 certificate per order certifying that the fasteners meet the ISO specification's dimensions, tensile, hardness, coating thickness and thread standards. CBC Fasteners have supplied into two solar projects before, one of which was a 500 MW solar plant.

Local production capacity is 4.5m tons per year, which is greater than the entire SA market of 2.5m ton per year. However, local demand is presently low. Manufacturers have supplied into the solar PV value chain before and have also worked in the broader RE industry, noting that around 1 ton of nuts and bolts is required per MW of capacity in utility scale projects. The main material for fasteners is steel coils which are supplied locally.

One manufacturer operating at maximum capacity and supplying 14,000 tons per annum, could supply a maximum of 14 GW of solar PV roll-out per annum. This capacity would be sufficient to supply the value chain even at its peak of 11 GW newly installed capacity in 2025 (the median estimate of this report).

7.1.2 Top challenges described by engaged manufacturers.

Five main themes emerged following engagements with these stakeholders, which were:

- Competition faced from imports,
- Fluctuating demand,
- Certification challenges,
- Skills shortages, and
- Lack of regulations.

These are summarised in Figure 14 below. These themes are described in more detail per component in sections 7.3-7.8 below where the barriers and enablers for localisation for each component are addressed.

Figure 14: Localisation themes from industry engagements in the solar PV value chain.

Lack of control of imports

All manufacturers and suppliers highlighted this as a key issue, particularly identifying competition from Chinese imports as the biggest challenge.

"We fight the imports…currently unfair dumping. We do have safeguard duties and a dumping duty application is in progress. Without protection, local manufacture is dead."

Fluctuating demand

Fluctuating demand created pockets of intense demand followed by stagnation that ultimately caused a decline in investor confidence. Lack of visibility on future demand meant it was impossible for suppliers to anticipate and plan.

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.

Shortage of skills

Skilled technicians will be critical to conduct maintenance and refurbishment work as component warranties and lifespans expire in the coming few years. Trained staff find better opportunities overseas, and it is becoming increasing challenging to find and retain staff in SA a challenge to retain skilled staff in RSA.

Lack of regulation

Specifically for roof top mounting structures. This is currently resulting in sub-standard mounting structures being installed with poor maintenance. Identified as a potential risk to current projects.

"There are now standards in South Africa on inverters but not on installation frames…the importance of frames is not understood by the energy regulators. This is a major weakness which will be felt in South Africa over the next few years."

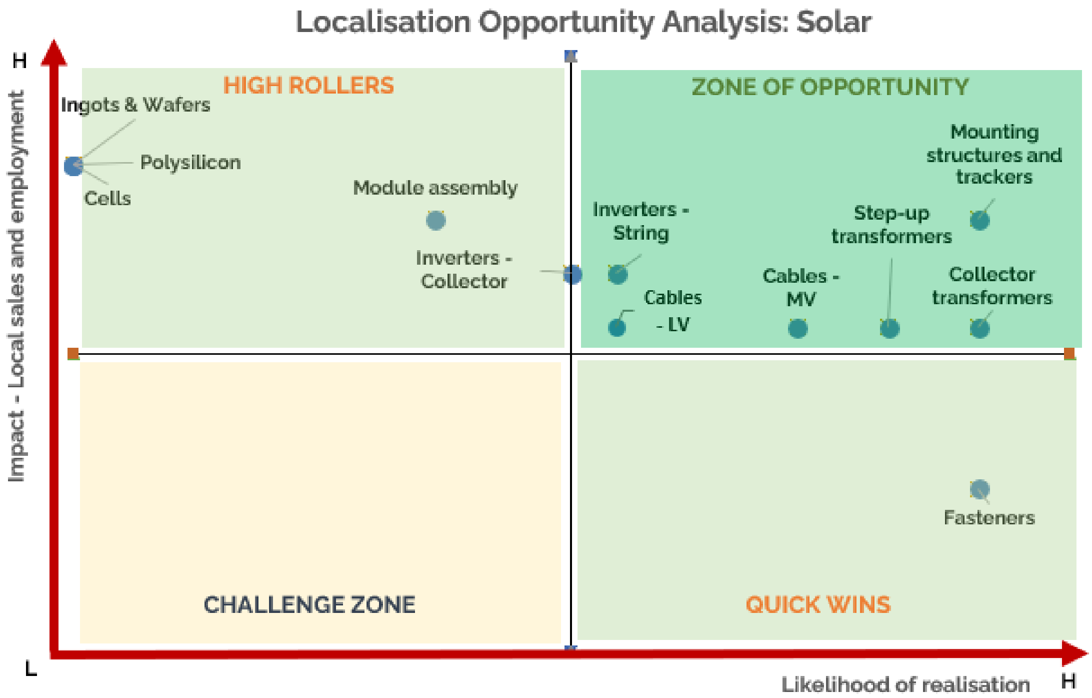
7.2 Localisation potential in South African solar energy value chain

7.2.1 Localisation potential matrix

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[xliv]. 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.

