South African Renewable Energy Masterplan (SAREM)

Desktop research summary

30 Nov 2020

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Purpose

Research purpose and process

Purpose

The Research phase of SAREM aims to provide a foundation of prior knowledge and evidence for the development of the Masterplan

Approach:

Three phase approach

1. Desktop review
2. Verification and augmentation through government, industry, labour, expert and wider stakeholder engagement during the SAREM Consultation phase
3. As required additional research to support plan development

Scope and intent

Scope

- This document provides a summary of the key insights from the first phase of the research.
- It is based on desktop review.

Intent

- This document provides input into the plan formulation in the development of SAREM. It serves as a reference point, providing a summary of learnings and tools for consideration.
- During the consultation process, this document is available to stakeholders to review. It helps form a common information base. Where principles are discussed in consultation this reference material can assist to verify, test and triangulate discussion points.
- Concurrent initiatives, draft or published reports that provide evidence that either verify or refute the insights herein or help move to implementable specifics are welcome to be brought forward to the SAREM team.

Status quo

Status quo

Goal and Scope

Status quo: goal

Goal:

- to obtain insight into the current status and potential for renewable energy industrialisation in South Africa

Status quo: scope

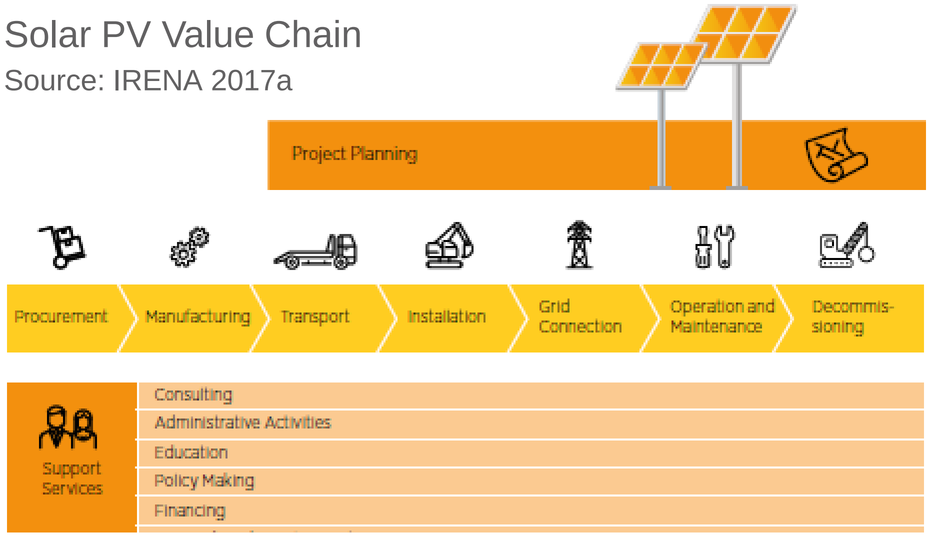
- The DTIC Masterplans are industrialisation plans. They aim to expand South Africa's manufacturing industry to realise the substantial benefits and multiplier effects of manufacturing in the economy. These include contribution to gross domestic product (GDP), direct and indirect job creation, and skills development.
- The Status Quo review thus focusses on those parts of the value chain that are relevant for industrialisation in the renewable energy value chain.
- Industrialisation refers to the core elements of the value chain related to the "design, in manufacturing and servicing of renewable energy products" (Semelane, 2020)
- Localisation refers to the wider set of activities that are required to enable renewable energy to be deployed.
- The core value chain components are specific to renewable energy products, while the wider or related value chain components can be more generic (e.g. project management, civil works, transportation, environmental analysis, legal services), albeit that some adjustment to and experience in the renewable energy context is required.
- The differences between localisation and industrialisation are illustrated on the next two pages.

Localisation illustrated in the context of solar PV and wind value chains

Localisation refers to the wide set of activities required to enable renewable energy to be deployed

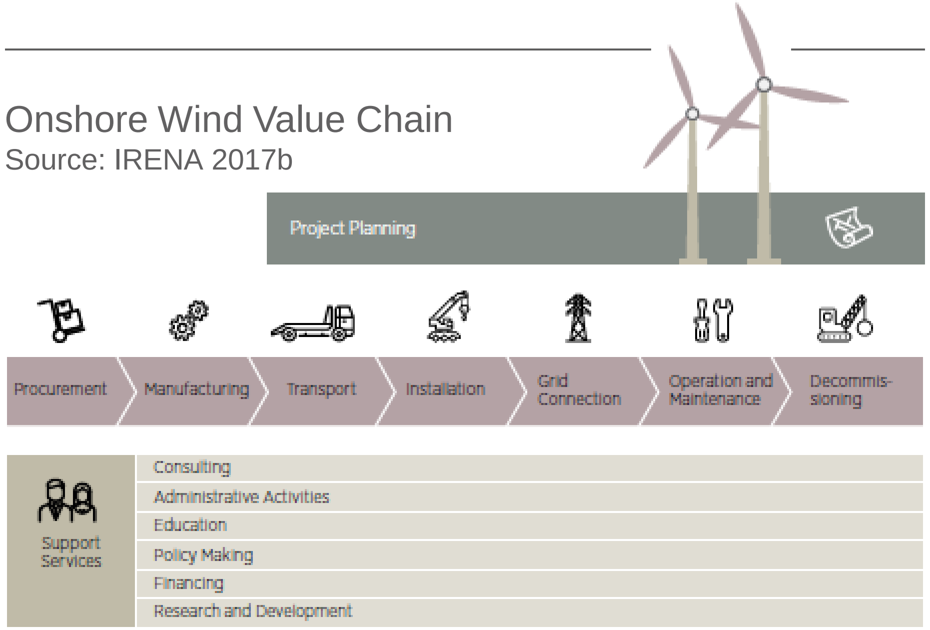
Solar PV Value Chain

Source: IRENA 2017a



Onshore Wind Value Chain

Source: IRENA 2017b



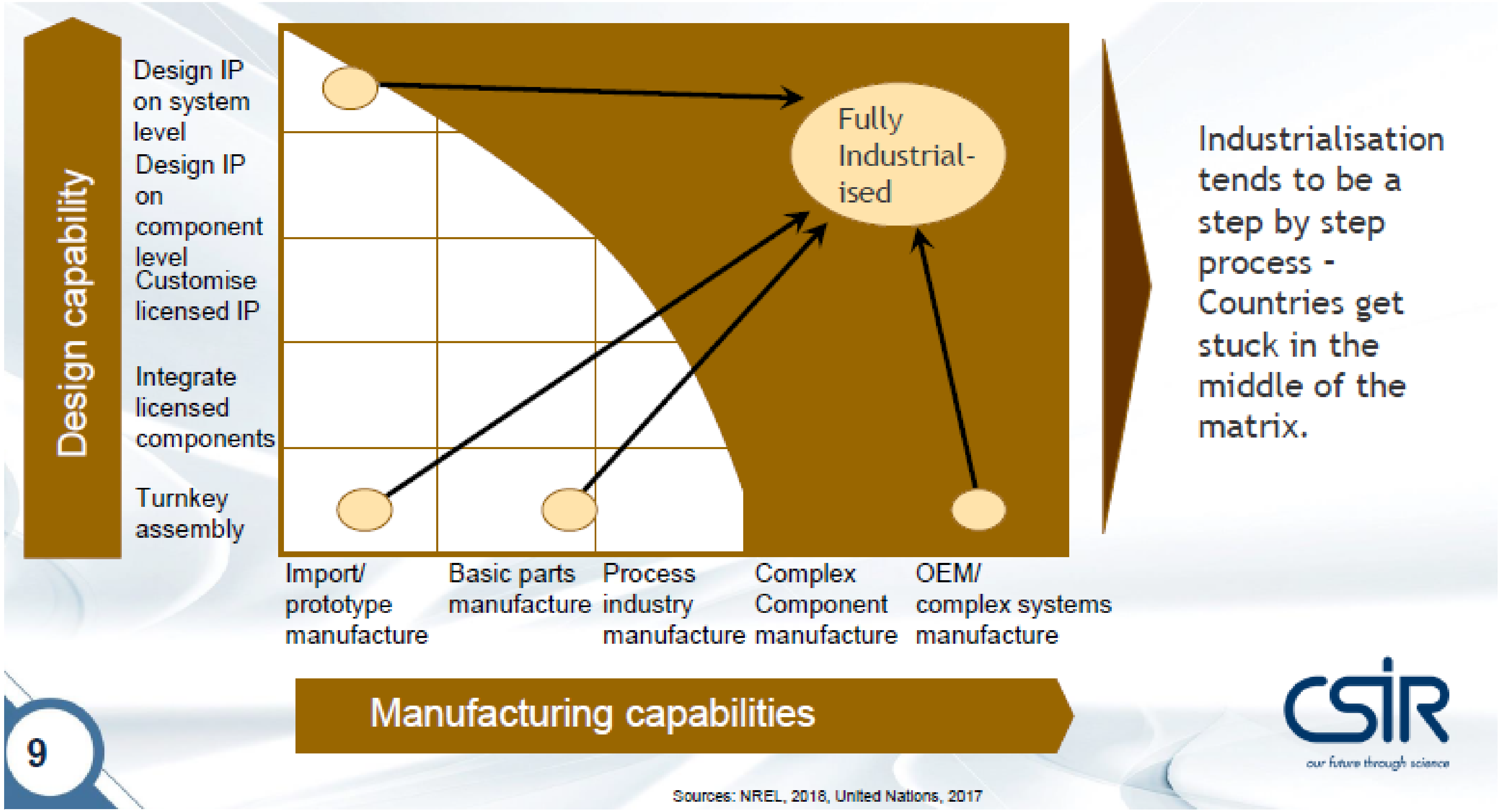
SEGMENT OF THE VALUE CHAIN PHASE	ACTIVITIES
Project planning	1.1. Site selection
	1.2. Technical and financial feasibility studies
	1.3. Engineering design
	1.4. Project development
Procurement	2.1. Identification of specifications
	2.2. Assessment of the local availability of materials
Manufacturing	3.1. Nacelle manufacturing and assembly
	3.2. Blades manufacturing
	3.3. Tower manufacturing and assembly
	3.4. Monitor and control system manufacturing
Transport	4.1. Transport of equipment
Installation	5.1. Site preparation and civil works
	5.2. Assembling equipment
Grid connection and commissioning	6.1. Cabling and grid connection
	6.2. Commissioning
Operation and maintenance	7.1. Operation
	7.2. Maintenance
Decommissioning	8.1. Planning the decommissioning
	8.2. Dismantling the project
	8.3. Disposing/recycling the equipment
	8.4. Clearing the site

Source: IRENA 2017b

Localisation

Industrialisation

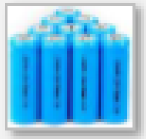
Industrialisation involves building a country's capabilities and capacity to design, manufacture and service products of increasing complexity and value (Semelane, 2020)



Source: Semelane, 2020)

Renewable energy technologies

The focus in SAREM is on localisation of renewable energy technologies.
This includes utility scale renewables and embedded generation technologies.[1]

GREENTECH TAXONOMY					
Renewable Energy Generation 	UTILITY SCALE		C&I EMBEDDED GENERATION		SMALL-SCALE EMBEDDED GENERATION (SSEG)
	• PV • Wind • Landfill gas • Geothermal	• Biomass • CSP • Hydro • Biogas	• PV • CSP • Biomass • Biogas	• Wind • Micro Hydro • Geothermal	• PV • Biomass • Mini wind
Energy Storage 	Batteries • Lithium Ion • Vanadium Redox Flow				

Source: Altgen (2019)

1. Concentrated solar power (CSP) is currently not analysed in detail as there is no new CSP capacity planned in the IRP 2019. CSP's benefit is its storage ability. However, Solar PV with battery storage is increasingly cost competitive against CSP and is hence CSP is not featuring prominently in future modelled scenarios.

Status quo

Key insights

Status quo – summary of key insights (1)

- Renewable energy value chains are highly competitive value chains led by a number of lead firms.
- Due to competitive pressure, and hence investment in innovation by lead firms, renewable energy technologies are developing rapidly, requiring the (financial) ability to rapidly adapt/change production lines in manufacturing facilities.
- This requires a shift from import-substitution (ISI) and export-oriented industrialisation (EOI) to vertically specialised industrialisation (VSI), i.e. a focus on traded intermediate goods and regulating links to the global economy to capture more value.
- This suggests that strategic localisation, rather than whole-of-value-chain localisation, may be an effective strategy for capturing the potential value in renewable energy manufacturing.
- Alternatively, quite a fundamental shift in renewable energy procurement mechanisms could be used to draw extensive local manufacturing to South Africa (see insights from Country Comparisons).

Status quo – summary of key insights (2)

- Expectations regarding export opportunities globally and into Africa in order to provide sustainable business for local manufacturers need to be realistic.

- Many countries globally have established renewable energy manufacturing capability, the majority with better access to large renewable energy markets (Asia, North America and Europe).

- The Africa and Middle East build could be 22 GW/year of wind capacity and 27GW/year of solar PV capacity between 2030 and 2050. However, given current trends, the largest portion of this annual build is expected to contributed by the Middle East and North Africa (MENA).

- The Sub-Saharan African utility scale market is largely at a project- rather than programme-level. However, small scale embedded generation and generation for energy access in the African market has potential and may be good opportunities for local developers and manufacturers.

Status quo – summary of key insights (3)

- South Africa is strong on installation and maintenance of commercial/industrial and residential scale solar PV. There is potential for export of these services to the African market. This market may be a key point of leverage for local manufacturing of solar PV components. Industrial support may be required to enable cost competitive local manufacturing.
- South Africa has been relatively successful in establishing local manufacturing to serve the utility scale market (particularly wind and solar PV).
- Due to the gap in procurement over the last few years, a lead time may be required for the previously established core manufacturing and balance of plant (BOP) capacity to ramp up again.
- There is potential for an increase in local renewable energy manufacturing leveraging off the build for the IRP2019. (See SWOT analysis and pages 58-68).
- Addressing input material costs and quality, particularly of steel and aluminium, can be a key enabler of expanded local manufacturing in both wind and solar PV value chains.

Status quo – summary of key insights (4)

- Price premiums for local production of components varies from 5- 20% for utility scale wind and 5 – 60% for utility scale solar PV components. However, estimates of the price premium for local content across the full value chain and individual components vary widely making it difficult to assess the likely impact. A research study through South African Wind Energy Programme (SAWEP) has been commissioned to provide better estimates.

- There may be ways in which procurement could be structured to minimise the impact of price premiums. (See Country Comparisons.)

- There are a number of ways in which local manufacturing can be established (see next page manufacturing typologies) and value in exploring potential new innovative local manufacturing models. The type of model has implication for the relative distribution of benefits between local and international manufacturers, as well as the extent to which the local production facilities can meet local demand, especially concurrent demand for a number of projects/OEMs.

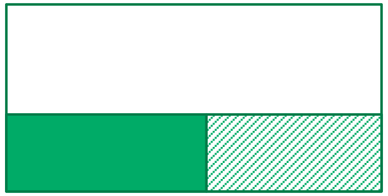
Status quo - local manufacturing typologies

These manufacturing typologies illustrate a number of ways in which local manufacturing can be established. The relationships between owners could influence the relative distribution of benefits. The type of manufacturing facility also influences the extent to which the local production facilities can meet local demand, especially concurrent demand for a number of projects/OEMs.