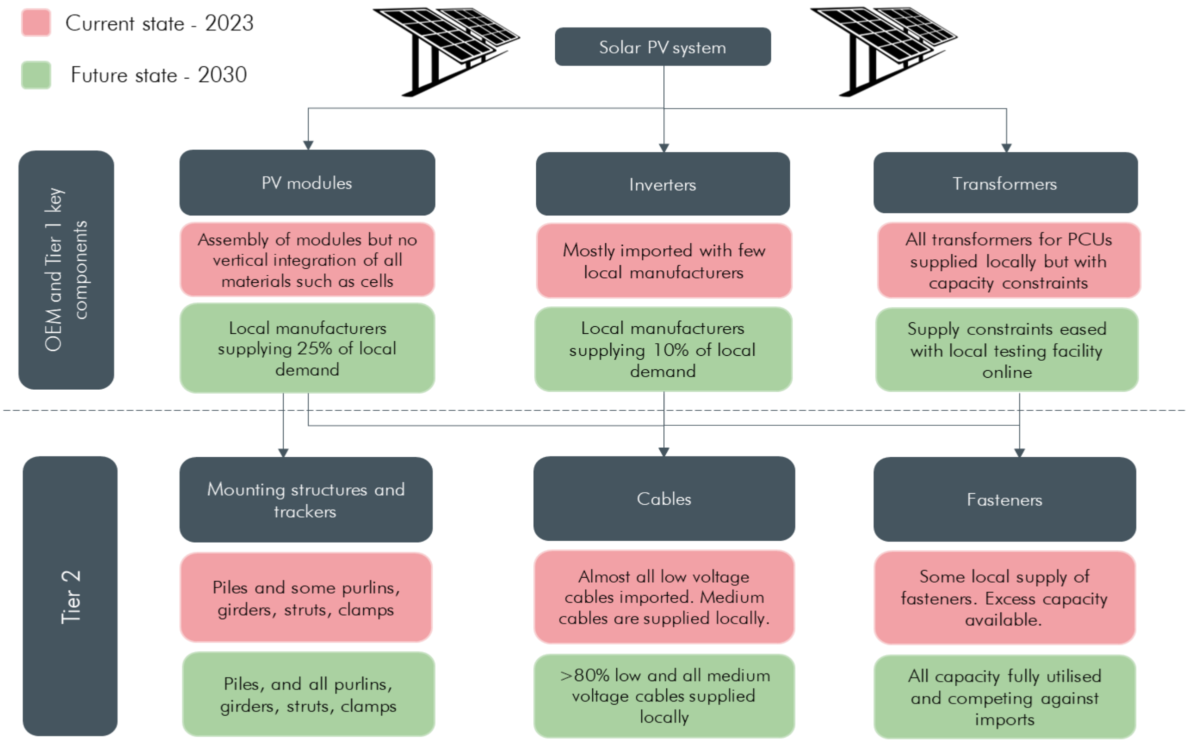
Module assembly is a 'high roller', requiring investment to grow capacity and policy revision to level the playing field against imports. Inverters (string inverters such as those made by Ario, as well as smaller types for the residential market such as those made by Rubicon) show promise with local 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.

Figure 15: Localisation opportunity analysis for components in the solar PV supply chain.



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.



7.3 Solar module localisation realisation pathway

7.3.1 Solar module impact and implementation risks

An estimated 71 million 500W solar PV modules would be needed to cater for the projected 35,715 MW of total South African demand to 2030. This is worth an estimated R250-300 billion. Local suppliers can supply 12-15% of this demand to 2030 given their current production levels. Therefore, if this were to be increased to 25%, significant value would be generated in sales, estimated to be R62 billion in value. The knock-on job creation impact would be substantial: an estimated 200-300 direct jobs.

Importantly, local assembly capabilities exist and are of high quality. However, the intellectual property (IP) for cell manufacturing lies with overseas technology partners, with local manufacturers importing key components and assembling locally. Local manufacturers are marginally more expensive than similar high-quality imported modules, but the market is flooded with cheaper lower quality products. A revision of the value chain's duty structure could level the playing field with imported products, and when coupled with investment to expand or develop new capacities, this would boost the localisation of PV modules.

A summary of the insights from engagements with manufacturers is captured in Table 5.

Table 5: Modules (Solar) localisation potential

	Market	Asset		Resource
Medium Potential	Demand	Capability	Capacity	Supply
Status quo	Two main domestic market segments (roof top and commercial farms) Local supply into local market only Strong demand growth anticipated.	Advanced assembly of mono and bi-facial panels, but under technology/licensing agreements and of mostly imported material Limited depth of production, although some local R&D with aspirations to assemble other components into the renewable value chain.	Aspirations for expansion plans suggest increased capacity in the short-medium term.	90% of materials imported. The 10% locally supplied includes packaging, flux, alcohol, and soldering wire. Imports materials chiefly through technology partners and their designated suppliers
Barriers	Inconsistent demand from public and private markets limits procurement from local manufactures and investment by local manufacturers in dedicated capacity.	No vertical integration and limited R&D leading to local capabilities being tied to overseas technological partners. OEMs overseas highly technologically advanced.	Assembly versus production .	Shifting suppliers is dependent on approval of technological partners, which is generally not given. Short notice of bid window opportunities. Costly auditing process to supply IPPs. Exclusion

	Market	Asset		Resource
Medium Potential	Demand	Capability	Capacity	Supply
	Stiff competition with imports mainly from Chinese manufacturers. Lack of verification of localisation standards.			from REIPPP bidding process results in engagements only taking place at the critical stages, placing manufacturers in unfavourable positions.
Enablers	A level of consistent demand from both private and public markets. Major growth in residential and commercial rooftop demand – creates opportunity for more consistent demand.	Growing demand in South Africa opens opportunities for expanded local production, but depth of capability dependent on lead firms internationally.	Price competitiveness of local assembly focusing attention on future growth potential of domestic market	Growing demand and technology shifts may create greater linkages to local resource supply.

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7.3.2 Solar module interventions

There are two manufacturers of solar panels in the country, ArtSolar and Seraphim. Both supply the market with Tier 1 panels. Local capabilities focus on the assembly of high-quality modules using mostly (~90%) imported materials that are supplied by the manufacturers' technology partners. Localised materials include packaging, flux, alcohol and soldering wire.

To boost the local supply of high quality locally assembled inverters, local manufacturers stress the importance of four enablers.

First is the need for consistent demand (see Table 6). This has been identified as the biggest barrier limiting large-scale investment to expand current production capacities. Close to R 100 million of capital is needed to establish a 300 MW solar PV manufacturing facility which was noted as infeasible when demand spikes and then falls due to the inconsistent demand.

Second, localisation could be further supported by reviewing current import tariffs and possibly increasing them to levels appropriate for the local market. There is currently a 10% WTO bound rate that South Africa could potentially apply.

Third, the establishment of local, verifiable standards would open more domestic opportunities for local manufacturers. Most importantly, this would limit the importing of poor-quality modules. Further engagements between manufacturers and relevant public departments on the establishment of certifiable local standards (that are then enforced) would significantly benefit localisation opportunities.

Fourth, given that local manufacturers currently capture only a small percentage of the local market, there is huge opportunity for local manufacturing for the domestic market. This relates to both the residential and Commercial & Industrial (C&I) markets, as well as at the utility scale. It also means there is potential space in the domestic market for new manufacturing investors.

Table 6: Enablers and interventions for the localisation of solar modules into the solar PV value chain.

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Consistent demand	3 years	Updated IRP 19 aligned with demand forecast	A	DoE	1 year
		Annual bid windows with consistent allocation volumes	A	DMRE	3 years
		Transparency in respect of grid availability, grid allocation rules and grid connection timelines	A	ESKOM	1 year
Review import tariffs	2.5 years	Investigate the maximum allowed import duty under WTO rules and test impact on value chain if current duty rates are raised. Currently a 10% WTO bound rate.	A	LSF, ITAC	0.5 years
		Implement duty changes and train customs officials to correctly apply duty codes to modules	A	ITAC, Customs	2 years
Verification of localisation standards	1 year	Discussion to understand current weaknesses in the system to verify standards	B	ArtSolar, Seraphim, SAPVIA, dtic	0.5 years
		Mechanisms established to ensure localisation standards are verified	B	Dtic	0.5 years

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Investment in dedicated capacity to manufacture and supply into solar industry (dependent on consistent demand).	3 years	Investment into expansion projects or new manufacturing facilities to boost local supply into the market.	A	Private sector	2 years
		Government support for local investment	A	Public sector	1 year

Key = A (critical / high priority intervention); B (medium priority intervention); C (low priority intervention)

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7.4 Inverter localisation realisation pathway

7.4.1 Inverter impact and implementation risks

The inverter market is currently dominated by imported products. Any increase in localisation will therefore significantly contribute to both value addition and job creation. In the residential market, local supply has captured <1% of the market. The total estimated demand for embedded solar PV is 12,655 MW between 2024-2030. This has the potential to generate over R90 billion in total value through the sale of inverters. Even if only 10% of this demand were to be locally supplied, it would add R9b in value to the local industry and generate an estimated 720 new jobs.

Utility scale inverters are also dominated by imports. The potential value to supply all demand by 2030 would be significant - an estimated R89 billion. Currently, domestic manufacturing could only supply 3% of this demand to 2030. If this were increased to 10%, a further R9 b in value would be generated, leading to the creation of at least 350 new jobs.

There is currently no surplus capacity in the domestic manufacturing portion of the value chain. This is evident for the residential, C&I and utility scale market segments. Local manufacturers appear to be competitive with regards to their assembly operations, but growth opportunities are hindered by the requirement to send products overseas for testing since no local testing facilities currently exist in country. No new policies are required as an intervention, but rather an updating of existing policies due to emerging capabilities in the local manufacturing of utility-scale inverters. Large investments could facilitate expansion of existing capacity. Alternatively, new market entrants could boost local supply, and facilitate the development of a local testing facility.

A summary of the insights from engagements with manufacturers is captured in Table 7.

Table 7: Inverters (Solar) localisation potential

	Market	Asset		Resource
Med Potential	Demand	Capability	Capacity	Supply
Status quo	Supplies into the PV value chain to build up portfolio of evidence for certification process. Companies supplying/importing inverters that offer on-site maintenance teams have a competitive advantage.	Can supply into the solar industry. Modular units for utility scale built in batches. Most inverters are imported, and the local value add involves distribution and maintenance. Inverter importers purchase locally manufactured transformers and switchgears to form power conversion units that have 70% local content.	Established manufacturer of residential inverters producing 50 x 10kWp units per week. Only one utility-scale manufacturer in the country which is still gaining certification. One manufacturer gaining certification is producing 2 units per week, with aspirations to ramp up to 5 per day.	Most materials are imported. Metal work is localised, but all metal is imported due to concerns over local quality.
Barriers	Designation currently only set at 40% for local assembly.	Scarcity of skilled technicians for maintenance of the units on site.	Inconsistent demand limits direct investment from manufacturers to dedicate volumes to solar industry.	No local certification facility. Certification is long (3+ years) and expensive causing delays to begin entering the market officially.

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	Market	Asset		Resource
Med Potential	Demand	Capability	Capacity	Supply
			Building up a bankability portfolio for proof of quality hindering access to finance to expand.	Long lead time for Transformers needed for power conversion units.
Enablers	Review of designation for local supply.	Courses and training offered to create a talent pipeline to feed into the solar PV value chain.	Investment in dedicated capacity to manufacture and supply into solar industry (dependent on consistent demand). Financial support for expansion.	Local certification facilities. Financial support for certification process. Boost capacities for local production of transformers - since transformers are the bottleneck in the supply of PCUs. By boosting the supply of transformers, the ability for local manufacturers to supply PCU's with their associated inverters would be boosted, and in so doing would boost the demand for local inverters.

7.4.2 Inverter interventions

There are several enablers and interventions that could boost local inverter manufacturing capacities (see Table 8). Like solar modules, consistent demand is again considered crucial. Currently, the supply of inverters is dominated by imported products. Local suppliers of imported units provide on-site servicing and maintenance as their local competitiveness differentiator. The local manufacturing landscape is varied, comprising some long-standing manufacturers of small inverters for the residential market who have been supplying the local market for several decades, alongside new market entrants who manufacture string and centralised inverters for larger-scale projects such as C&I and utility-scale. One firm is undertaking the certification process and is preparing to fully enter the domestic market.

As per many other components of the value chain, the most important barrier remains inconsistent demand and it is therefore here where the biggest opportunity to boost local production lies. Currently, inverters are included on the list of designated materials with 40% local assembly set as the minimum local content threshold, However, it is recommended that the minimum local content threshold and conditionality be revised, and a new assessment of local capabilities undertaken due to emerging manufacturing capabilities identified in this study.

Inverter units require testing, and this currently can only be done overseas. The process is costly and time-consuming and, if localised, could have hugely beneficial outcomes to lead times and the competitiveness of local manufacturers. It could also allow for the increased sourcing of local parts, since any change to an inverter's bill of materials requires re-testing. If testing were localised, there would be a much greater opportunity for manufacturers and suppliers to incorporate local components in their assembly operations and manufacturing processes. This is important for those materials where local capability exists, and where local manufacturers and assemblers struggle with long international lead times.