Ownership key
- Foreign
- Black SA
- Other SA

Local Subsidiary of Foreign Company

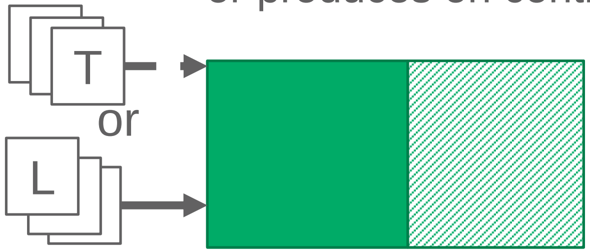
OEM or supplier to OEM
IP: OEM / supplier to OEM



Examples:
- GRI Towers (Steel Towers)
- Seraphim (PV modules)

Local Manufacturer: Toll OR licensee

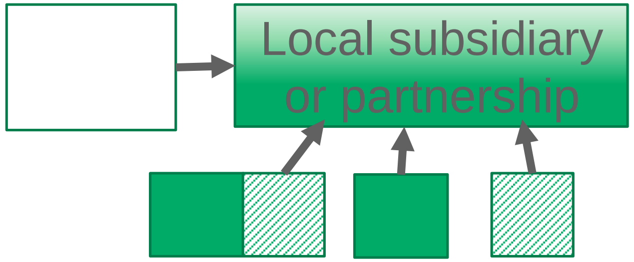
Set up equipment to manufacture uses OEM / supplier IP under licence or produces on contract to spec



Examples:
- Toll (T): ArtSolar (toll PV modules)
- Licensee (L): TUB (when active) (inverters)

Local Assembler

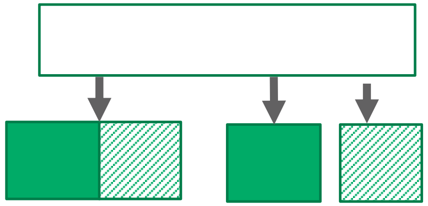
OEM combines imported and locally made components
IP: OEM & supplier / component



Examples:
- SMA proposal for units

Local Partner Manufacturer

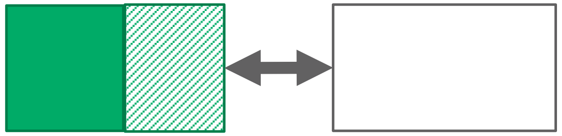
OEM / supplier to OEM provides manufacturing support (e.g. tooling, expertise)
IP: OEM / supplier, build local capability



Examples:
- STI Norland (PV Mounting & Trackers)

Local Manufacturing Partnership

OEM / supplier to OEM
Installs local production line in partner company / scales-up & down as required
IP: OEM / supplier

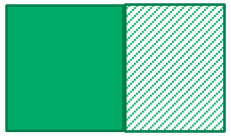


Examples:
- GPTech (inverters)

Local Manufacturer

supplier to OEM / balance of plant

IP: Own



Examples:
- Ver-bolt (fasteners, nuts & bolts))

Status quo – summary of key insights (5)

- The small scale embedded generation market (SSEG) is dominated by solar PV (95%+).
- The SSEG market driven private sector demand and decisions are made on price.
- Due to the significance of price, there is less than 5% local content in SSEG systems.
- Local manufacturing for SSEG is primarily the production of balance of system inputs to local rooftop solar PV.
- The is a very limited small scale wind market locally, as small scale wind struggles to compete with solar PV on price and ease of implementation. However, a South African company is a market leader in small scale wind and is manufacturing locally primarily for the export market.

Status quo – summary of key insights (6)

- Job creation along the full wind and solar PV value chain is a key benefit of deploying these renewable energy technologies.

- However, the estimation, reporting and comparison of job creation opportunities and impacts is complicated as the nature of jobs during the construction and installation, manufacturing, operation and maintenance differ in nature (e.g. full time on one site, moving from site to site etc.).

- The units person-days, job-years and full time equivalent (FTE) are used to make these comparable, but do not correspond to the more intuitive sense of a job / headcount.

Status quo – summary of key insights (7)

- Manufacturing contributes 22% and 17% of the jobs (in terms of person-days) in utility scale solar PV and wind value chains, respectively.

- Compared to utility scale wind value chains, utility scale solar PV value chains appear to be more labour intensive in the construction, installation and manufacturing (CIM) stages, as well as the operation and maintenance (OEM) stages of the value chain.

- Growth in the small scale embedded generation (SSEG) in the commercial/industrial and residential sectors is expected to be a substantial job creator. However, this is the installation and maintenance stages, rather than in manufacturing.

Status quo

Details of manufacturing opportunities for wind and solar PV

Status quo - details of manufacturing opportunities for wind and solar PV (1) (see supporting information for sources)

- South Africa has well established manufacturing capability in lower tech utility scale wind energy components. However, there is not enough capacity to serve the full annual build in the IRP2019. With a need for 400 MW/year/OEM, there is potential for 2-3 new wind tower manufacturers within the scope of the IRP2019, depending on the size of turbines and the split between steel and concrete towers.

- The current manufacturing capacity for crystalline silicon solar PV modules matches the annual demand in the IRP2019. However, 50% of this is for one original equipment manufacturer (OEM), while the other is a toll manufacturer that could accommodate more than one OEM. This suggest there could be some additional potential for module manufacturing, but the business case may not be strong based on local demand only (possibly <300 MW/year given the (nature of the) capacity already installed locally). Continuity in renewable energy build (i.e. demand every year with no gap years) is also important if this potential is to be realised.

- Due to the gap in procurement over the last few years, there a lead time may be required for the previously established core manufacturing and balance of plant (BOP) capacity to ramp up again.

- A breakdown of the main cost components gives a sense of the relative scale of financial and economic benefit in localising particular components. In the case of wind, 64-85% of the value of the project until operation is in the supply of the wind turbine including installation. Of the capital cost, towers and blades combined are about half the cost and the nacelle and all its sub-components the other half.

Status quo - details of manufacturing opportunities for wind and solar PV (2) (see supporting information for sources)

- Steel, tooling for manufacturing, towers and generators are considered to be the inputs and components most readily localised, followed by carbon fibre, fibreglass, blades and nacelle electronics. Local nacelle assembly (even if initially from largely from imported components) is an important enabler of higher value local turbine component manufacturing

- A demand of 400 MW/year/OEM for a minimum of 5 years is required to make the local manufacture of blades a potentially viable investment. An additional total local market of 1000 MW/year would enabled local nacelle assembly, and local manufacturing of generators and converters. The expected premium for local manufacturing is 5% for blades, 10-20% for nacelles and 20% for the other components. Local nacelle assembly could also enable expansion in existing casting, forging and transformer production if capacitated for renewable energy component production. However, it should be recognised that the localisation potential of all of these components is currently considered medium rather than high.

- A local manufacturing sequence of towers, blades, nacelle assembly, castings and forgings (hub, main shaft, mainframe and housing), and finally nacelle interior components could lead to 68.6% local content in turbines assuming the required minimum build of 400 MW/OEM/year for 5 years and a total market of 1000 MW/year.

Status quo - details of manufacturing opportunities for wind and solar PV (3) (see supporting information for sources)

- Much of South Africa's local capacity is in the downstream stages of the solar PV value chain, particularly in the large scale commercial and industrial market (100kW – 1 MW) and small scale commercial, industrial and residential market (<100 kW)

- Sustained demand of at least 300 MW/year is required to justify investment in module manufacturing. Crystalline silicon (c-Si) manufacture is more readily produced locally than other types due to the more fragmented nature of the value chain, but forward integration of solar PV value chains presents a barrier to local manufacturing

- A breakdown of the main cost components gives a sense of the relative scale of financial and economic benefit in localising particular components. Modules and converters contribute about 40-50% of the capital cost with modules making up the about 75 – 80% of this contribution

- The production of solar PV components locally is also an enabler for the growth of local raw material supply chains. Glass, steel, concrete and aluminium are some of the largest, but not the only, raw material inputs to solar modules.

Status quo - details of manufacturing opportunities for wind and solar PV (4) (see supporting information for sources)

- South Africa has manufacturing capability in crystalline silicon (c-Si) modules, aluminium frames and junction boxes, and a solar cell manufacturing facility is expected to be complete in April 2021.
- There may be additional local manufacturing opportunities through the expansion of aluminium module frame, junction box manufacturing facilities. The localisation of glass would need substantial investment and may come with a considerable price premium due to the high iron content of South African silicon.
- Inverter supply is a highlight competitive international market. Tier 1 companies invest considerably in R&D to improve efficiency and ensure reliability. Rigorous testing and certification is required. There is thus a considerably entry barrier for local producers and challenges to become competitive.
- Inverter-unit assembly with core imported products and some local components, as well as manufacturing under licence, have been achieved before, but requires reestablishment and rebuilding of the confidence of international suppliers to re-enter the local market and support to local producers to meet quality standards and access testing and certification locally.
- For inverters, magnetics and transformer capability can be expanded through reductions in raw material costs (especially steel), additional milling capacity for magnets and improvement in efficiencies of local transformers to meet the standards expected by international inverter manufacturers. There is also potential for expansion of enclosure and packaging production.

Status quo - details of manufacturing opportunities for wind and solar PV (5) (see supporting information for sources)

- Mounting structures are more readily localised due to the high cost of transport, but are relatively lower value components of a solar PV system. Local manufacturing is done by local producers and local suppliers supported by international brand owners, but cost of raw materials (steel and aluminium) makes local production not cost competitive. Lost cost input materials and capacity for adaptable manufacturing are key requirements for cost competitiveness. Addressing input material (i.e. steel and aluminium) costs could open the way for more local mounting structure manufacturing. Support for tooling, additional aluminium extrusion capacity and building capability for adaptable manufacturing could also assist local producers to be more competitive.

- There is established local production of cables due to use of cables in other sectors, but local suppliers face competition from imported cables and need to build confidence of international OEMs and finance providers. Conductors constitute the largest portion of cable cost, followed by insulation and armour. Production of all of these components is established locally. There is much potential for further localisation of conductors, insulation, and armour, but input material prices (steel, aluminium and polymers need to be addressed. Local aluminium rod production could boost to local cable production.

Country comparisons

Country comparisons

Goal and Scope

Country comparisons: goal, approach and scope

- Goal:
  to obtain insight into the approach to- and relative success of -renewable energy industrialisation in other countries
  - to benchmark South Africa, and
  - to identify possible levers that South Africa could use to expand and deepen its renewable energy industrialisation

- Approach
  Countries selected for comparison based on whether they
  - are driving or have driven renewable energy industrialisation, not only renewable energy uptake
  - could be considered comparable to South Africa based on level of development and level of industrialisation (using indicators such as manufacturing contribution to GDP)

- Scope
  - Desktop review
  - To be verified and refined though expert engagement in the SAREM Consultation Phase

Country comparisons

Summary of general insights

Country comparisons – summary of general insights (1): Success factors for renewable energy industrialisation

There are five common factors in countries that have successfully established local renewable energy manufacturing (Agence Nationale port la Maîtrise de l'Energie, 2013)

1. **Size of local market and longer term visibility of / certainty in local market**
   - Wind: 400 MW/OEM/year for 5 years; Solar PV : 300 MW/OEM/year for 5 years
   - Can be smaller for countries close to large export markets (e.g. Morocco, Tunisia, Turkey)
2. **The establishment of "local content requirements“ (LCRs) (with the exception of Denmark)**
   - To (initially) protect "infant industries" and attract foreign investment
3. **Industry support mechanisms and government investment**
   - Includes (a) training; (b) diffusion of best practice (e.g. through clustering); (c) standards and means of testing and certification; (d) R&D (financial support & public programmes)
4. **Export aid**
   - Includes trade promotion, export credits, and binding commitments for export as part of LCRs
   - Successful countries export 60-80% of production (e.g. Morocco local market = 30% of production of blades)
5. **Consistency with the industrial strengths of the country**
   - Existing capabilities: leveraging local strengths in existing or related industries
   - New capabilities: initially leveraging off foreign companies through a range of mechanisms (local subsidiaries, joint-venture, licenced production)

Country comparisons – summary of general insights (2): mechanisms to support localisation

- There are a number of mechanisms to support the development of local renewable energy markets globally.
- The most common for utility / large scale systems are: feed-in tariffs (FITs)/ premium payments and tendering/competitive auctions.
- The most common for smaller scale systems are: feed-in tariffs and net metering.
- There has been an increase in the number of countries that use tenders/competitive auctions, but, in 2019 there were still more countries with feed-in tariffs than countries with auctions (REN21, 2020).
- Some countries use only one, both simultaneously or have changed over time from one to the other.
- Within both mechanisms, local content requirements (LCRs) can be used to enable renewable energy localisation and industrialisation.
- The degree to which the FIT or auction design, specific LCRs and other supporting mechanisms are aligned has a strong influence on the nature, extent and success of the establishment of local manufacturing capacity.

Country comparisons – summary of general insights (3): mechanisms to support localisation

- Other factors that play a role in the success of LCRs to drive localisation and industrialisation include market size and stability, policy design and coherence, restrictiveness of LCRs and the industrial base (Hansen et. al. 2019).
- In the case of auctions, it was found that *cost of capital*, *resource* and *expected commercial operating date (COD)* may have a stronger influence on electricity price than factors such as *local content, concessional finance, guarantees and site selection* (Kruger et al. 2018). Innovative project de-risking and financing strategies could be used to address cost of capital (Kruger et al. 2018), while COD is a variable over which the procurer has some control, among others, through good planning. There may thus be means within the auction design process that could help to reduce potential cost premiums for locally manufactured goods.
- LCRs protect local manufacturing industries to assist in their development, but can also be a hindrance to global competitiveness.
- The appropriately timed ending of LCRs is thus important to incentivise the local manufacturing industry to achieve the level of efficiency and quality required for global competitiveness.

Country comparisons – summary of general insights (4): mechanisms to support localisation

- Local renewable energy manufacturing can be established without local content requirements. Market certainty is the key determinant of success under these circumstances (Kuntze and Moerenhout, 2013).[1]
- Such market certainty can be enabled by stability in renewable energy consumption support (e.g. feed-in tariffs, tax credits, loan guarantees, cash grants)[2] (Haley and Schuler, 2011).
- Although protection mechanisms (e.g. tariffs on imports) have been used to "support" local manufacturing, a wide range of more pro-active production support mechanisms can be used (e.g. low interest loans to invest in plants and equipment, export credits, R&D assistance) (Haley and Schuler, 2011).

1. When the USA introduced stability into its wind energy support schemes, the domestic content of wind projects grew from 25% in 2006 to more than 60% in 2011, without LCRs. (Kuntze and Moerenhout, 2013). It is worth noting that LCRs were also introduced in some US states, so not all US renewable energy industrialisation was done in the absence of LCRs. However, local manufacturing was promoted without LCRs when market stability and a combination of consumption support and production support was provided.
2. All of these renewable energy consumption support mechanisms were used in the USA. Tax credits proved to be a key enabler in the US context. In the case of solar PV, protection mechanisms were also used. These included tariffs on imported solar cells and countervailing duties on Chinese solar companies to prevent product dumping.

Country comparisons – summary of general insights (5): mechanisms to support localisation

- Firms strategies in terms of local manufacturing will depend on the combination of renewable energy consumption and production support mechanisms. For example, where there is consumption support and no production support, there is a tendency to import, rather than manufacture locally and/or build a local industry that exports (Haley and Schuler, 2011).

- To effectively enable a sustainable local renewable energy manufacturing industry to develop, it is important to understand the effect of different combinations of consumption support and production support (Haley and Schuler, 2011). (See supporting information for details.)

Overview of comparator countries

Countries that have / are attempting renewable energy industrialisation and that have levels of development and industrialisation similar to South Africa

Indicator	South Africa	Brazil	Russian Federation	India	China[1]	Argentina	Morocco	Turkey
Population Size (World Bank, 2020a)	58.6 million	211.1 million	144.4 million	1 366 million	1 398 million	44.9 million	36.5 million	83.4 million
GDP per capita US$ Nov 2020 (World Bank, 2020b)	$6 001	$8 717	$11 585	$2 104	$10 262	$10 006	$3 204	$9 042
Installed RE Capacity in 2019 (MW) (IRENA 2020)	6 167 Wind: 2 094 Solar: 3 061[2]	141 933 Wind: 15 365 Solar: 2 485	52 728 Wind: 102 Solar: 1 064	128 233 Wind: 37 505 Solar: 35 060	758 626 Wind: 366 452 Solar: 205 493	12 689 Wind: 1 609 Solar: 441	3 267 Wind: 1 225 Solar: 734	44 587 Wind: 19 949 Solar: 5 996
Manufacturing (% of GDP in 2019) (World Bank, 2020c)	12	9	13	14	27	13	16 (2018)	19
Renewable electricity targets	40% of installed capacity (MW) and 33% annual energy contribution (% of MWh) by 2030 (based on IRP2019)	Target 20% of electricity mix from non-hydro renewables (RECAI, 2015) Currently expect 28% of energy mix from non-hydro renewables by 2027 (Renewable Energy World 2019)	4.5% by 2024 (IFC 2011)	By 2020 100 GW Solar 60 GW wind (Kruger et al. 2018) The 100 GW solar is split into 60 GW utility scale solar and 40 GW rooftop PV (RECAI 2015)	35 % by 2030 (Renewable Energy World 2018)	20% by 2025 (Kruger et al. 2018)	42% by 2020 and 52% by 2030 (Hochberg 2016).	50% by 2023 (revised in 2018 from 30%) (Livingston 2018)

1. China is included as a member of the BRICS group of countries and due to its success in renewable energy industrialisation
2. This amount includes PV and CSP. It differs from the IRP and CSIR REIPPPP statistics, but is presented here to be part of a consistent data set from the same source.