Lead time of components was mentioned as a concern regarding imported products and can be up to 13 months for certain components. One part that has a long lead time is microchips. Inverter manufacturers who order relatively small quantities of microchips struggle to compete for supply against huge orders by vehicle OEMs. There appears to be an opportunity to localise the manufacturing of one component that has the longest lead time: fans. It is understood that fans are made to very high technical specifications and that there are currently no local manufacturers. It would be worthwhile investigating whether manufacturers of similar products could manufacture the imported fans. Other small parts noted as having a high likelihood of localisation include fuses and capacitors, as well as the outer shells which are made from steel. Having these supplied locally would require further investigations into local capabilities but would rely on the ease of certification to facilitate their likely inclusion in the bill of materials.

Inverters at utility sites are installed as part of the power conversion units, and alongside transformers and switch gears. These units are assembled on site and represent a critical element of each solar plant. Any technical failures result in costly downtime and therefore EPC contractors are looking for suppliers that can provide on-site after-sales service to ensure operational efficiencies and minimal downtime. Technical skills relating to the maintenance of inverters has been identified as a current skills gap. Technicians require over five years of experience, and it is becoming increasingly difficult for manufacturers to source and retain skilled staff, with most qualified technicians finding better opportunities overseas. Local skills development could prove critical to local manufacturers who, by providing in-house skilled teams on site to maintain units, would be highly competitive relative to imported alternatives.

With the predicted surge in demand to 2030, local manufacturers are looking to expand existing capacities and therefore their investment. Table 8 below provides interventions based on engagements with a manufacturer of inverters for the residential market, and another who is manufacturing string inverters for larger project. The findings are therefore limited, given the wide range of inverters that are on the market.

Table 8: Enablers and interventions for the localisation of inverters into the solar PV value chain.

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Consistent demand	3 years	Updated IRP 19 aligned with demand forecast	A	DoE	1 year
		Annual bid windows with consistent allocation volumes	A	DMRE	3 years
		Transparency in respect of grid availability, grid allocation rules and grid connection timelines	A	ESKOM	1 year
Revision of conditions under designation for inverters	1 year	Conduct a new assessment of emerging local capabilities	A	Ario, dtic	0.5 years
		Review minimum local content threshold and conditionality	A	dtic	0.5 years
Development of a local certification facility	3 years	Investment to develop a local testing facility.	A	Private sector	3 years
		Government support for local investment.	A	Public sector	3 years
Development of skills related to the maintenance and	2 years	Interaction between manufacturers and skills developers around skills gaps and training requirements.	B	Inverter manufacturers, EWSETA	0.5 years

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
refurbishment of inverters		Development of courses and programmes specifically targeting the skills needed to maintain a talent pipeline in the field of inverter maintenance and refurbishment.	B	EWSETA, TVET colleges, other skills development, and training stakeholders	1.5 years
Investment in dedicated capacity to manufacture and supply into solar industry (dependent on consistent demand)	3 years	Investment into expansion projects or new manufacturing facilities to boost local supply into the market.	A	Private sector	2 years
		Government support for local investment	A	Public sector	1 year

Key = A (critical / high priority intervention); B (medium priority intervention); C (low priority intervention)

7.5 Transformer localisation realisation pathway

7.5.1 Transformer impact and implementation risks

Most transformers are supplied locally. It is an industry that could generate roughly R5.7b in sales up to 2030, sustaining close to 250 jobs. Currently there appears to be no excess capacity in this industry. Transformer supply has therefore been identified through industry engagements as a bottleneck specifically for supply into PCUs at utility scale plants. Panels are strung together in 'strings and the energy feeds through a collector, then inverter, then a GSUT. Local manufacturers have the capabilities required as almost all local demand is met by supply from local manufacturers. No policy changes are required to unlock further localisation given that 80-90% of the market is supplied by existing manufacturers. Moreover, the investment required to increase this to 100% is not expected to be substantial.

A summary of the insights from engagements with manufacturers is captured in Table 9.

Table 9: Transformer (Solar) Localisation Potential

	Market	Asset		Resource
High Potential	Demand	Capability	Capacity	Supply
Status quo	Collector transformers procured locally (1-2 per solar farm) as part of balance of plant. Generator Step Up Transformer (GSUT) depends on the design of the solar farm. Panels are strung together and runs through collector, then inverter, then GSUT.	For collector transformers the local manufacturing level is world class. There was a learning curve for the GSUTs, but local companies have invested in skilled overseas resources to design and build their own transformers that are high quality.	The two main manufacturer in SA have a combined capacity of 8 GW per year for collector transformers. Actom is the only known manufacturer for GSUTs. They can produce 480 per year (2.4 GW).	Raw materials are about 60% of the cost, 40% value addition. Steel is sourced locally. Copper and core steel is imported.
Barriers	Inconsistent demand. IPPs and EPCs want to procure the entire electrical unit (inverter, transformer, switchgear) as a complete	Local manufacturers are not set up to assemble and test the entire electrical conversion module.	If combined with wind energy demand, there can be a shortage for GSUTs. Shortage on collector transformers not likely with the current capacity available.	Only a few mills globally that produce the core steel.

	Market	Asset		Resource
High Potential	Demand	Capability	Capacity	Supply
	and tested kit and not individual parts.	This potentially locks them out of being able to supply locally.		
Enablers	Consistent demand will increase local procurement because project timelines are more structured. Correct application of duties for imported components that are going through as equipment.	Development of a local assembly and testing facility for the complete inverter, switchgear, and transformer module. It would be about R100-200m and employ 100+ skilled workers.	The large manufacturers of transformers have the appetite to expand but require consistent volume and a longer pipeline of projects to invest in additional capacity. New GSUT facility with +-2GW capacity would be R400m.	Opportunity to localise copper rod will also make them more competitive along with the cable manufacturers.

7.5.2 Transformer interventions

Three key enablers have been identified to support local transformer manufacturers (see Table 10). Per the other components investigated, inconsistent demand is the biggest challenge. Therefore, the publication of an updated IRP aligned with demand forecasts, the consistent release of annual bid windows and transparency in grid availability will benefit the further localisation of transformers. The development of a local assembly and testing facility for the complete PCU has been identified as an enabler which would require up to R200 million to develop. The third enabler would be the correct application of import duties to imported transformers to ensure all imported products have the correct tariffs applied.

Table 10: Enablers and interventions for the localisation of transformers into the solar PV value chain.

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Consistent demand	3 years	Updated IRP 19 aligned with demand forecast	A	DoE	1 year
		Annual bid windows with consistent allocation volumes	A	DMRE	3 years
		Transparency in respect of grid availability, grid allocation rules and grid connection timelines	A	ESKOM	1 year
Development of a local assembly and testing facility for the complete inverter, switchgear, and transformer module	3 years	Investment of R100-200m to develop a local testing facility	A	Private sector	3 years
		Government support for local investment	A	Public sector	3 years
Correct application of duties for imported components that are going through as equipment.	1 year	Train customs officials to correctly apply duty codes to transformers	B	ITAC / Customs	2 years

Key = A (critical / high priority intervention); B (medium priority intervention); C (low priority intervention)

7.6 Mounting structures and tracker localisation realisation pathway

7.6.1 Mounting structure and tracker impact and implementation risks

An average of 68 tons of steel is required per MW of ground-mounted solar PV, and 34 tons for rooftop-mounted systems. For aluminium, 7.5 tons is required per MW of ground-mounted projects and 11 tons per MW for rooftop systems. If the estimated 35,000 MW of solar is realised by 2030, close to 2.4 million tons of steel and 350,000 tons of aluminium would be required to supply the full demand of ground mounted and rooftop projects. Given that steel costs are close to R17,000 per ton, and assuming local manufactures supplied 100% of domestic market demand, the estimated steel revenue generated locally could reach R 40b by 2030. This would sustain close to 1,400 jobs in the steel industry alone.

Excess capacity exists amongst local mounting structure manufacturers, with up to 40% spare capacity waiting to be utilised if the market conditions for localisation improve. Local manufacturers have the capabilities to meet domestic market requirements, with several firms already supplying into the solar PV value chain. Locally manufactured components can be competitive, however there is concern that imported components are more price competitive due to their importation under incorrect tariff codes (principally those tariff codes where no duty is applied). For this reason, no policy interventions are required other than to ensure existing import duties are correctly applied to mounting structure and tracker components. Since capacity exists within current production facilities, the investment required to realise full localisation is not expected to be substantial.

A summary of the insights from engagements with manufacturers is captured in Table 11.

Table 11: Mounting Structures (Solar) Localisation potential

	Market	Asset		Resource
High Potential	Demand	Capability	Capacity	Supply
Status quo	Supply into the solar market. Long lead time of imported structures means locally supplied structures can be supplied faster (but at greater cost).	Local manufacturing of roof top and ground mount solutions including single axis and tracking systems. Maintenance done by EPCs.	Spare capacity exists with aspirations to manufacture 100% local tracking units. 34 tons of steel required per MW for trackers.	Roof top: Components are largely locally fabricated but using imported materials. Ground mounted: Piles, which make up 30% of the structures, are locally sourced. The balance is imported from China and Turkey.
Barriers	Inconsistent demand brought about by the IRP. Imports cheaper.	Lack of standards enforced for SSEG installations.	Access to capital for expansion projects. Limited capacity in roll forming and outdated technology being used. Low trust with rolling mills.	Poor quality of materials. Stretched galvanising capacity identified as a bottleneck. Long lead times for materials.

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	Market	Asset		Resource
High Potential	Demand	Capability	Capacity	Supply
Enablers	Duties that are high enough to even the market for competition from China.	Development and enforcement of standards for SSEG projects like what was done for utility-scale, ground mounted projects.	Investment to modernise and grow roll-forming industry.	Mechanisms established to Increase capacity upstream to reduce lead times.

7.6.2 Mounting structure and tracker interventions

The key enabler to localisation is consistent demand (see Table 12). Three interventions can realise this enabler: an updated IRP19 aligned with the demand forecast, the regular release of bid windows, and transparency of grid availability, grid allocation rules and grid connection timeframes.

The second enabler is the correct application of import duties. Local component manufacturers assert they are competitive when the correct import duties are applied. However, the ability for locally produced components to be price-competitive against imports falls away when mounting structure and tracker components are being imported under zero duty tariffs. Correcting this anomaly where possible would enhance local supply, especially given local lead time and flexibility advantages.

The last enabler is specific to roof-top solar installations and refers to the establishment of legally enforceable standards to ensure that materials of high quality are used and installed correctly. The South African market unfortunately comprises many different technologies and standards – mainly because there are no standards that are enforced. This results in very poor construction of residential and commercial solar panel systems, often with major negative consequences. The biggest opportunity in the domestic market is therefore to enforce regulations to a set standard for residential and commercial solar panel installations. This would be invaluable to establishing localization opportunities.

At present the SSEG market is not regulated sufficiently with substandard, corrosion sensitive materials being used in several installations. While the government has done nothing to resolve the problem, the banks have become involved and are presently exploring the establishment of a standard that all installers will need to use for projects where financing is required for the installation. Building off this process, there is also a drive for the insurance companies to do the same. SAPVIA has developed a quality mechanism called the PV GreenCard to ensure installations are done safely. This GreenCard is issued to the customer by qualifying installers who have undergone training on PV solar installation and that meet certain quality criteria. This will protect the insurance companies from poor installation, which leads to panels being damaged, performing poorly, or being separated from their roof structure.

The setting of standards is critical as this will ensure a level playing field in the domestic market and create a business case for the localization of specific products. For example, brackets, bolts, and clamps could all be localised more easily if they were common standards that provided sufficient scale for investment in often high technology areas with high fixed capital costs.

The quality of materials has been a challenge and few roll forming companies are trusted to supply at the quality required. Adding to this is the old technologies still being used by roll formers (*"the* *[local] industry is using archaic technology"*), who are already facing severe capacity constraints. Efforts by plants to modernise have been met with challenges, with unions preventing purchases of new forms of technology that, if implemented, would see a reduction in the labour force. Actions to modernise and increase roll-forming capacity would alleviate supply delays for mounting structure manufacturers supplying into the PV value chain.

Table 12: Enablers and interventions for the localisation of mounting structures and trackers into the solar PV value chain.