Country comparisons

Insights from comparative analysis

Country comparisons – insights from comparative analysis (1)

- Countries with a similar scale and rate of procurement to South Africa are Brazil and Turkey.
- Argentina, the Russian Federation and Morocco show early signs of success in industrialisation, but the scalability and sustainability of this success still needs to be demonstrated.
- Key factors contributing to successful localisation in Brazil were lead times for project construction which allowed ramp up of manufacturing (3, 4 and 6 years for renewables compared to a typical 2 years in SA[1]) and LCRs that were not obligatory, but allowed access to very favourable concessional finance.
- It took about 12 years (1997 – 2009) for China to establish extensive value chain manufacturing and the ultimate dominance of its local turbine developers in its local market. Thereafter LCRs were discontinued. Apart from LCRs, key enablers were the very large local market and strong manufacturing base.
- Countries with very stringent requirements for ownership/local partnership, setting up local manufacturing facilities and transfer of IP are the Russian Federation and Turkey. Both support this with complementary mechanisms/incentives (financial and non-financial)

1. Such longer lead times may have been enabled by the concessional finance provided in Brazil. There is thus merit in gaining better insight in the relationship between cost of capital, COD and the other variables that affect auction electricity prices (see earlier point drawing on Kruger et al. 2018). However, with sufficient size and continuity of market, and attendant establishment of local manufacturing capacity over time, lead time to set up new local manufacturing capacity to meet the procured capacity for new auction is likely to become of lesser significance.

Country comparisons – insights from comparative analysis (2)

- Countries that have “winner-takes all” bidding/award multiple projects to single or limited bidders (e.g. Morocco, Turkey YEKA/REZ system) provide economies of scale to developers/OEMs to enable the setting up of local manufacturing facilities. The attendant combination of enabling lead times, stipulations for setting up local manufacturing facilities and accompanying support lead to notable investment in local manufacturing of several components (Morocco) and more extensive value chain development (Turkey).

- Flexibility in how LCRs are met has been a key enabler in countries which have established local renewable energy manufacturing (Brazil, Argentina, the Russian Federation, Morocco, Turkey). The mechanisms for this flexibility differ from LCRs being a condition of access to concessional finance (Brazil, Argentina) or special tariffs (Turkey YEKDEM system), ability to make local content “offers” (the Russian Federation, Turkey YEKA/REZ system, Morocco) and innovative contracting arrangements (the Russian Federation, Turkey YEKA/REZ system).

Country comparisons – insights from comparative analysis (3)

- Site selection, permitting and development by government (Morocco, Turkey YEKA/REZ system), including renewable energy parks (Morocco) have been an enabler particularly in "winner-takes-all"/limited award contexts.

- Since export of 60-80% of production contributes to the business case for investment in production facilities, those countries with access to large markets (e.g. Morocco, Turkey) have an advantage in attracting investment in local manufacturing.

- By 2018, SA had the largest auction programme in Sub-Saharan Africa (SSA): 6300 MW multiple renewable energy technology programme vs 20-100 MW individual solar PV projects in other SSA countries[1] and most stringent LCRs (min 40% vs 5-20% in other SSA countries) consistent with market scale, expected ability to provide products and services, and relative emphasis on cost-effective pricing (Kruger *et al*. 2018)

1. Note: other technologies have been enabled via feed-in tariffs schemes (e.g. hydro and biomass in Uganda) and there are a number of large scale non-auction/non-FIT wind investments in SSA (e.g. Kenya, Ethiopia) where procurement has been done through mechanisms such as direct negotiations

Country case studies

Renewable energy contributions to a Just Transition

Country case studies – insights on renewable energy contributions to a Just Transition (1)

- Creating localised green jobs, including through decentralised energy and energy efficiency are key Just Transition implementing measures internationally.

- Understanding the country context is important when looking to learn from other countries.
  Just Transition experiences to date are primarily from wealthier countries, so adaptation to the developing country context, and specifically to the local context, is critical.

- Renewable energy infrastructure and supply chains can contribute to diversification of regional economies in transition areas, particularly where these can build on related existing industries and businesses.

- Multi-stakeholder contribution to strategic considerations that inform planning ensures relevance and validity and supports implementation. Organised Labour have been key champions of transition planning and implementation.

Country case studies – insights on renewable energy contributions to a Just Transition (2)

- Public procurement and sustainable infrastructure projects are key measures for job creation in transition areas.
- Public and private sector skills development is important for the redeployment of workers and the creation of income opportunities for workers, their families and communities.
- Investment in educational institutions and technology development increases a region’s ability to be come a significant player in the global renewable energy value chain.
- Successful transitions can take considerable time (e.g. the Ruhr region of Germany took 60 years to go from a coal and steel industry dominated region to being a renewable energy and clean technology leader in Germany and internationally.

Country case studies – insights on renewable energy contributions to a Just Transition (3)

- Utility scale and small scale renewable energy infrastructure and renewable energy manufacturing can be key enablers of socio-economic development in coal-mining and coal-based power generation regions in South Africa.

- Drawing on international case studies, this could be through, for example,:
  - Adaptation of existing industries and infrastructure
    - coal mining companies and coal-based power generators can become renewable energy generators (e.g. mining companies / mines sites becoming renewable energy generators; coal-based generators converting to biomass)
  - Adaptation of existing supply chains to become renewable energy component suppliers
    - For example, gearboxes for mining equipment expertise adapted to gearboxes for turbines, steel industry pivoting to wind power manufacturing.
  - Creation of renewable energy markets through stimulating local demand for green technologies
    - For example energy efficiency projects in industry, building retrofits for energy efficiency, community-based renewable energy generation.
  - Conversion of existing industrial sites to renewable energy technology and manufacturing hubs

Localisation and industrialisation: strengths, weaknesses, opportunities and threats (SWOT – Draft for Discussion)

Draft based on desktop research

For discussion and augmentation by government, industry, labour and wider stakeholder engagement in the SAREM Consultation Phase

Strengths

Localisation

- Strong specialised services (e.g. environmental studies, legal services, structuring financials deals, engineering design, location assessment and others)

Industrialisation

- Nascent renewable energy local component manufacturing industry (steel and concrete towers, solar module assembly)
- Access to local raw materials (e.g. steel, aluminium)[1]
- Manufacturing base in selected allied industries (e.g. structural steel, electrical equipment, fibreglass)[2]
- Special economic zones (SEZs) (including one Green Tech SEZ) and associated incentives

1. There are some concerns regarding the relative cost of local raw materials
2. There has been a decline in manufacturing in the last decade, and there are contradictory views on the ability of the local industries to produce at the quantity and quality required by the renewable energy industry

Strengths

Localisation and Industrialisation

- Local experience in balance-of-plant (BOP) (i.e. civils, transport & erection, grid integration) and in manufacturing of BOP components (esp. electrical components for grid integration)
- Reasonably diverse representation of OEMs in country – renewable energy market beyond "emerging" stage[1]
- Proximity to- and established trade with- Sub-Saharan African (SSA) countries
- Relatively strong industrial sector and manufacturing capacity amongst Sub-Saharan African countries and SADC in particular.
- Strong finance sector with extensive experience in structuring of project finance both in SA and SSA

Further strengths to be added as they emerge from the direct consultations in the Consultation Phase of SAREM.

1. However, renewable energy **manufacturing** can still be considered as nascent or emerging

Weaknesses[1] (1)

Localisation and industrialisation

Policy context

- Lack of energy policy certainty / long term reliability / continuity and predictability in growth of market
- Lack of policy (implementation) certainty with regard to renewable energy allocations and procurement (bid windows in auctions) and market structure limiting bulk of market demand to REIPPPP
- Slow planning cycles that do not correspond to the dynamics of demand and supply
- Government and industry interactions focussed primarily on compliance (rather than a strategic agenda)
- Complex business environment / low ease of doing business

Manufacturing enablers

- Policy instability leading to economic instability and exchange rate volatility
- Lack of energy security / load shedding
- Financial viability of primary buyer / off-taker (Eskom)
- Relatively expensive local finance compared to international finance.

1. Drawing primarily from Morris et. al 2020

Weaknesses[1] (2)

Industrialisation

Policy context

- Limited alignment between energy and industrialisation policy
- Local content rules that focus on total spend rather than specifically tailored to industrialisation (i.e. focussing on content)
- Local content rules that focus on quantum of employment rather capacity being built
- Limited integrated industrial policy and support mechanisms (incl. lack of renewable energy specific support mechanisms)
- Limited government support for localising technology suppliers and increasing technology capacity

Market context

- Relatively small local renewable energy market at great distance from other high growth markets
- Due to delays in establishing local manufacturing, potentially missing the global renewable energy industrialisation window of opportunity

1. Drawing primarily from Morris et. al 2020

Weaknesses[1] (3)

Industrialisation (continued)

Manufacturing enablers

- *Relatively weak industrial base and weak supply fields (e.g. steel, metal casting, electronics assembly)*[2]
- Cost of material inputs to renewable energy manufacturing and particularly steel and aluminium.
- Low level of technology intensity in the market
- Relatively limited R&D capability (technologies and manufacturing processes)
- Shortage of required technical skills

  Applies to localisation as well.
- Relatively unpredictable and expensive labour (compared in particular to Asian economies)
- Skills base skewed to unskilled labour

  Majority of labour in renewable energy value chains is skilled labour and there is currently a shift to knowledge intensive services and higher order production capabilities in renewable energy value chains.
- Other factors that reduce global competitiveness (compared in particular to Asian economics): relative expensive of electricity, relative expense of property rental, relative expensive of capital and relative cost of overheads

Further weaknesses to be added as they emerge from the direct consultations in the Consultation Phase of SAREM.

1. Drawing primarily from Morris et. al 2020
2. There are contradictory views on the ability of the local industries to produce at the quantity and quality required by the renewable energy industry

Opportunities (1)

Localisation

- Export revenue through strong specialised services (e.g. environmental studies, legal services, structuring financials deals, engineering design, location assessment)

Industrialisation

- Expansion of local steel and aluminium manufacture, provided cost can be reduced to be cost competitive with imports.

  For example, for the IRP2019 build, it is estimated that there is a potential for 5% (Wind: 4%, Solar PV 1%) increase in annual local steel production, which would contribute about 2.2 billion to GDP and create over 700 jobs.[1]
- Toll manufacturing facilities that allow production for more than one project/OEM so as to enable local manufacturing in response to the current nature of procurement of utility scale renewable energy in South Africa (i.e., local content requirements for concurrent projects with short lead times and considerable upfront uncertainty with regard to whether local manufacturing capacity will be utilised).

1. Estimate based on IRENA (2017a, 2017b) and South African Iron and Steel Institute factors per 1000 tonne steel (Engineering News, 2020)

Opportunities (2)

Industrialisation (cont.)

Wind:

- Additional wind tower and tower internal manufacturing
- Local nacelle assembly (even if initially largely from imported components) is an important enabler of higher value local turbine component manufacturing.
  Local nacelle assembly could also enable expansion in existing casting, forging and transformer production if capacitated for renewable energy component production. However, it should be recognised that the localisation potential of all of these components is currently considered medium rather than high.

Solar PV

- Additional module manufacturing, but the business case may not be strong based on local demand only (possibly <300 MW/year remaining capacity given currently established (dedicated OEM and toll) module manufacturing capacity).
- Expansion of aluminium module frame and junction box manufacturing facilities, provided cost of aluminium can be reduced to be cost competitive with imports. .

Opportunities (3)

Industrialisation (cont.)

Solar PV (cont.)

- Inverters
  - System assembly with core imported products and some local components, as well as manufacturing under licence, but this would require support to local producers to meet quality standards and access to testing and certification locally.
  - Expanding magnetics production and support through additional milling capacity
  - Expanding transformer production through reductions in input material costs (especially steel), and support for improvement in efficiencies to meet the standards expected by international inverter manufacturers.
  - Expanding of enclosure and packaging production.
- Mounting structures are more readily localised due to the high cost of transport, but are relatively lower value components of a solar PV system.
- Expansion of production of steel and aluminium mounting structures, provided steel-production and aluminum extrusion production capacity can be expanded, support provided for tooling and cost of these inputs reduced to be cost competitive with imports.

Opportunities (4)

Industrialisation (cont.)

Solar PV (cont.)

- Expansion of cable production by expanding local production of conductors, insulation, and armour, provided input material costs (steel, aluminium and polymers) are addressed.
  Local aluminium rod production could boost to local cable production.

Small scale embedded generation renewable energy technologies

- Expanded manufacturing and export of small scale/embedded generation renewable energy technologies (particularly, small scale wind turbines, biogas digesters)

Further opportunities to be added as they emerge from the direct consultations in the Consultation Phase of SAREM.

Threats

Localisation and industrialisation

- Reduced economic growth expectations (in part due to COVID-19) leading to lower local energy demand than considered in energy planning

Industrialisation

- Lower margins in industry leading to reluctance of OEMs to share technologically advanced and knowledge elements of value chain
- Competitions from other emerging economies: many other developing / emerging economy countries have increase own renewable market and put in place mechanisms to promote localisation
- Possible oversupply of renewable energy manufacturing capacity globally which could make it difficult to achieve local manufacturing profits or justify development of manufacturing capacity in a new region.

Further threats to be added as they emerge from the direct consultations in the consultation phase of SAREM.

Supporting information

Status quo

Supporting information

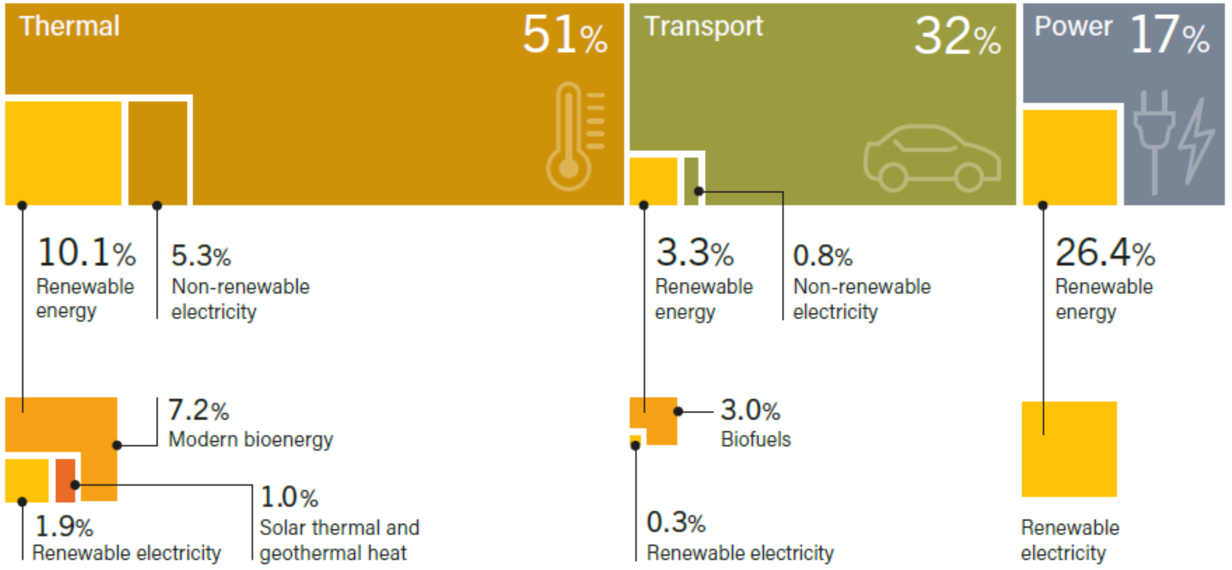
Global trends

Renewable energy for power, thermal and transport uses

Power is the largest portion of realised potential for renewable energy. Internationally, it is recognised that policy is needed to stimulate uptake of renewable energy in non-power end-uses.

Global status of renewable energy presented in relation to end use (2017)

- Power/electricity is small portion of opportunity (17%), but a large portion of realised potential for renewable energy.
- Renewable energy for power/electricity has shown greatest growth in capacity and generation over last 5 years (compared to renewable energy for thermal and transport uses)



Note: Data should not be compared with previous years because of revisions due to improved or adjusted methodology.

Source: Based on IEA data. See endnote 50 for this chapter.

Source: Ren21 (2020)

KEY FACTS

- Renewable energy grew three times faster than fossil fuels and nuclear over a five-year period, but accounted for less than one-third of the increase in total final energy demand.
- The largest advances have been in the power sector (in both capacity and generation), while significantly less progress has occurred in heating, cooling and transport.
- Renewables continued to meet low shares of final energy demand in the buildings, industry and transport end-use sectors, where support policy remained crucial to spurring uptake, yet was lacking.