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Consistent demand	3 years	Updated IRP 19 aligned with demand forecast	A	DoE	1 year
		Annual bid windows with consistent allocation volumes	A	REIPPP	3 years
		Transparency in respect of grid availability, grid allocation rules and grid connection timelines	A	ESKOM	1 year
Correct application of import duties	2 years	Work with current mounting structure manufacturer to unpack mechanisms being used to avoid import duties on imported steel components	A	Public-private-partnership	0.5 years
		Implement duty changes and train customs officials to correctly apply duty codes to tower internals	A	Customs	2 years

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Develop and enforce mounting structure standards for roof top projects	1 year	Existing manufacturers to advise on standards required	B	Modetech	0.5 year
		Mounting structure standards set to assure quality and safety and ways to enforce standards established.	B	dtic	0.5 years

Key = A (critical / high priority intervention); B (medium priority intervention); C (low priority intervention)

7.7 Cable localisation realisation pathway

7.7.1 Cable impact and implementation risks

The cabling industry has indicated that no new manufacturing facilities are required to meet demand, but rather that the market conditions be changed to allow for increased market participation. The industry currently supports an estimated 690 jobs and manufactures cable quantities totalling 8,400 tons per month. Calculating sales is nuanced as manufacturers are able to produce both medium and low voltage cables with production volumes dependent, and the number of tons or km of cables needed per project varies and therefore estimates to supply for projected demand. Impact on jobs and sales for cables was therefore estimated to be medium-level relative to the other solar PV components when evaluating the position of cables within the localisation matrix (see Figure 15).

Excess local production capacity is present in terms of both medium and low voltage solar PV cables. There is also investment interest in high quality, locally manufactured cables, but only if low-cost, poorer quality imported cables face greater barriers to entry into the South African market. Local designation has been identified by manufacturers as a lever to boost localisation. However, establishing and implementing clear quality standards is deemed even more important. This would also benefit the market by ensuring installed cables are safe for consumers. The size of the investment required would be relatively low given that established capacity exists within existing facilities.

A summary of the insights from engagements with manufacturers is captured in Table 13.

Table 13: Cables (Solar) Localisation Potential.

	Market	Asset		Resource
High Potential	Demand	Capability	Capacity	Supply
Status quo	Cables are designated through REIPPP. Medium voltage cables are majority procured locally. Majority of PV low voltage cables are imported. Exemptions are easily obtained from the dtic.	For medium voltage cables there is a compulsory safety standard (SANS 97 or 1339), and all local manufacturers adhere to this. For low voltage PV cables there is no compulsory safety standard. The AECMS have developed the standard (IEC 62930) and it is with the DTIC and NRCS for adoption. There are 2 local manufacturers capable of producing the PV cable (SOEW, Aberdare) that adhere to the standard.	For medium voltage cables there is excess capacity of >3,500 km/year. Total capacity is estimated to be 8400 tons per month for all cables by the five main manufacturers in South Africa (Aberdare, CBI, SOEW, Tulisa and M-tech)	All aluminium, XLPE, copper (except small supply from Phalaborwa Mining Company, PMC) imported, +- 90% of raw materials. Only getting PVC locally.
Barriers	IPPs apply for exemption to DTIC, manufacturers must respond in 48 hours that they can supply the cables	Most of the PV cables are being imported and are of low quality. There is no blocking of low-quality inferior cables at the ports.	There is excess capacity of both medium voltage cables and low voltage PV cables.	Importing from the same sources globally for XLPE and Copper and Aluminium rod.

	Market	Asset		Resource
High Potential	Demand	Capability	Capacity	Supply
	else the IPP will get an exemption. There is no consistent flow of demand.			They can't improve cost base without competitive local suppliers.
Enablers	Duties that are correctly applied to imported cables. Alter the process for exemptions obtained through the DTIC to give local manufacturers time to manufacture.	NRCS must adopt the safety standard and make it compulsory. Improve the ability of the customs officials to validate the standards of cables coming in. Ensure that the local manufacturers meet the standard through an independent testing facility.	Excess capacity is available but needs steady demand and reasonable project timelines to ensure that capacity can be accessed.	Expand local supply of copper rod through PMC. Support company setting up in Richards Bay to convert aluminium ingots to 8mm rod (name not disclosed but Hulamin will know).

7.7.2 Cable interventions

There are several enablers for cable localisation (see Table 14). These include establishing consistent demand to enable local manufacturing to supply into the public utility-scale market and designation in respect of public procurement.

When firms bid in one of the Bid Windows, they request at short notice an indication from cable manufacturers their ability to supply the desired quantity in the specific time. However, without advanced notice, cable manufacturers do not always have the required stock available and therefore cannot supply the quantities required. Further to this, exemptions are easily obtained by buyers to have cheaper imported cables supplied for projects. There is an opportunity to review the process for exemptions, ensuring more time is given to manufacturers to supply local demand. Tied to this is a lack of visibility in respect of upcoming demand, which is underpinned by inconsistent demand coming through irregular REIPPP windows.

In addition, there is a need to have import duties correctly applied, import tariff headings correctly defined and applied, and for custom officials to be sufficiently skilled to identify and discern import cables. Industry stakeholders are concerned by the poor-quality cables being imported, especially for low-voltage solar PV cables. There is a real opportunity to support and improve the ability of customs officials to validate the standards of cables being imported. Since there is currently a standard developed by the AECMSA (which is awaiting adoption by the dtic and NRCS), there is an opportunity to ensure that all cables locally meet the required standard through an independent local testing facility.

Boosting price competitiveness of local cable manufacturers is another enabler of localisation. Reviewing import duties on raw materials could facilitate this. Furthermore, since all cable manufacturers globally are sourcing their materials from the same suppliers of XLPE, copper and aluminium rod, manufacturers will only be able to improve their cost base if local suppliers can supply at a more competitive cost. Therefore, supporting new and existing capacities and capabilities of local suppliers such as the new aluminium rod supplier in Richard's Bay or the existing copper capabilities in Limpopo, could improve the downstream competitiveness of solar PV cable manufacturers.

Table 14: Enablers and interventions for the localisation of cables into the solar PV value chain.