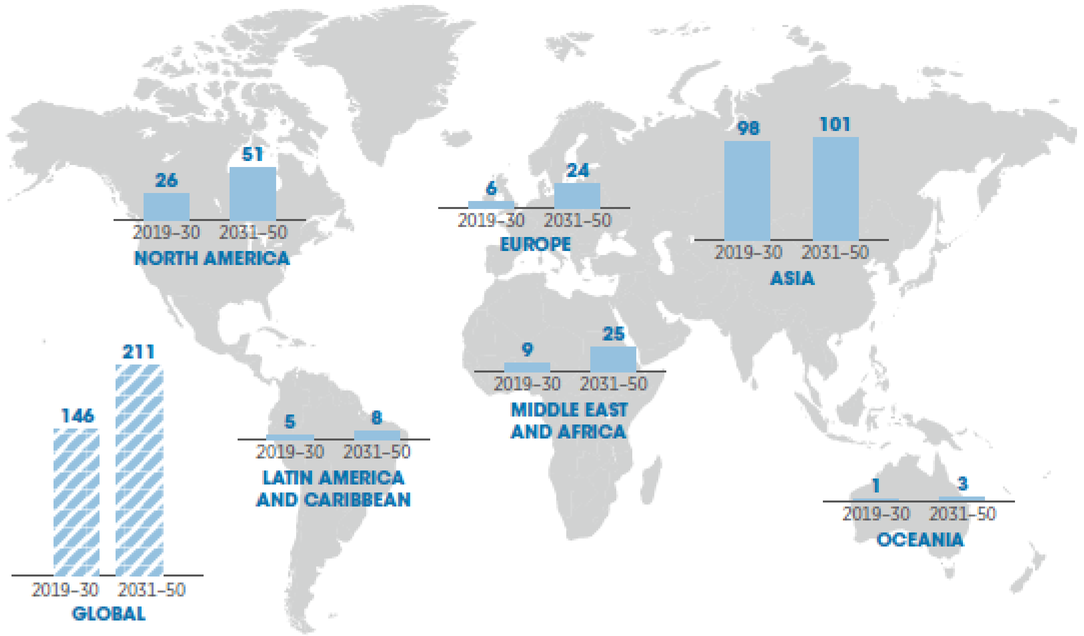
Source: Ren21 (2020)

Global wind energy outlook

In both the medium (2030) and longer term (2050), Asia and North America are expected to be the largest wind markets globally. Africa and Middle East could build 22 GW/year between 2030 and 2050. Given current trends, the largest portion of this annual build is expected to be in North Africa and the Middle East (IRENA, 2019b)

Onshore wind installed capacities (GW)

Average annual investment for onshore wind deployment (USD billion/year)

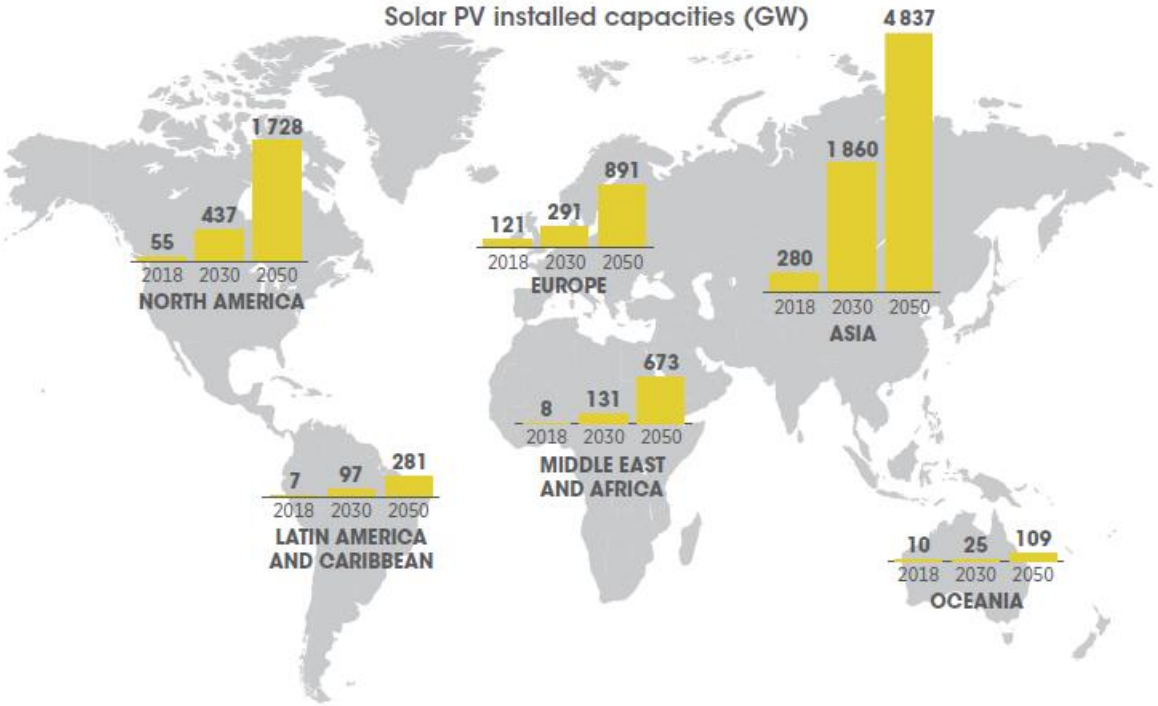


Source: IRENA 2019b

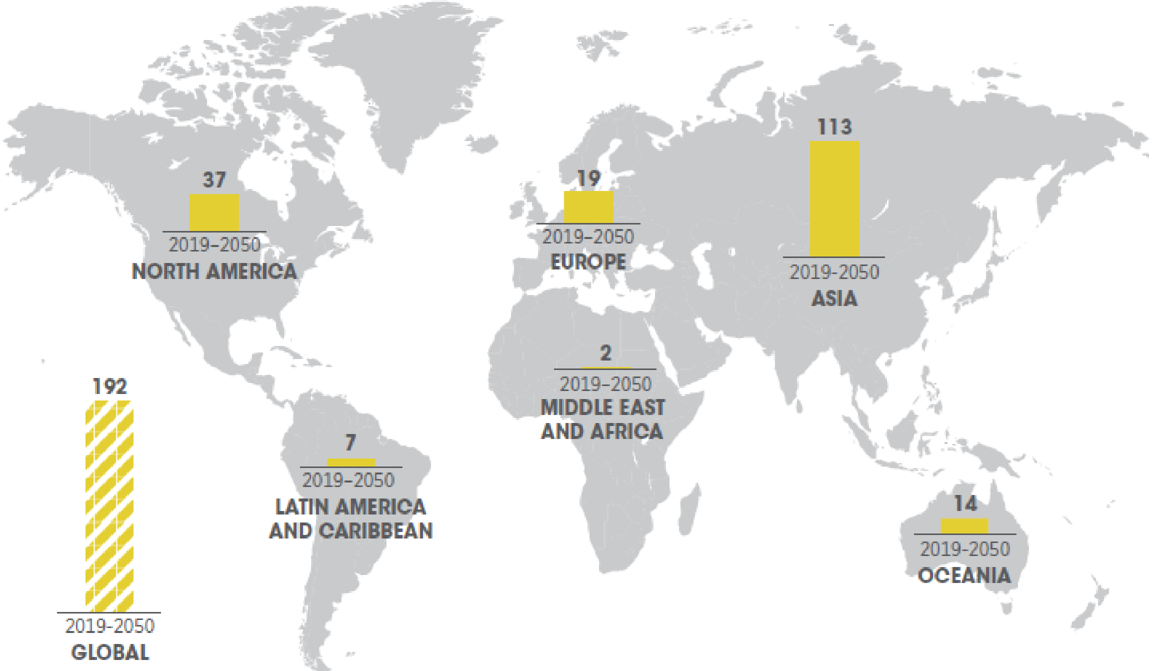
Global solar PV outlook

In both the medium (2030) and longer term (2050), Asia and North America are expected to be the largest solar PV markets globally. Africa and Middle East could build 27 GW/year between 2030 and 2050. Given current trends, the largest portion of this annual build is expected to be in North Africa and the Middle East (IRENA, 2019c)

Solar PV installed capacities (GW)



Average annual investment for onshore wind deployment (USD billion/year)



Source: IRENA 2019c.

Global renewable energy industry trends (1)

The renewable energy industry is a highly competitive global and increasingly consolidated industry

- The levelised cost of renewable energy (RE) has decreased substantially over last 9-10 years. In part, driven by intense competition due to rise in energy auctions globally.

- Margins have become very small leading to increased pressure for innovation (to reduce capital cost and improve performance).

- This has lead to considerable consolidation in wind industry, but also in solar industry, i.e. a small number of lead firms capture largest share of the market:
  - Wind: top 10 companies captured 85.5 % of the market share in terms of installed capacity in 2019
  - Solar PV: top 10 module suppliers shipped almost 60% of the total in 2018
    China continues to dominate solar PV manufacturing as it has done since 2011.
    In 2018, 7 of top 10 manufacturers and the top 3 were Chinese-based companies
    In 2019, Chinese firms produced 80% of the modules shipped by the top 10 manufacturers

(Ren 21, 2019 and 2020)

Global renewable energy industry trends (2)

Renewable energy value chains are vertical specialisation value chains lead by the lead firms (Morris and Staritz, 2019)

- Renewable energy value chains are global value chains (GVCs) and specifically vertical specialisation (global) value chains (VSVCs).
- This requires a shift from import-substitution (ISI) and export-oriented industrialisation (EOI) to vertically specialised industrialisation (VSI), i.e. a focus on traded intermediate goods and regulating links to the global economy to capture more value.
- Lead firms in GVCs are the original equipment manufacturers (OEMs) who have a strong influence on the geographic distribution of production and service activities.
- OEMS (and finance providers for projects) set the standards for components and systems
- These OEMs tend to follow a model of "follower sourcing," i.e. lead firms would encourage foreign first tier suppliers (e.g. with whom they have long-standing trusted relationships to set up subsidiary plant in a country.

Characteristics of vertical specialisation value chains (VSVC) and associated industrialisation path (Morris and Staritz, 2019)

In VSVCs the industrialisation path is typically an initial narrow focus to develop capability followed by expansion to more of value chain and more of the value add tasks over time

Type of global value chain (GVC)	Description	Type of products	Industrialisation path
Vertical specialisation value chain (VSVC)	• Lead firms tend to focus on core competencies and outsource non-core activities. • Allows for simultaneous and parallel production activities and hence fragmentation and geographic dispersion of production.	• Occur for final products that can be assembled from a range of components.	• Initial narrow focus on productive tasks and capabilities that may only make up a small fraction of products' final production cost. Strategy known as "thinning" value add productive activities to gain global competitive advantage. • Subsequent "stretching" to higher rent niches to gain competitive advantage and avoid highly competitive chain segments.

Global renewable energy industry trends (3)

Technology advances requires higher order production capabilities. This presents a challenge for industrialisation in the SA context, but also opens opportunities in other stages of the value chain Morris et al. (2020)[1]

- There is considerable pressure for innovation due to lower margins.
- Technology advances to increase output (longer blades, larger rotor size, higher hub heights) means that industry is shifting to more knowledge intensive services and higher order production capabilities.
- Technology advances also mean that less of the readily localised elements (fewer towers, foundation platforms, connective infrastructure) is required for same output.
- Considerable technology adaptive capacity is required to respond to pressures for improved efficiencies and lowering costs.
- However, these pressures also enable related value chain opportunities (e.g. drones and sensors to do tower, nacelle and blade analysis; increasingly specialist transport and construction capabilities to move and install wind energy facilities).
- Service localisation can provide local income and could be leveraged as an export capability

1. Primarily based on wind, but generally also relevant to solar

Renewable energy localisation and industrialisation in South Africa

Approach

Approach to renewable energy localisation and industrialisation in SA (1)

The primary mechanism used to drive renewable energy industrialisation to date has been leveraging off procurement at utility scale. New mechanisms may open due to impending changes to the electricity market .

- Renewable energy localisation and industrialisation in South Africa have been driven primarily through the Renewable Energy Independent Power Producer Programme (REIPPPP).

- Localisation is one of several economic development goals, i.e. not a singular additional goal as is the case in other countries that are leveraging off renewable energy procurement to enable economic development (see Country Comparisons section).

- The approach to localisation in the REIPPPP, albeit successful in leading to the establishment of notable local manufacturing capacity, has been identified as having a number areas that merit reconsideration if it is to be used as a stronger driver of industrialisation (next page).

- The impending changes in the electricity market (e.g. potential for direct municipal procurement, establishment of an independent system operator, easing of restrictions on embedded generation) may enable new mechanisms for driving industrialisation.

Approach to renewable energy localisation and industrialisation in SA (2)

The approach to localisation in the REIPPPP to date presented some challenges in terms of driving industrialisation (Morris et al. 2020)

- Consideration of many factors in the scoring system reduced the leverage to specifically target industrialisation.

  In the South African context there are many socio-economic objectives that need consideration. Local content is one of seven elements that contribute to the economic development component of the score. It contributes 25% of the 30 points for economic development and ultimately 7.5 points to the total score.

- Thresholds set for local content allowed for any aspect of project costs to qualify not specifically local content items (e.g. manufactured components) by specifying percentage spend rather than specifically targeting manufacturing.

  (See Country Comparisons for alternative systems including points system for localisation of specific components and stronger mechanisms (as used, for example, in Morocco, the Russian Federation and Turkey.)

Approach to renewable energy localisation and industrialisation in SA (3)

The approach to localisation in the REIPPPP to date presented some challenges in terms of driving industrialisation (Morris et al. 2020)

- Local content focussed only on establishment/deployment phase and the specific rules for local content skewed local content spend away from other value added activities in the supply chain
  These include post project planning services, critical manufactured items or technology acquisition. Operation and maintenance (O&M) phase accounts for 20-30% of a project's life time value and also a consistent value over 20-year life of plant.[1]

- Limited focus on supporting development of service industries where South Africa has strengths has limited the opportunity to earn export revenue.

- Focus on the quantum of jobs rather than technological capabilities and skills associated with renewable energy value chain jobs[1] enabled short term (unsustainable) gains rather than driving the longer term industrial possibilities.

1. The 2019/20 Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) (which is scored on a 90/10 basis rather than the 70/30 of the REIPPPP) specifically includes Skills Development into the Economic Development element and also specifies requirements for local content spend during the operations phase

Approach to renewable energy localisation and industrialisation in SA (4)

The approach to localisation in the REIPPPP to date presented some challenges in terms of driving industrialisation (Morris et al. 2020)

- The procurement process was not accompanied by strong industrial policy driving (renewable energy) industrialisation. Supporting mechanisms tended to be general, rather than specifically tailored to the renewable energy industry.

  Typical mechanisms could include incentives, concessional finance, R&D support, trade and investment facilitation, special industrial zones and the development of other technical and physical infrastructure specifically tailored to the renewable energy industry (See Country Comparisons for how specific mechanisms aimed at renewable energy have been provided in other countries.)

- Industry support initiatives did not recognise some of dynamics of global value chains (GVCs): a focus on indigenous production at an early stage in the development of the local industry missed wider benefits that could have been had through follower sourcing.

  (See localisation pathways for vertical specialisation pathways earlier and Country Comparisons for industrialisation paths followed by other countries.)

Approach to renewable energy localisation and industrialisation in SA (5)

The approach to localisation in the REIPPPP to date presented some challenges in terms of driving industrialisation

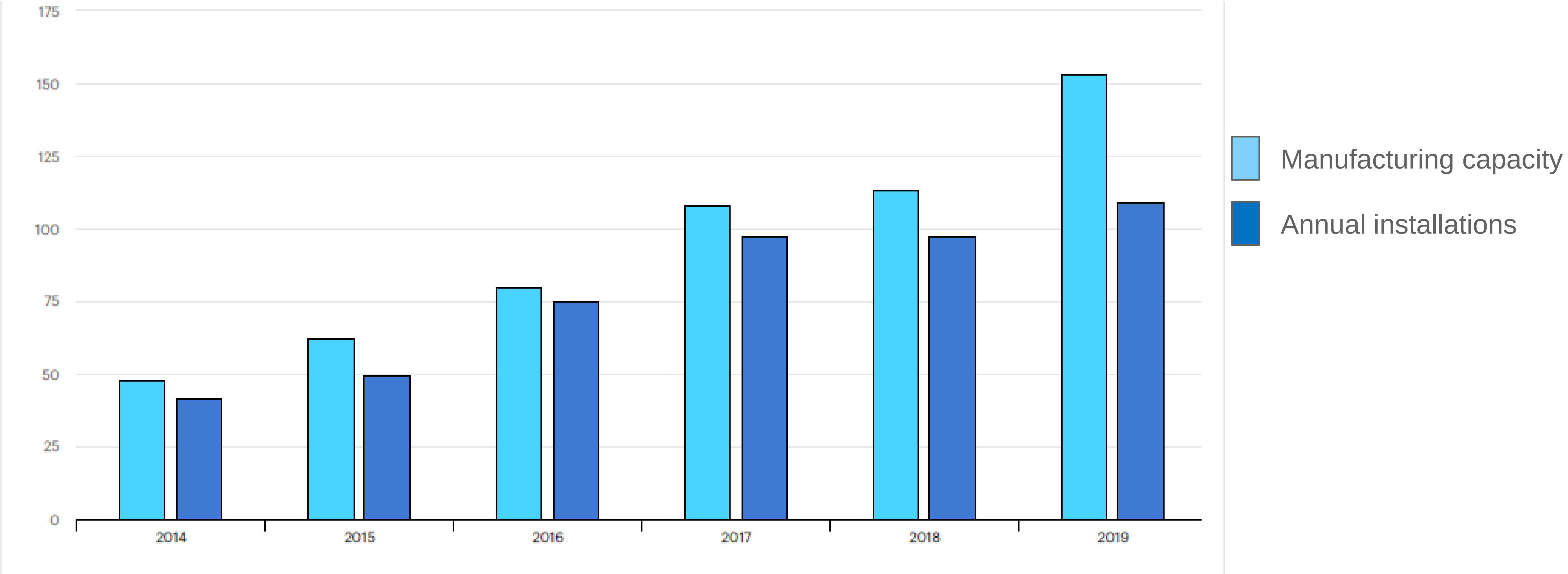
- The time between financial close and commercial operating date (COD) left lead time for the (feasible and/or affordable) construction of local manufacturing facilities, and limited room to adjust to challenges in developing local supplier to meet OEM requirements.
  The lead time to COD in the REIPPPP is typically 24-25 months. See Country Comparisons for other countries (e.g. the 4 and 6 year lead time introduced specifically for renewable energy in Brazil, government-developer interaction in Morocco, Russia and Turkey)

- The limited focus on driving industrialisation and the gap in the REIPPPP process means that South Africa may have missed “window the opportunity” to be a base for exporting to other markets (including future renewable energy projects in Africa), especially as other emerging economies have stepped into the renewable energy (manufacturing) space in the interim.
  There is currently an oversupply of manufacturing capacity globally particularly in the solar PV industry (see next page).

Global manufacturing context

There is currently an oversupply of solar PV manufacturing capacity globally

Solar PV module manufacturing and demand 2014 - 2020



Source: IEA (2020

Renewable energy industrialisation in South Africa

Status and opportunities

Utility scale wind and solar PV

Status of industrialisation in South Africa: utility scale wind

South Africa has well established manufacturing capability in lower tech utility scale wind energy components. However, there is not enough capacity to serve the full annual build in the IRP2019. Furthermore, due to the gap in procurement over the last few years, there a lead time may be required for the previously established core manufacturing and balance of plant (BOP) capacity to ramp up again.

Status of local manufacturing for wind energy projects (Morris et al. 2020)

Type of activity/product	Tech Level	Status
Civils inputs (aggregate, cement, steel, pre-cast elements, some yellow goods (plant and equipment)	Low/medium tech	Established
Ancillary structures – fencing, building materials for temporary/permanent buildings	Low tech	Established
Grid integration – cables, distribution and power transformers, medium voltage primary and secondary switchgear, mineral oil and bio-electra oil pole mount switchgear, pylons, indoor and outdoor ring main units	Low/medium tech	Established
Towers – steel towers	Low tech	Established
Towers – pre-cast concrete tower units	Low tech	Mostly disestablished [1]
Tower internals – ladders, cabling, lighting	Low Tech	Established
Blades	Medium tech	None
Turbines – for the commercial grid wind energy sector	Medium tech	None
Nacelles panels	Low Tech	None
Assembly of nacelles & turbine elements	Medium tech	None

Authors adapted from SAWEA and Urban Econ data.

1. Concrete tower production has been done for a number of wind farms completed recently so the term disestablished may not be entirely valid.

Opportunities for industrialisation: utility scale wind (1)

A breakdown of the main cost components gives a sense of the relative scale of financial and economic benefit in localising particular components. 64-85% of the value of the project until operation is in the supply of the wind turbine including installation. Of the capital cost, towers and blades combined are about half the cost and the nacelle and all its sub-components the other half.

Breakdown of main cost components of developing wind projects (IRENA 2017a)

Component	Comments	Contribution to installed cost (%)
Wind turbines, including towers and installation	Costs can fluctuate with economic cycles and cost of commodities such as copper and steel.	64 – 85 % (but more typically 64-74 %)
Civil works	Includes site preparation and foundations for towers	8 – 17 %
Grid connection	Includes transformers and sub-stations	8 – 11 %
Project planning	May include expenses and fees related to development, licences, financial closing, feasibility and development studies, legal processing, rights of way, insurances etc.	9 – 11 %

COMPONENT	% OF TOTAL INVESTMENT OF WIND FARM
Wind turbine	64 - 85
Tower	16 - 18
Rotor blades	13 - 15
Rotor hubs	0.8 - 0.9
Rotor bearings	0.7 - 0.8
Main shaft	1.2 - 1.3
Main frames	1.7 - 1.9
Gearbox	7.8 - 9.7
Generator	2.1 - 2.3
Yaw system	0.76 - 0.84
Pitch system	1.6 - 1.8
Power converter	3.0 - 3.4
Transformer	2.2 - 2.4
Break system	0.8 - 0.9
Nacelle housing	0.8 - 0.9
Others	7.7 - 8.5

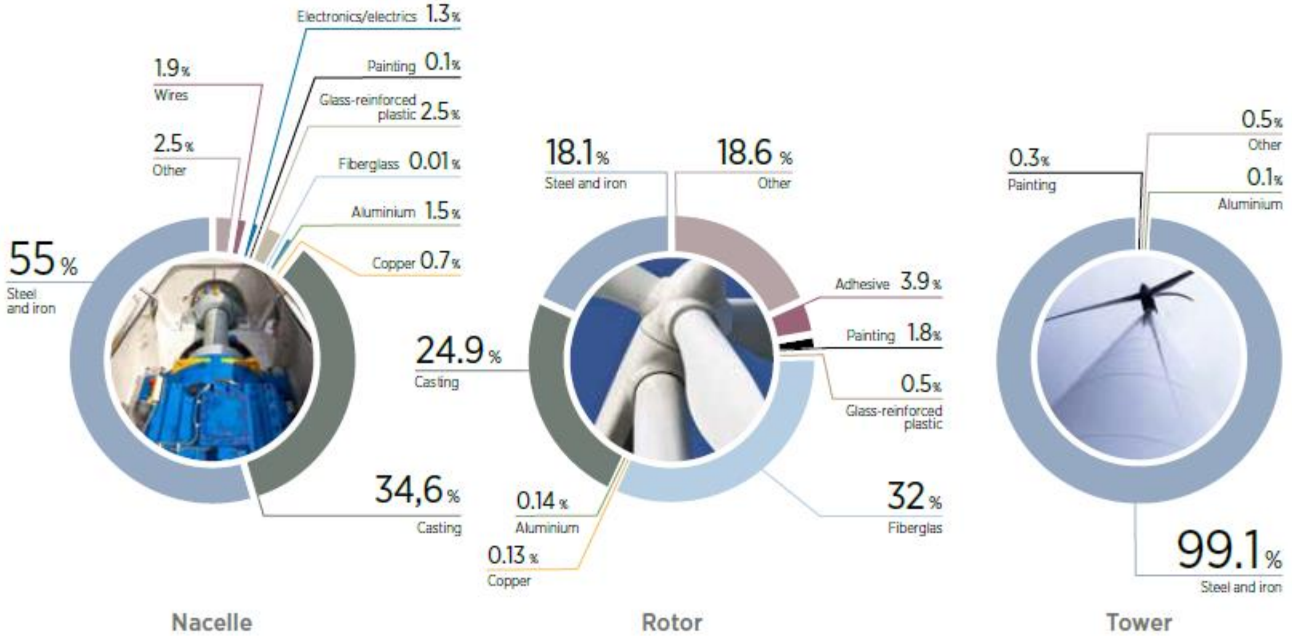
Opportunities for industrialisation: utility scale wind (2)

The production of wind turbine components locally is also an enabler for the growth of local material supply chains. Concrete, steel, polymers and fibreglass are some of the largest, but not the only, material inputs to wind turbines.

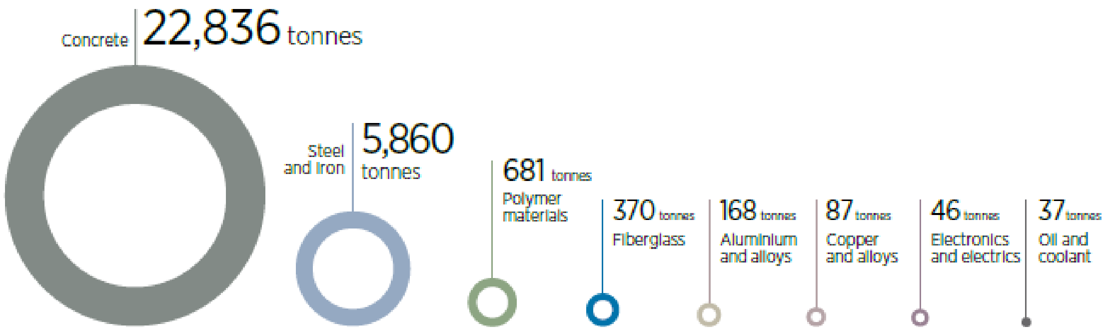
Example of material value chain opportunity

If steel towers using local steel were used for the IRP2019 build of 1600 MW/year from 2022, it could increase annual steel production in South Africa by an estimated 4%, adding R 1.7 billion to GDP annually and enabling a spend of R 94 million with SMMEs and the creation of 560 new jobs.[1]

Materials inputs per major component (% by weight) (IRENA 2017a)



Materials needed to develop a 50MW wind farm (tonnes) (IRENA 2017a)



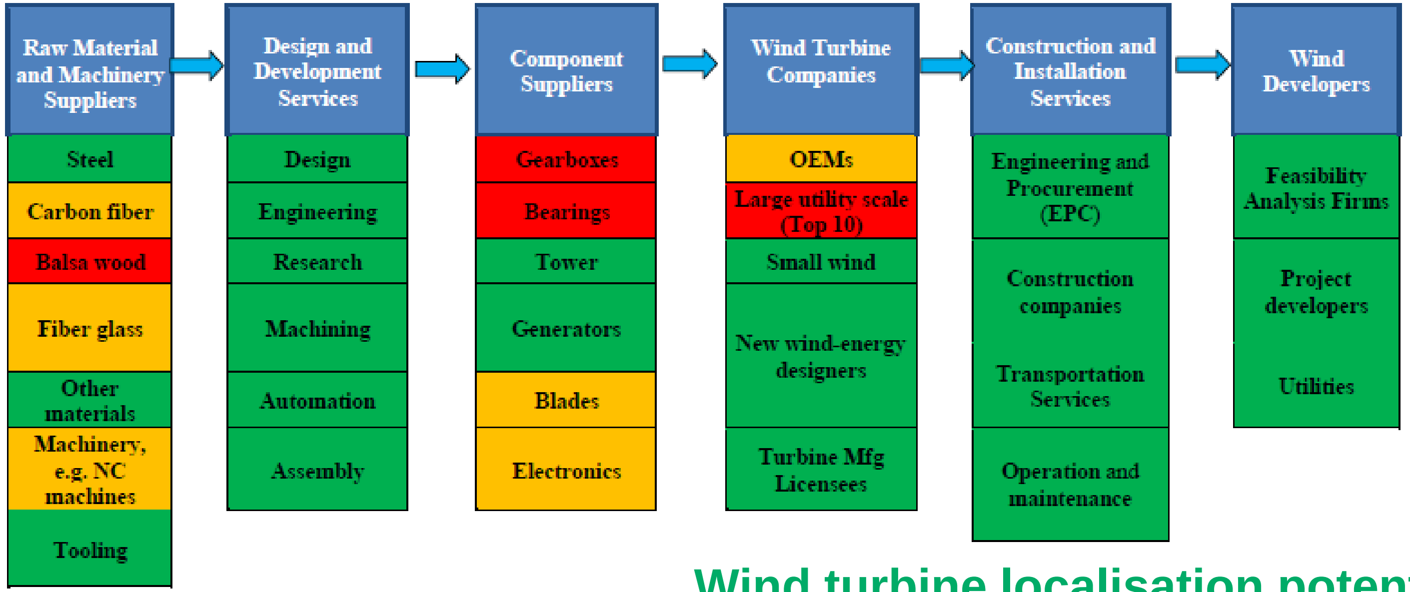
Source: Vestas, 2015

1. Estimate based on IRENA (2017) (RHS) and South African Iron and Steel Institute factors per 1000 tonne steel (Engineering News, 2020)

Opportunities for industrialisation: utility scale wind (3)

Steel, tooling for manufacturing, towers and generators are considered to be the input and components most readily localised, followed by carbon fibre, fibreglass, blades and nacelle electronics. Local nacelle assembly (even if initially from largely from imported components) is an important enabler of higher value local turbine component manufacturing

Relative ease of localisation in wind value chain (Szewczuk et al. 2010)



Wind turbine localisation potential per component (Urban-Econ & EScience 2015)

Key component	% of Project Value*	Localisation potential	Local content to be achieved*	Local content contribution
Blades	9.1%	Medium	60%	5.5%
Nacelle Assembly	2.1%	Low	80%	1.7%
If local assembly is established:				
Rotor Hub	4.3%	High (hub)	38.7%	1.7%
Nacelle Drivetrain	12.0%	Medium to High (castings and forgings)	15.4%	1.9%
Nacelle Exterior	2.7%	Medium to High (composites)	90%	2.4%
Nacelle Interior	9.3%	Medium (generator, transformers, etc.)	84.4%	7.9%

Note: *Assuming constant 2013 prices and fixed exchange rate

Opportunities for industrialisation: utility scale wind (4)

A demand of 400 MW/year/OEM for a minimum of 5 years is required to make the local manufacture of blades a potentially viable investment. An additional total local market of 1000 MW/year would enabled local nacelle assembly, and local manufacturing of generators and converters. The expected premium for local manufacturing is 5% for blades, 10-20% for nacelles and 20% for the other components. Local nacelle assembly could also enable expansion in existing casting, forging and transformer production if capacitated for renewable energy component production. However, it should be recognised that the localisation potential of all of these components is currently considered medium rather than high.