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Stable and consistent demand	3 years	Updated IRP 19 aligned with demand forecast	A	DoE	1 year
		Annual bid windows with consistent allocation volumes	A	REIPPP	3 years
		Transparency in respect of grid availability, grid allocation rules and grid connection timelines	A	ESKOM	1 year
Designation of low and medium voltage cables	1 year	Demonstrate capacity to supply products to national government	A	CBI, Aberdare, SOEW	0.5 years
		Add low and medium voltage cables to list of designated components.	A	dtic	1 year

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Duties correctly applied to all imported cables.	1 year	Provide technical support to government on cable identification	A	CBI, Aberdare, SOEW	0.5 years
		Improvement in the process of applying import duties	A	ITAC / Customs	1 year
Review current exemption process through DTIC to give local manufacturers time to manufacture.	0.5 years	Alteration of the rules that apply for exemptions, providing a larger window for manufacturers to respond and supply	A	dtic	0.5 years
Safety standards enforced, (especially noted for low voltage solar PV cables)	0.5 years	Adoption of safety standards (already developed and with the dtic) and implement its enforcement	A	NRCS & dtic	0.5 years

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Ensure that local manufacturers meet the standard through an independent testing facility.	3 years	Investment to develop independent testing facility	B	Private sector	3 years
		Support for private sector Investment to develop independent testing facility	B	Dtic	3 years
Improve the ability of the customs officials to validate the standards of imported cables.	0.5 years	Training for customs officials on the various cable standards	B	Customs	0.5 years
		Support for public sector training on cable standards	B	Dtic	0.5 years

Key = A (critical / high priority intervention); B (medium priority intervention); C (low priority intervention)

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7.8 Fastener localisation realisation pathway

7.8.1 Fastener impact and implementation risks

A full ton of fasteners is needed for each MW of solar PV installation. Each ton costs R40,000 (or R40/kg). Currently the two largest fastener manufacturers in South Africa can supply over 22,000 tons per annum if operating at full capacity. As such, local manufacturers have more than sufficient capacity to cater for local demand under the current solar PV demand estimates. This includes the year of peak solar demand which is 11,000 MW in 2025. It can therefore be assumed that if the local manufacturers were given the right economic and policy environment, they could capture 100% of the market, with this generating R 1,4b in revenue.

Job creation is not expected to be significant since manufacturing fasteners is a highly automated process. Given current manufacturing capacities, there is no need to develop completely new manufacturing facilities. Therefore, job creation is likely to be marginal.

The only critical barrier to increased local supply is the global availability of cheaper imported products. For this reason, the enforcement of the existing WTO bound rate of 30% is required to better enable local competitiveness. However, no new policy appears to be required.

A summary of the insights from engagements with manufacturers is captured in Table 15.

Table 15: Fasteners (Solar) Localisation Potential

	Market	Asset		Resource
High Potential	Demand	Capability	Capacity	Supply
Status quo	Supplied into two solar projects before – one of which was a 500 MW solar plant. Approx. 1 ton of fasteners required per 1 MW of Utility solar.	Most major fastener manufacturers can supply to solar industry. Most are made to an ISO specification in terms of dimension and hardness. Construction bolts are required to pass suitability test EN 14399-2.	Excess capacity in the industry to supply fasteners (currently not dedicated) to renewable value chains. One manufacturer working at <50% capacity. The two largest manufacturers have a combined capacity of 22,000 tons per annum.	All steel being supplied by local mills and merchants. Local high-quality steel Capacity exists in local market with capacity of 4.5m ton/year, more than entire SA market. Currently running only 2.5m ton/year because of low demand.
Barriers	Mass imports of cheap fasteners from China ('unfair dumping' noted as a concern).	Fasteners treated almost like a commodity and barriers to manufacturing is low.	Inconsistent demand limits direct investment from manufacturers to dedicate volumes to solar industry.	Local steel although of a sufficient quality is priced higher than imported steel. Lead times of local steel supply are long and limits flow through value chain.

	Market	Asset		Resource
High Potential	Demand	Capability	Capacity	Supply
Enablers	Robust industrial policy focussing on import duties to give local manufacturers a competitive advantage against cheap Chinese imports.		A level of consistent demand from both private and public markets.	More competitive local steel prices (at import parity or below). Improved lead times from steel mills and merchants.

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7.8.2 Fastener interventions

Fastener manufacturers identified cheaper imported products as being the most important barrier currently to localisation. South Africa's MFN and WTO bound rate for fasteners is 30%, but the actual average applied rate in 2022 was only 13.7% (WTO 2023). This is because fastener imports are often sourced from countries or economic regions with which South Africa has preferential trade agreements. These bilateral trade agreements make it highly unlikely that South Africa will be able to apply the full 30% on imported fasteners. It is therefore critical that South African customs applies the correct tariffs on imported fasteners (Table 16). Consistent demand is another key enabler as this would allow manufacturers to plan production outputs appropriately to meet local demand. Three interventions appear key: an updated IRP19 aligned with demand forecasts, bid windows to be released regularly and with consistent volumes, and lastly for grid availability, grid allocation rules and grid connection timeframes to be made transparent. The last enabler is to secure preferential steel prices for local manufacturers. This would have a positive knock-on effect on fastener prices and thus the competitiveness of local fastener manufacturers.

Table 16: Enablers and interventions for the localisation of fasteners into the solar PV value chain.

Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
Apply appropriate import duties on fasteners to provide local manufacturers a competitive advantage in the domestic market.	1 year	Ensure correct import duties are imposed on fasteners	A	ITAC, customs	<0.5 years
Consistent demand	3 years	Updated IRP 19 aligned with demand forecast	A	DoE	1 year
		Annual bid windows with consistent allocation volumes	A	DMRE	3 years
		Transparency in respect of grid availability, grid	A	ESKOM	1 year

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Enabler	Outcome timeframe	Interventions	Intervention category	Key stakeholder	Implementation timeframe
		allocation rules and grid connection timelines			
More competitive steel prices for local fastener production	0.5 years	Government to consider introduction of rebates on fastener grade steel duties	B	dtic	<0.5 years

Key = A (critical / high priority intervention); B (medium priority intervention); C (low priority intervention)

7.9 Solar energy cross component interventions

Two enablers emerged as being the most important across the solar PV chain: demand consistency and the appropriate alignment and application of import duties (see Table 17). All manufacturers identified demand inconsistency as the biggest limitation to localisation. Similarly, import duties were noted as a problem across five of the six components. Fasteners and cables require existing import tariffs to be correctly applied, whereas modules, transformers, mounting structures and trackers require import duties to be revised and possibly raised (to South Africa's WTO bound rates). Associated with this is the need to capacitate customs officials to correctly discern between different product types and to apply duties correctly. Where the training of customs officials has been noted as necessary, this has been added as an intervention.

Table 17: Cross-cutting interventions to enable localisation in the solar PV value chain.

Intervention	Modules	Inverters	Transformers	Mounting structures and trackers	Cables	Fasteners
Updated IRP 19 aligned with demand forecast	A	A	A	A	A	A
Annual bid windows with consistent allocation volumes	A	A	A	A	A	A
Transparency for grid availability, grid allocation rules and grid connection timelines	A	A	A	A	A	A

Intervention	Modules	Inverters	Transformers	Mounting structures and trackers	Cables	Fasteners
Import duty level revised or correctly applied	A		A	A	A	A
Capacitation of custom officials to correctly apply duties	A		A	A	A	A

Key = A (critical / high priority intervention); B (medium priority intervention); C (low priority intervention)

8 Ramp up analysis.

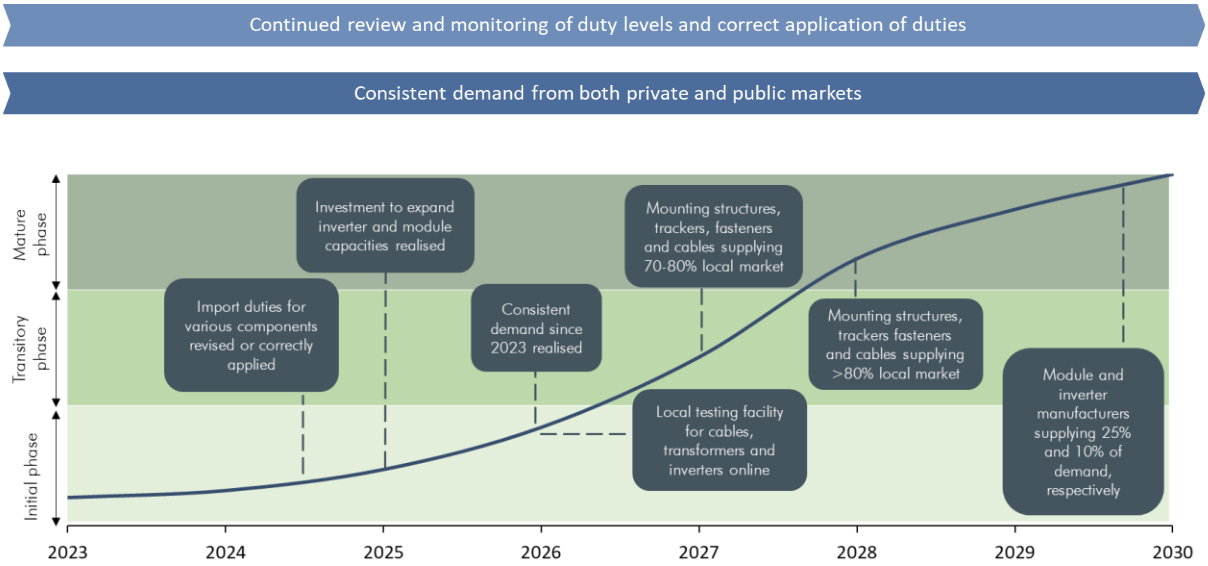
8.1 Solar energy ramps up analysis

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

1. 2023-2024. The **revision and correct application of existing duties** for solar modules, mounting structures, cables, and fasteners (see Figure 17). These components specifically highlight competition against imports as being a major challenge.
2. 2023-2026. 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. 2023-2026. **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.

Additional key milestones are provided in Figure 17 to boost localisation of the key solar PV components.

Figure 17: Key milestones to realising increased localisation of the solar PV value chain.



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.

9 Conclusion

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.

Our assessment of inverters positioned larger inverters, such as those used in large C&I and utility-scale projects as sitting on the edge of the zone of opportunity. This is because there is only one manufacturer of centralised inverters in the country; and it is awaiting certification before it can ramp up capacities. The firm is already supplying into the RE value chain and expansion could lead to substantial sales and job creation. This same firm also manufactures string inverters, which are modularised and can therefore be scaled to create centralised inverters. An established manufacturer of smaller string inverters such as those used in the residential market has excess capacity and long-standing existing capabilities and therefore can easily ramp up capacity with relatively low levels of investment and policy intervention. For this reason, this kind of inverter is placed in the zone of opportunity.

A key component used in the assembly and manufacturing of inverters is fans. Therefore, it will be valuable as part of future research to evaluate to what degree these can be localised. Fans are imported and increasing global demand is resulting in lengthening lead times for inverter manufacturers globally. Key is understanding whether this component could be manufactured competitively locally.

Solar modules were considered in this study to be a high roller, given that large investment would be required to ramp up capacity. This reduces the likelihood of realisation but elevates its importance in respect of potential local value addition and employment creation. This supports the finding of the draft SAREM that positions module assembly as showing medium growth potential. However, it is important to emphasise that no engagements took place with potential manufacturers of polysilicon, ingots and wafers, and cells. As such, inclusion of these PV module sub-components is based on the fact that no current capabilities exist, and large investments would be required. The draft SAREM indicates cells as the next frontier, which is a fair assessment given that this would be the most likely technology to follow from module assembly.

Fasteners were identified in this study as a 'quick win'. This supports the findings of the draft SAREM that indicated fasteners as having high growth potential. However, fasteners are not placed in the zone of opportunity based on the lower sales generation and job creation potential relative to the other components. This should not however diminish the importance of localising fasteners: Local capacity exists, and additional capacity to supply the RE value chain in South Africa could be created organically off existing operations.

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'.

Appendix I

Table 18: Engaged stakeholders in the solar PV value chain.

Company	Date (2023)
Aberdare Cables	31 July
Actom	18 July
ArcelorMittal	4 August
Ario MetaPower	6 July
ArtSolar	5 July
Barnes Tubing	24 July
Caracal Engineering Services	5 July
CBC Fasteners	5 July
CBI African Cables	24 July
CSIR	25 July
Impala Bolts	25 July
K2 Solar Mounting Solutions	3 July
Modetech	17 July
PV Hardware	19 July
Rubicon	24 July
SAISI	4 July
Santerno	30 June
SEIFSA	21 June
South Ocean Cables	28 July
Sungold Solar	1 August

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