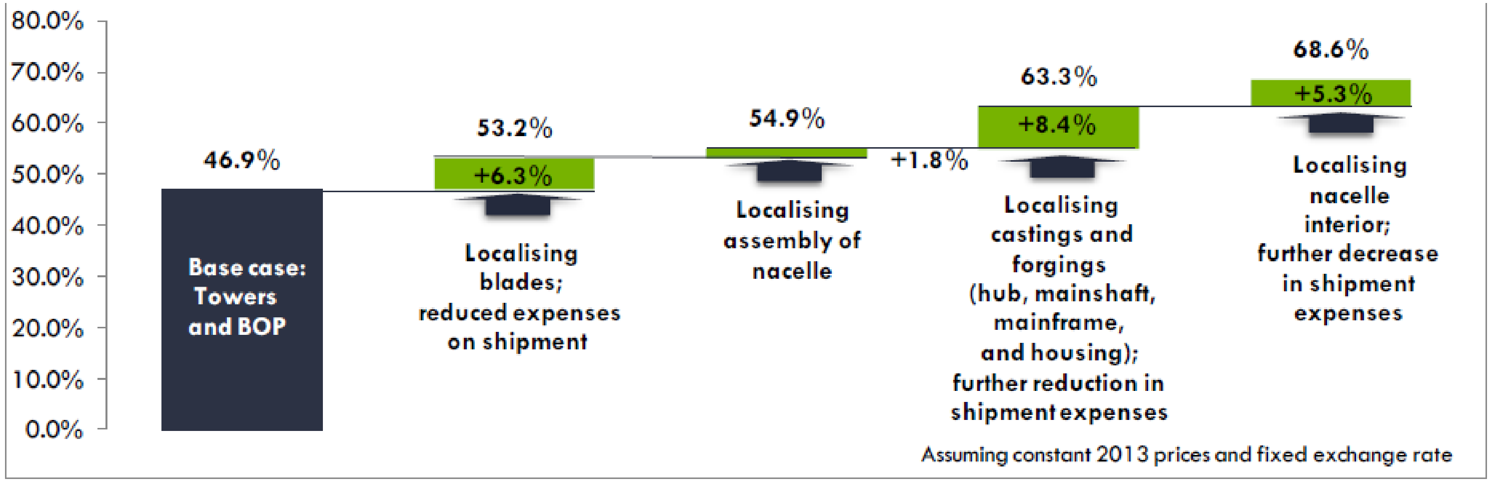
Summary of assumptions on wind turbine component localisation potential
(based on Urban-Econ & EScience 2015)

Component	Key Assumptions	Localisation Potential	Local Content Potential	Price Increase Compared to Imports	Job Creation Potential (per facility)
Blades	400 MW/year/OEM for min of 5 years	Medium	60%	5%	228
Nacelle Assembly	400 MW/year/OEM with total market of 1000 MW/pa over 5 years	Low	80%	10-20%	230
Nacelle Castings & Forgings	Expansion of existing facilities	Low w/o nacelle assembly Medium w nacelle assembly	90%	20%	-
Nacelle Exterior	Expansion of existing facilities	Low w/o nacelle assembly Medium w nacelle assembly	80-100%	20%	-
Nacelle Interior	Generators: 400 – 450 MW/year/OEM with total market of 1000 MW/pa over 5 years Converters: 400 MW/year/OEM with total market of 1000 MW/pa over 5 years Transformers: sourced from local manufacturer	Low w/o nacelle assembly Medium w nacelle assembly	80%	20%	-

Opportunities for industrialisation: utility scale wind (5)

Level and sequence of local manufacturing considering identified potential (Urban-Econ & EScience 2015)

(2013 constant prices and fixed exchange rate)

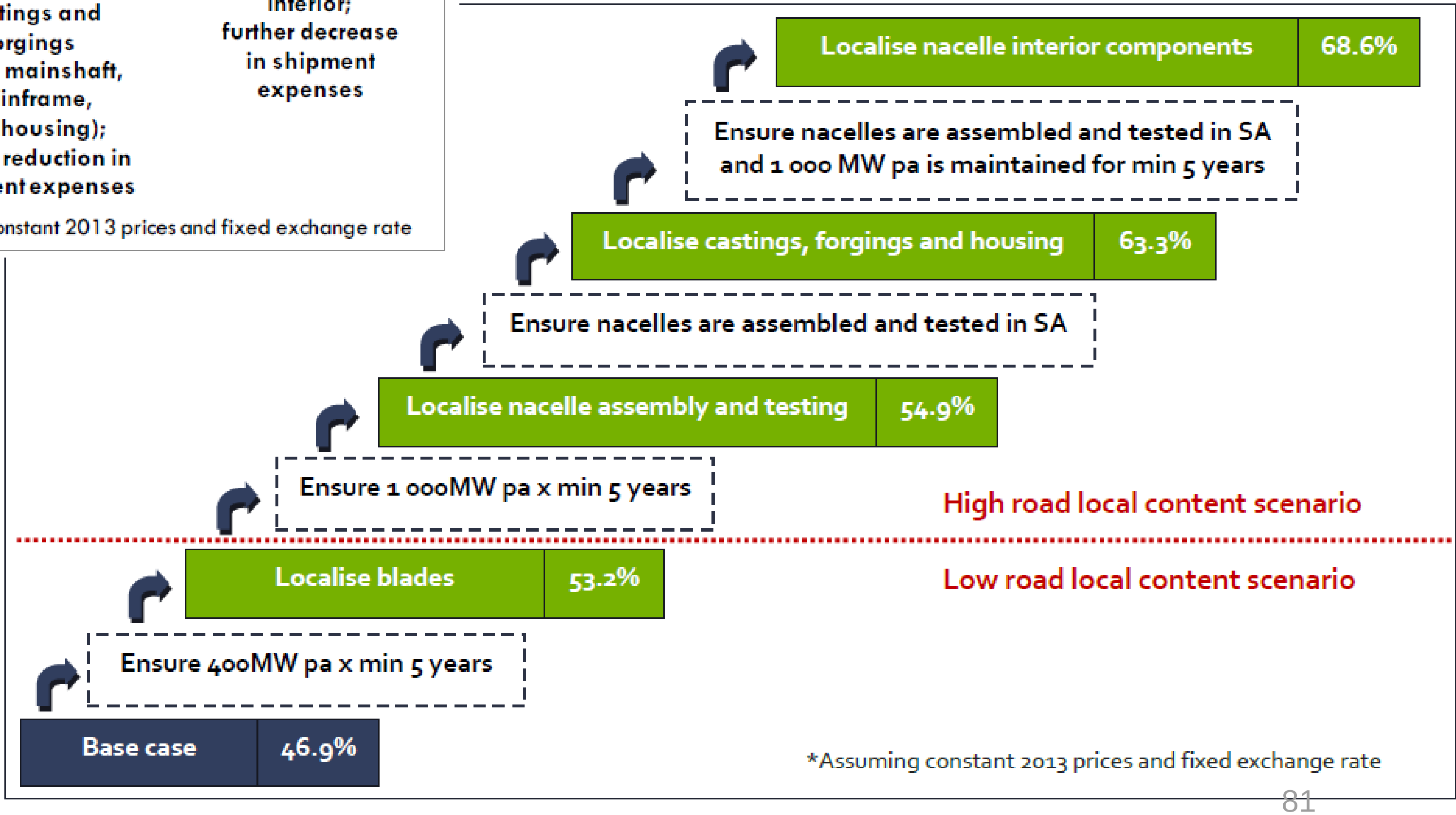


Source: Urban-Econ & EScience (2015)

A local manufacturing sequence of towers, blades, nacelle assembly, castings and forgings (hub, main shaft, mainframe and housing), and finally nacelle interior components could lead to 68.6% local content in turbines assuming the required minimum build of 400 MW/OEM/year for 5 years and a total market of 1000 MW/year.

Local content roadmap for wind based (Urban-Econ & EScience 2015)

(2013 constant prices and fixed exchange rate)



Source: Urban-Econ & EScience (2015)

Opportunities for industrialisation: utility scale wind (6)

Estimate of number of manufacturing facilities and job creation potential for wind turbine localisation for IRP2019 build (extrapolation from data from Urban-Econ & EScience 2015)

Component	Key Assumptions	Expected number of facilities	Job Creation Potential (FTE)
Balance of Plant	Already localised **(may require time to ramp up again)**	N/A	5387
Towers	150-165 towers/facility; average of 2.5 MW/turbine[1]	1 existing (steel towers) 3 new	220 existing 568 new
Blades	400 MW/year/OEM for min of 5 years	4 new	899
Nacelle Assembly	400 MW/year/OEM with total market of 1000 MW/pa over 5 years	4 new	604
Nacelle Castings & Forgings	Expansion of existing facilities	Expansion of existing facilities	994
Nacelle Exterior	Expansion of existing facilities	Expansion of existing facilities	
Nacelle Interior	Generators: 400 – 450 MW/year/OEM with total market of 1000 MW/pa over 5 years Converters: 400 MW/year/OEM with total market of 1000 MW/pa over 5 years Transformers: sourced from local manufacturer	4 new	935
Total			BOP: 5387 Manufacturing: 4220

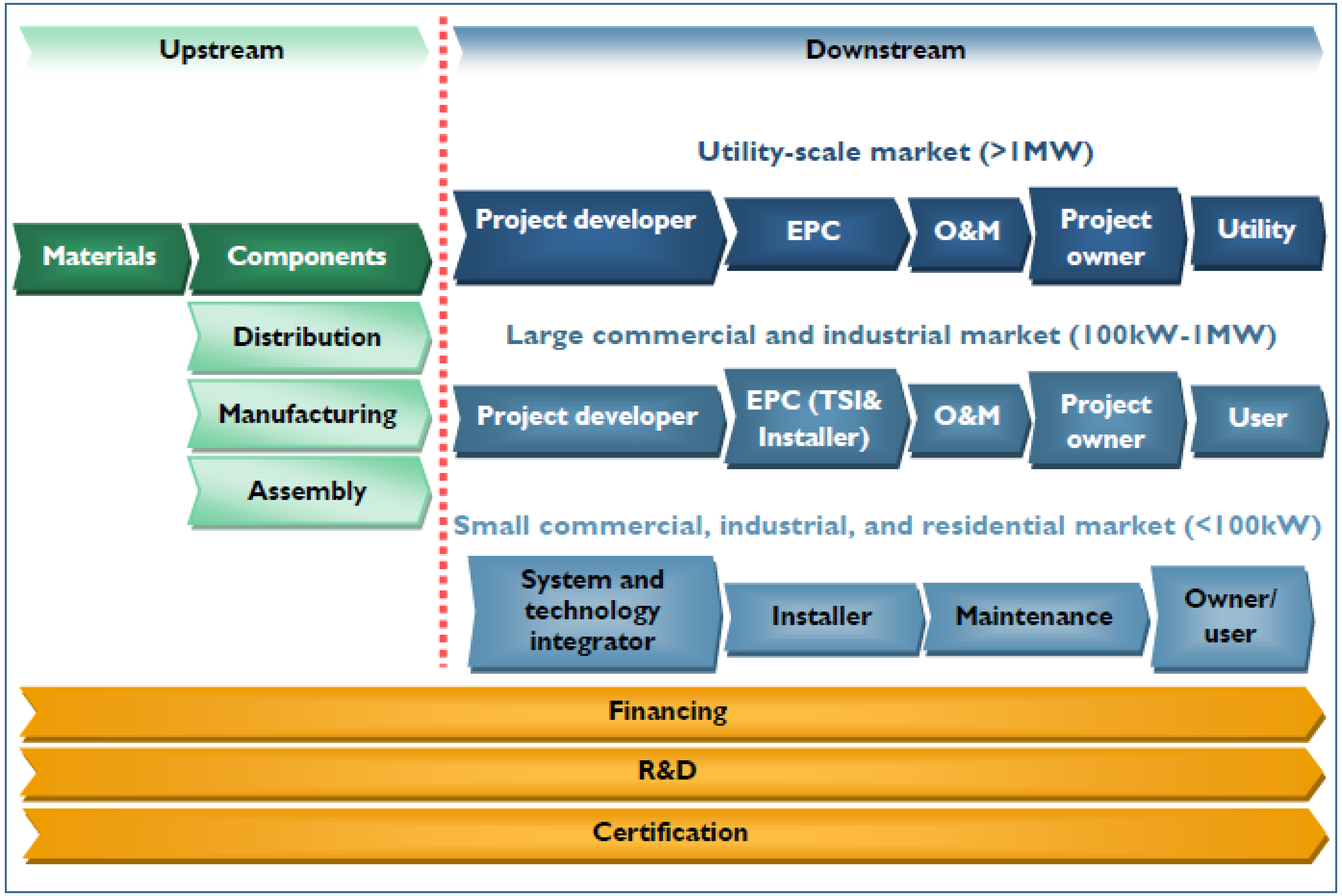
* Note: tower data excludes concrete towers and may be optimistic given increase in turbine size

- The feasibility of above localisation and potential rate of localisation needs to be determined (given, among others, current global value chain dynamics, entry barriers and estimated ease of localisation of the various components)
- A period of 3-5 years is expected from importation of nacelle to local production of some to all of components
- It is general acknowledged that it takes 3-4 years local supplier of critical renewable energy components to be able to deliver at the expected quality

Status of industrialisation in South Africa: solar PV (1)

Much of South Africa's local capacity is in the downstream stages of the value chain, particularly in the large scale commercial and industrial market (100kW – 1 MW) and small scale commercial, industrial and residential market (<100 kW) (EScience et al. 2013)

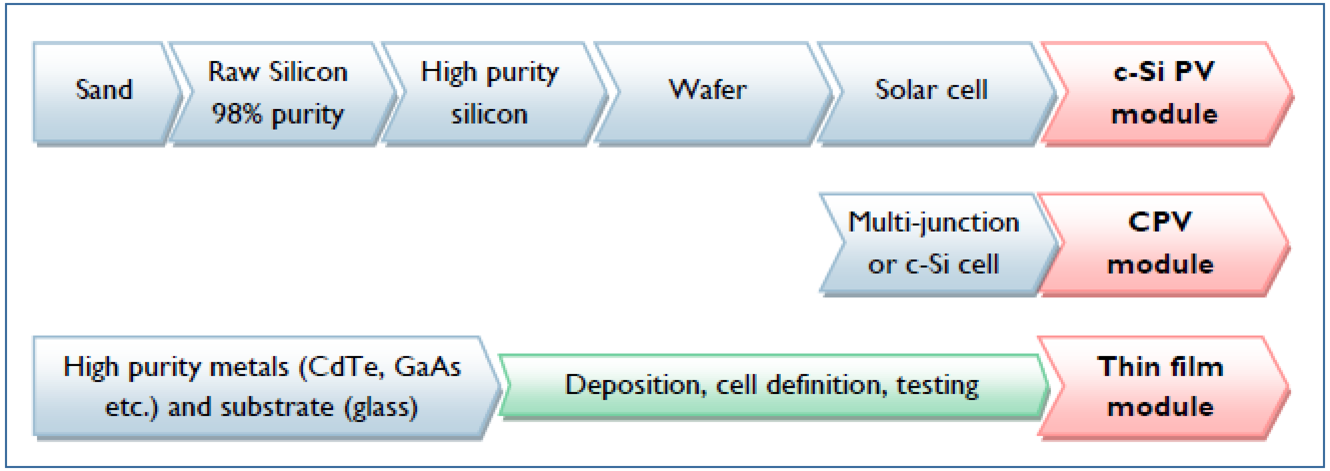
Solar value chain (EScience et al. 2013)



Opportunities for industrialisation in South Africa: solar PV (1)

Sustained demand of at least 300 MW/year is required to justify investment in module manufacturing.
Crystalline silicon (c-Si) modules are more readily produced locally than other types due to the more fragmented nature of the value chain, but forward integration of solar PV value chains presents a barrier to local manufacturing.

PV Module value chain (EScience et al. 2013)



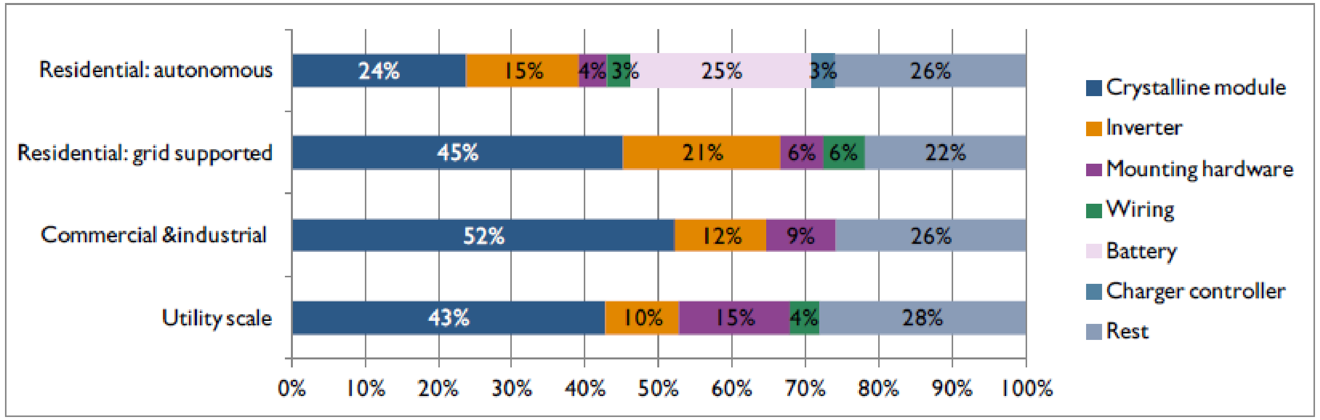
Localisation challenges (EScience et al. 2013):

- Value chains are forward integrated even up to EPC level. This limits the ability for local manufacturing especially at utility and large commercial & industrial scale.
- Tier 1 suppliers invest considerably in R&D on process and product for efficiency and quality to retain competitiveness
- Crystalline silicon (c-Si) PV module manufacturing is more fragmented so there is a greater opportunity than concentrator photovoltaics (CPV) and especially thin film modules, which are produced in a one step process.
- Investment into manufacturing of thin film manufacturing capacity is of the order of ten times more expensive than c-Si PV manufacturing capacity.
- Sustained demand of at least 300 MW/year is required to justify investment in module manufacturing and backward linkages (cells, other components)
- There is a risk of non-Tier 1 manufacturers setting up to access emerging markets and thus overcrowd market with low quality modules.

Opportunities for industrialisation: solar PV (2)

Breakdown of main cost components of developing solar project

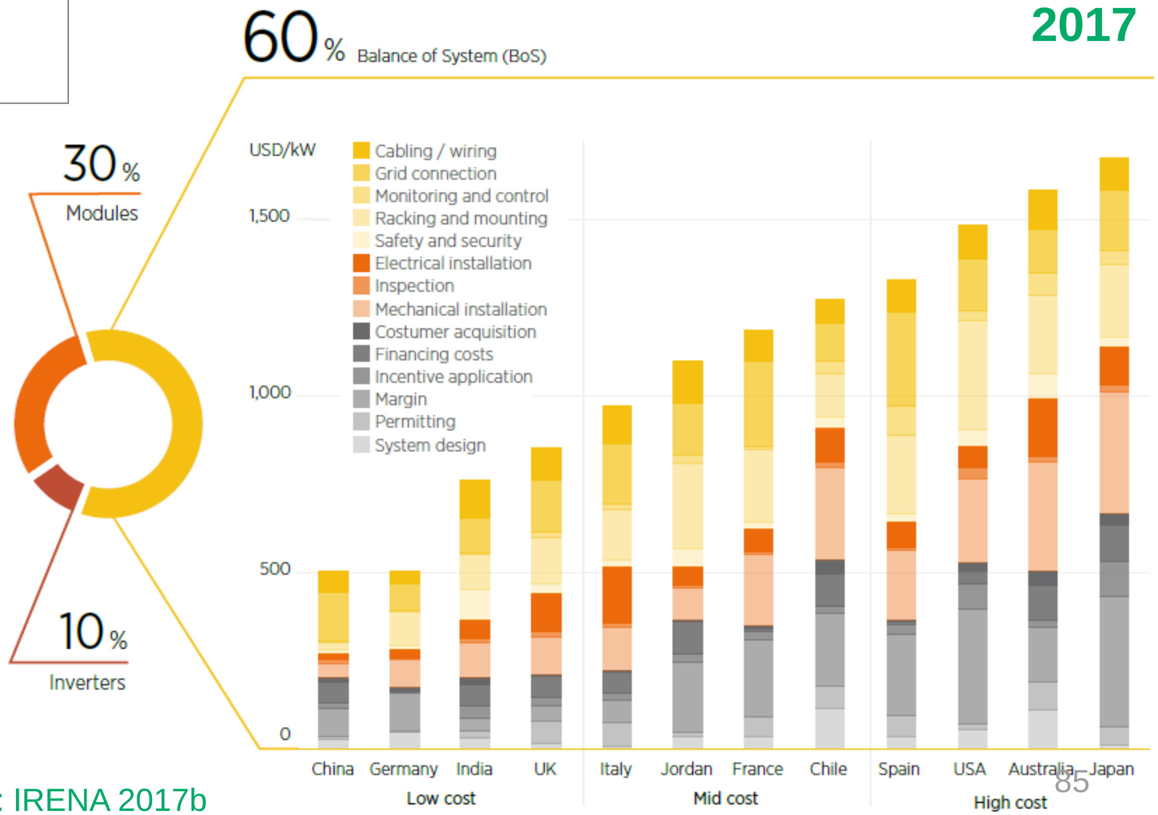
2013



Source: EScience et al. (2013)

A breakdown of the main cost components gives a sense of the relative scale of financial and economic benefit in localising particular components. Modules and converters contribute about 40-50% of the capital cost with modules making up the about 75 – 80% of this contribution.

2017

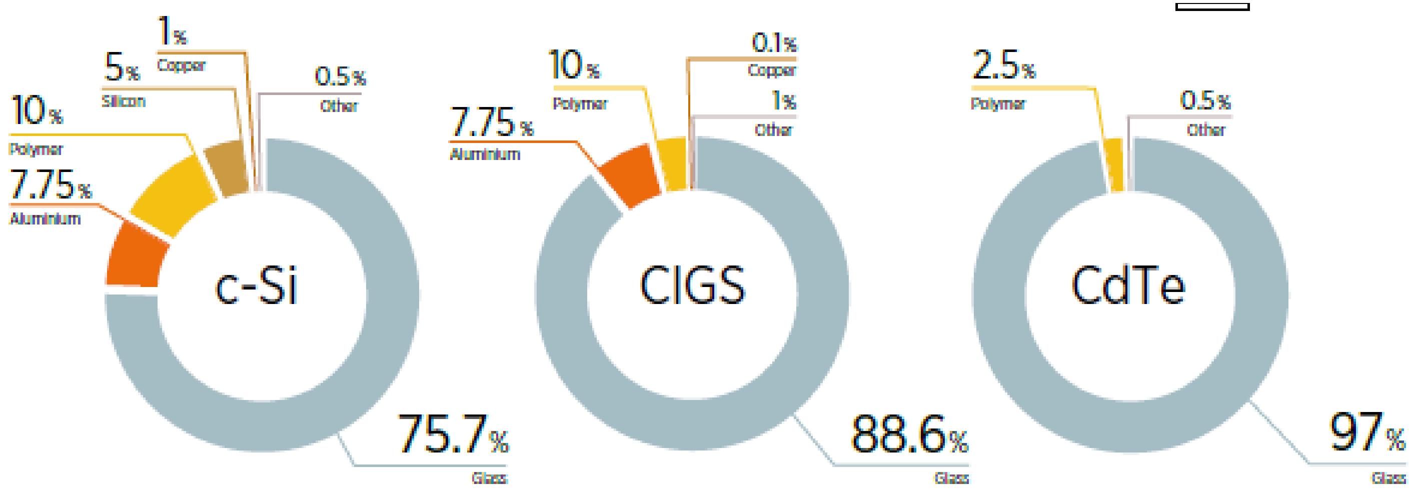


Source: IRENA 2017b

Opportunities for industrialisation: solar PV (3)

The production of solar PV components locally is also an enabler for the growth of local material supply chains. Glass, steel, concrete and aluminium are some of the largest, but not the only, material inputs to solar modules.

Types of material inputs to solar PV (% by weight) (IRENA 2017b)

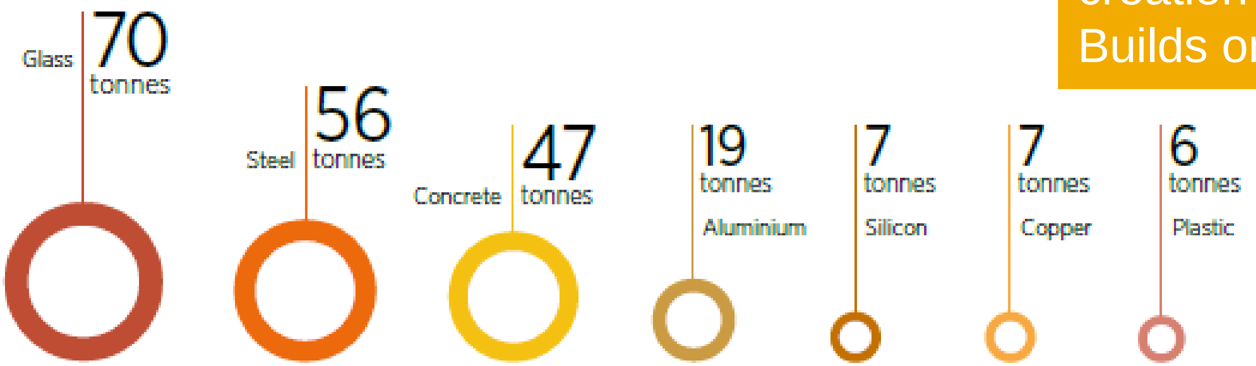


Source: IRENA and IEA-PVPS, 2016

Example of material value chain opportunity

If using local steel in PV plants for the IRP2019 build of 1000 MW/year from 2022, it could increase annual steel production in South Africa by an estimated 1%. adding R 0.5 billion to GDP annually and enabling a spend of R 28 million with SMMEs and the creation of 168 new jobs.[1]
Builds only occur 2023/24/25/28/29/30

Materials needed to develop a 1 MW silicon based PV plant (tonnes) (IRENA 2017b)



Source: Results of surveys and questionnaires conducted for this study.

1. Estimate based on IRENA (2017b) (LHS) and South African Iron and Steel Institute factors per 1000 tonne steel (Engineering News, 2020)

Opportunities for industrialisation in South Africa: solar PV (4)

South Africa has manufacturing capability in crystalline silicon (c-Si) modules, aluminium frames and junction boxes, and a solar cell manufacturing facility is expected to be complete in April 2021.

Status of local manufacturing for C-Si PV Modules

2013

Component	Average cost breakdown	General procurement practice
C-Si PV module		
Silicon cell	53.8%	Imported, no manufacturers in South Africa
Lamination	13.4%	100% local content due to the use of local labour
Aluminium frame	6.7%	Local
Supersubstrate (glass)	5.2%	Imported
EVA	4.3%	Imported
Backing sheet	5.3%	Imported
Wiring (copper ribbon)	3.1%	Imported
Junction box	4.3%	Imported and local
Other	3.9%	Local
TOTAL	**100%**	-

Potential	Local content of c-Si PV modules	Components
Current level	23.9%	• Lamination • Aluminium frame • Packaging • Transportation
Short- term potential	29.1%	• Supersubstrate (glass)
Medium to long-term potential	84.3%	• Silicon cell (min 300MW annual capacity) • Junction box • Copper ribbon

Source: EScience et al. (2013).

2020

Component	Status	Capacity
Modules	Established (2 factories)	1000 MW (by Feb 2021)
Cells	Established (I factory)	500 MW (by Apr 2021)
Aluminium frame	Established	tbd
Junction box	Established	tbd

The current manufacturing capacity for C-Si PV modules matches the annual demand in the IRP2019. However, 50% of this is for one OEM, while the other is toll manufacturing that could accommodate more than one OEM. This suggests there could be some additional potential for module manufacturing, but the business case may not be strong based on local demand only (possibly < 300 MW/year).

Opportunities for industrialisation in South Africa: solar PV (5)

There may be additional local manufacturing opportunities through the expansion of aluminium module frame and junction box manufacturing facilities. The localisation of glass would need substantial investment and may come with a considerable price premium due to the high iron content of South African silicon.

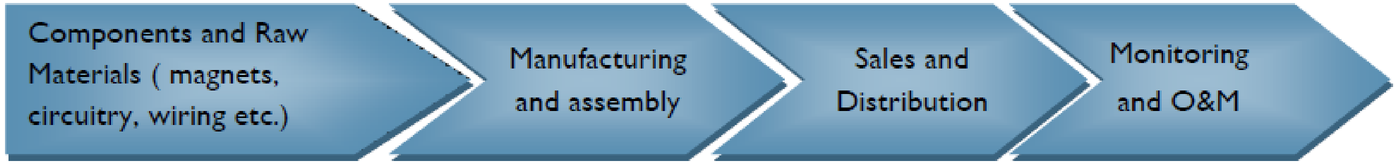
Potential for local manufacturing for C-Si PV Modules (EScience et al. 2013)

Component	Localisation Potential	Comments
Silicon Cell	Medium	• Highly competitive industry with current oversupply globally • Tier 1 companies forward integrated (only supply to companies making own PV modules) • 200-500 MW / year for 5 years required to justify investment
Aluminium Frame	Established (but not extensively utilised)	• Local module manufacturers import rather than source locally due to cost • Local producer needs economies of scale (increased demand) to reduce cost
Supersubstrate: glass	Medium-high	• 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
Ethylene Vinyl Acetate (EVA)	Low	• Concentrated supply chain limiting opportunity for local manufacturing • Some potential if large demand/economies of scale
Backing sheet	Low	• Concentrated supply chain limiting opportunity for local manufacturing
Wiring (copper ribbon)	Medium	• Local copper uncompetitive (quality and cost due to economies of scale)
Junction boxes	Medium	• Some smaller scale manufacturing established • Requires about 300 MW/year demand to justify investment in local production
Other (packaging)	Established	-

Opportunities for industrialisation in South Africa: solar PV (6)

Inverter supply is a highlight competitive international market. Tier 1 companies invest considerably in R&D to improve efficiency and ensure reliability. Rigorous testing and certification is required. There is thus a considerably entry barrier for local producers and challenges to become competitive..

Inverter value chain (EScience et al. 2013)



Localisation challenges: (EScience et al. 2013)

- Highly competitive international market
- High requirement for efficiency and reliability
- Tier 1 suppliers invest considerably in R&D on process and product for efficiency and reliability
- Local producers have experience at small and medium scale, but not utility scale, but are not cost competitive.
- At least three inverter manufacturing facilities set up in last decade – two international companies, one local company producing under licence.
- Stalling of REIPPPP lead to closure of utility scale inverter manufacturing facilities – reduced confidence in local market

Opportunities for industrialisation in South Africa: solar PV (7)

Inverter-unit assembly with core imported products and some local components, as well as manufacturing under licence, have been achieved before, but requires reestablishment and rebuilding of the confidence of international suppliers to re-enter the local market and support to local producers to meet quality standards and access testing and certification locally.

Large/utility >100 kW **Medium 26-99 kW**
Small <25 kW

2020

Component	% of Total Inverter Cost (Large-Scale)	% of Total Inverter Cost (Medium & Small-Scale)
Magnetics and Transformers	32%	30%
Power Stage and Power Electronics	16%	30%
Enclosure and Packaging	11%	5%
Printed Circuit Board/Misc Parts	23%	15%
Assembly, Production and Testing	18%	20%
TOTAL	100%	100%

Potential	Local content of inverters	Components
Current level	35-75%	• Enclosure and packaging • Assembly, production, and testing • Some companies already source magnetics locally so have a higher %
Short-medium term potential	55-75%	• Magnetics and transformers
Long-term potential	60-85%	• Printed Circuit Boards (some manufacturers already source locally assembled PCBs)

Source: EScience et al. (2013).

Two local manufacturers at small and medium scale.

At least three producers of utility scale inverters closed factories/discontinued production.

Opportunities for industrialisation in South Africa: solar PV (8)

Localisation potential of inverter components 2013

Table 3-12: Localisation potential of Key Inverter Components (Uses Average Cost data for 500-630kW inverter)

Component	Localisation potential	Enablers and barriers to entry
Magnetics and transformers	High	**Enablers** • Some manufacturers already source magnetics locally especially for small/medium-scale inverters • Significant impact on total inverter costs **Barriers** • Steel (~10% of total cost) and copper materials are often imported by local suppliers • Limited availability of mill equipment to make magnetics from steel in South Africa • Large-scale utility projects often require optimal efficiency so international products are given priority to minimise losses
Power stage and power electronics	Low	**Barriers** • Quality issues • Limited local manufacturing of power and semiconductor equipment currently (currently requires ~70% imported content)
Enclosure and packaging	High	**Enablers** • Some manufacturers already source locally • Can be expensive to ship internationally for large-scale inverters (size and weight issues) **Barriers** • Some suppliers prefer preassembled packaging especially for small-scale applications
Printed Circuit Board/Misc Parts	Medium	**Enablers** • Some suppliers already make PCBs locally (66% cost from local labour, electricity, and machining) with imported materials (34% of total costs) **Barriers** • Local suppliers have to compete with competitive international prices and labour costs
Assembly, production and testing	Existing capability	**Enablers** • Most manufacturers already source locally

Source: Interviews with inverter manufacturers and suppliers

Magnetics and transformer capability can be expanded through reductions in raw material costs (especially steel), additional milling capacity for magnets and improvement in efficiencies of local transformers to meet the standards expected by international inverter manufacturers.

There is also potential for expansion of enclosure and packaging production.

Source: EScience et al. (2013).

Opportunities for industrialisation in South Africa: solar PV (9)

Mounting structures are more readily localised due to the high cost of transport, but are relatively lower value components of a solar PV system.

Mounting Structures – Market trends

2013 2020

Item	Large commercial and industrial	
	Utility-scale	Small residential
Common materials used	• Steel and aluminium	• Rooftop: Aluminium and stainless steel • Pole-mounted: galvanised steel
Suppliers	• Many EPC contractors source imported mounting structures • Some international companies established local branches/facilities • Pia Solar and Reutech – local manufacture of tracker systems	• Rooftop: mostly imported, as is has the optimal combination of product flexibility, price, and quality; local companies are used in rare cases and mounting structures are then manufactured for the specific project • Pole-mounted: produced locally
Procurement challenges	• Both steel coil and aluminium are very expensive in South Africa • Due to high input costs, locally manufactured mounting structures are generally more expensive than imported ones	• International companies with local presence do not always carry stock or require purchase of an entire set in bulk • Installers do not have financial means to buy in sets and in bulk and in many cases certain items are not used at all

Source: EScience et al. (2013).

Challenges

- Localisation expected due to being relatively low value, high cost to transport component, but cost of local steel and aluminium still limiting local production.
- Requires adaptable manufacturing to respond to site or project specific requirements.

Opportunities for industrialisation in South Africa: solar PV (10)

Local manufacturing is done by local producers and local suppliers supported by international brand owners, but cost of input materials (steel and aluminium) makes local production not cost competitive.

Mounting Structures (EScience et al. 2013)

2013

Item	Aluminium structures	Steel structures
International products	• SunFix (ground of flat roof mounting) • SunTab (flat roof mounting)	• None known
Local capabilities	• PowerWay • Schletter • PIA Solar • Tenesol, Sol… …hers by out… …tion to local man… …urers Discontinued	• MacSteel • Robor • Trident • Sentinel • PIA Solar – Tracker systems • Reutech – Tracker Systems
Key features	• Mostly specialised companies with a focus on solar mounting structures • Some companies also design their own system and outsource production, while others outsource both the design and production	• Multi-sector specialisation • Solar mounting structures provide a small revenue stream

2020

Several local companies provide aluminium and steel sub-components. Not considered to be cost competitive.

At least one international company known to use local suppliers and supporting with tooling and capacity building.

Some export of locally produced tracker systems[1]

Established local suppliers of fastenings (nuts and bolts)

1. Reutech

Opportunities for industrialisation in South Africa: solar PV (11)

Addressing raw material (i.e. steel and aluminium) costs could open the way for more local mounting structure manufacturing. Support for tooling, additional aluminium extrusion capacity and building capability for adaptable manufacturing could also assist local producers to be more competitive.

Mounting Structures – Localisation Potential (EScience et al. 2013)

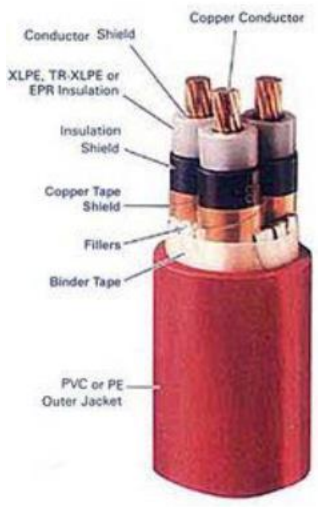
Component	Localisation Potential	Comments
Steel profile	Established	• Existing capacity in flat, rolled and stainless steel • Strong presence of imported steel from China, Taiwan & Korea • Local steel prices formerly at import parity or more expensive • Concerns about ability of local steel industry to meet demand (quality and quantity) for 100% local sourcing of steel in industry
Aluminium profile	High, but billets for extrusion (75% of content) typically imported	• Some, but limited extrusion capability in South Africa; • No dedicated extrusion capacity thus can cause production delays due to seasonality of other demand • Local aluminium prices formerly at import parity or more expensive
Clamps	Low	• Highly specialised • Sourced by parent companies from established manufacturing elsewhere
Nuts and bolts	Established	• Some local supply (part of business not dedicated)

Opportunities for industrialisation in South Africa: solar PV (12)

There is established local production of cables due to use of cables in other sectors, but local suppliers face competition from imported cables and need to build confidence of international OEMs and finance providers.

Cables – Composition (EScience et al. 2013)

Single core DC cable
Runs between modules, junction box and inverters
Needs to be waterproof and UV resistant



Three – five core AC cable
Runs between inverter and grid
Needs to be weatherproof

Source: EScience et al. (2013).

Market trends and challenges EScience et al. (2013)

- Cable production in South Africa fluctuates – dependent on electricity, mining and telecoms infrastructure builds
- Renewable energy industry not seen as core business
- Generally import raw materials (copper (50%), aluminium, insulation (some local))
- Local content varied between 20 – 70% (2013)
- Competition from imported cables – either subsidised or substandard ("cable dumping" by Asian manufacturers)

Opportunities for industrialisation in South Africa: solar PV (13)

Conductors constitute the largest portion of cable cost, followed by insulation and armour. Production of all of these components is established locally.- . .

Cables

Cost breakdown (EScience et al. 2013)

Component	Large scale	Small-medium scale
Conductors (copper rods ,aluminium rods)	60%-80%	60%-80%
Insulation (polymers)	10%-30%	10%-20%
Armour (steel)	5%-20%	0%-20%
Assembly, production and testing	Balance	Balance
TOTAL	100%	100%

Opportunities for industrialisation in South Africa: solar PV (14)

There is much potential for further localisation of conductors, insulation, and armour, but input material prices (steel, aluminium and polymers) need to be addressed. Local aluminium rod production could be a boost to local cable production. .

Cables– Localisation Potential (EScience et al. 2013)

Component	Localisation Potential	Comments
Conductors (copper rods, aluminium rods)	Established High potential for further localisation	• Relatively good backward integration (i.e. sourcing components locally) • Aluminium imported; local aluminium rod production would boost localisation potential of cables • Copper imported when local supply inadequate
Insulation (polymers)	Established High potential for further localisation	• Cost of polymers • Challenging to remain globally competitive due to technology development (requires investment in manufacturing)
Armour(steel)	High potential Some local sourcing	• Existing capacity in flat, rolled and stainless steel • Strong presence of imported steel from China, Taiwan & Korea • Local steel prices more expensive
DC cable connectors	Medium	• Highlight specialised component • Innovation required to enable competitive advantage – Design and quality for minimum losses – Design for tool-free assembly
Assembly, production and testing	Established	• Most manufacturers source locally

Price premium of local manufacturing: wind & solar PV (1)

Price premiums for local production of components varies from 5- 20% for utility scale wind and 5 – 60% for utility scale solar PV components. For wind full localisation at 2013 prices was estimated to add 0.01 R/kWh to the electricity price.

Price premiums for local manufacturing of components (EScience et al. 2013, Urban-Econ & EScience 2015)

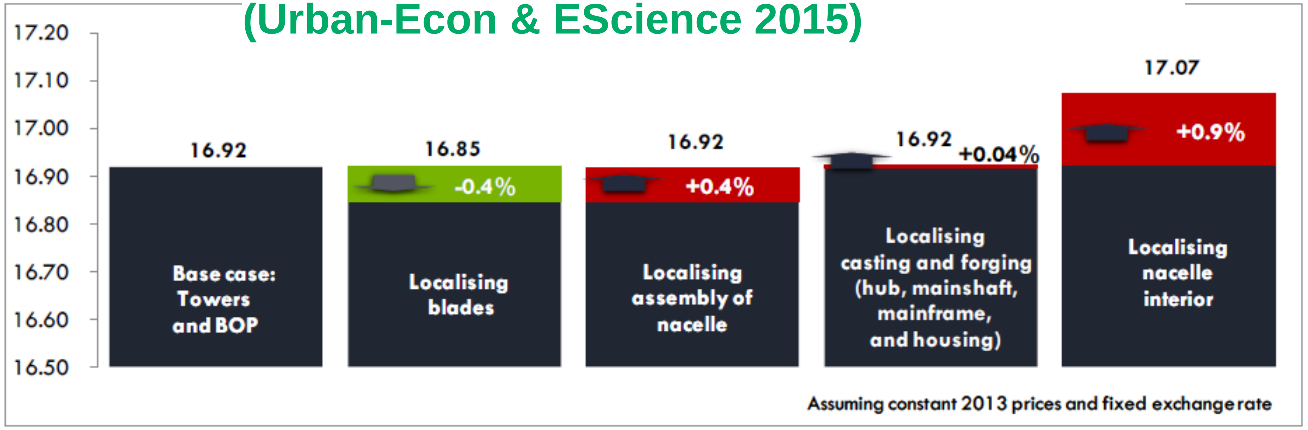
Utility Scale Wind (2015)		Solar PV (2013)	
Component	**Local Premium**	**Component**	**Local Premium**
Blade	5%	C-SI PV module	8-12%
Nacelle Assembly	20%	Inverter (small – medium scale)	Up to 60%
Nacelle Housing	20%	DC Cable	10-20%
Nacelle Interior	-	AC Cable	5-10%

Utility scale wind (2015)

The cost of full localisation assuming 2013 prices and market conditions:

- expected increase of **0.9% per MW** of wind energy developed
- estimated to lead to a price increase of **0.01 R/kWh** (based on the tariff for BW3)
- Excludes cost savings on shipping of components

Cost of wind localisation & price implications (Urban-Econ & EScience 2015)



Industry interviews (2020)

- Wind Turbine: 15- 20% increase
- Blades: 15-20%
- Cables: 20%

Price premium of local manufacturing: wind & solar PV (2)

Estimates of the price premium for local content across the full value chain and individual value chain components vary widely making it difficult to assess the likely impact. A research study through South African Wind Energy Programme (SAWEP) has been commissioned to examine this in greater depth.

Wider value chain cost premiums in REIPPPP

In a survey of IPPs and EPCs that participated in the REIPPPP, estimated average increase due to local content requirements was **9.89%** (Ettmayr and Lloyd 2017), albeit that not all of this could necessarily be attributed to local manufacturing of components.

Industry interviews (2020)

- Use of local EPC: 25% more expensive

Cost premium of local content on REIPPPP (Kaziboni and Stern 2020)

Stakeholder	Cost change, %	Explanation	Pricing response
Developer	Increase by 25% - 30%	Not due to LCRs, but retaining international experts for longer. LCR-related cost may be 10%	Partially passed onto the IPP
O&M	None	No LCR at the operations phase	N/A
EPC (1)	Increase by 15% to 20%	High cost of sourcing local parts, components, equipment, and machinery	Fully passed on to the IPP
EPC (2)	Increase by 15% to 20%	Compliance costs related to BEE and Economic Development, including sourcing from local suppliers	Absorbs the cost
OEM	Increase by 40%	High cost of sourcing local goods and services, and lack of price competition	Limited cost pass through due to competitive bidding process
Service provider	Increase by 10%	High cost of doing business in SA, which includes setting up, BEE compliance and LCRs	Developing cost structure that passes on the costs to the OEM
Tier 1 (1)	Increase by 18% to 40%	High cost of sourcing local parts and components	Partially pass onto the OEM
Tier 1 (2)	Increase by 25%	Opportunity cost of failing to implement REIP4, including auction delays	Absorbed by the company

Source: Responses from semi-structured interviews

Benefits of renewable energy local manufacturing – job creation (1)

Job creation along the full wind and solar PV value chain is a key benefit of deploying these renewable energy technologies. However the estimation, reporting and comparison of job creation opportunities and impacts is complicated as the nature of jobs during the construction and installation, manufacturing, operation and maintenance differ in nature (e.g. full time on one site, moving from site to site etc.). The units person-days, job-years and full time equivalent (FTE) are used to make these comparable but do not correspond to the more intuitive sense of a job / headcount.

Normalised comparison of jobs for utility scale renewables (Szewczuk et al. 2010)

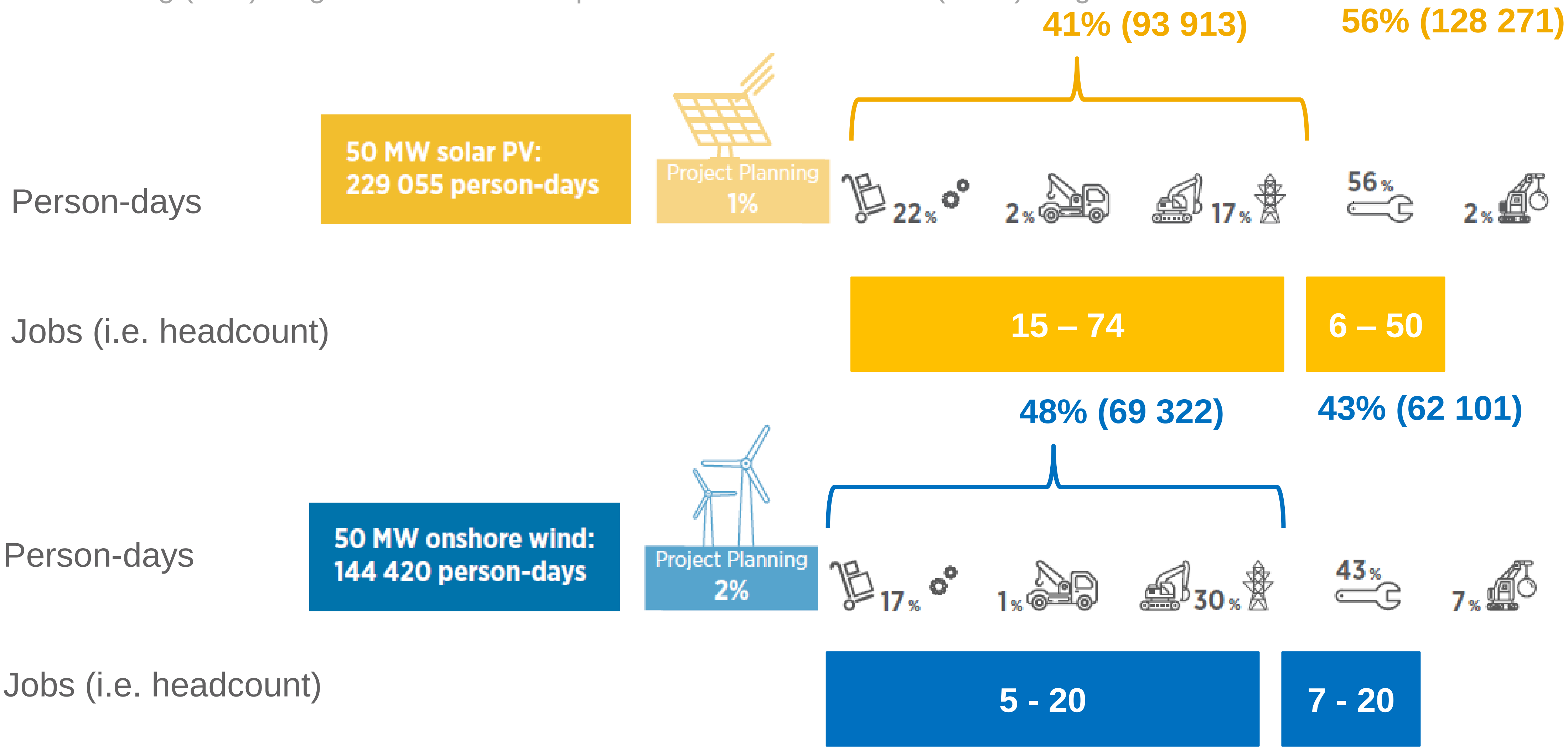
	Employment components		Ranges of employment over life of facility			
			Total jobs/MWp		Total jobs/MWa	
	CIM (job-years/MWp)	O&M (jobs/MWp)	CIM	O&M	CIM	O&A
PV	7.14-37.0	0.12-1.00	0.29-1.48	0.12-1.00	1.43-7.40	0.60-5.00
Solar (CSP trough)	4.50-10.31	0.22-1.00	0.18-0.41	0.22-1.00	0.45-1.03	0.6-5.00
Nuclear	15.20	0.70	0.38	0.70	0.42	0.78
Wind	2.57-10.96	O.14-0.4	0.1-0.4	0.14-0.4	0.29-1.25	0.50-1.14

Job years are defined as the equivalent of a full time employment opportunity for one person for one year with a defined number of working hours per month. For REIPPPP reporting, a particular definition is used to convert from the reporting unit (person months) to job years and ultimately to fully time equivalents (FTEs).

See REIPPPP quarterly reporting available from https://www.ipp-projects.co.za/Publications

Benefits of renewable energy local manufacturing – job creation (2)

Manufacturing contributes 22% and 17% of the jobs (in terms of person-days) in solar PV and wind value chains respectively. Compared to wind value chains, solar PV value chains appears to be more labour intensive in the construction, installation and manufacturing (CIM) stages as well as the operation and maintenance (OEM) stages of the value chain.



Source: IRENA (2017a & 2019b) for person-days & Szewczuk et al. (2010) for jobs in construction, installation and manufacturing (CIM) and operations and maintenance (O&M)

Benefits of renewable energy local manufacturing – job creation (3)

If full localisation of **wind turbines** is achieved, the IRP2019 build plan is estimated to enable 4220 FTE jobs in manufacturing. However, in the shorter term the localisation of all towers may create close to 800 FTE jobs.[1]

Estimate of job creation potential for wind turbines for the IRP2019 (based on data in wind localisation study Urban-Econ & EScience 2015)

Component	Job Creation Potential (FTE)	Contribution to Total Jobs (%)
Balance of Plant	5387	56.1
Towers	220 existing 568 new	8.2
Blades	899	9.4
Nacelle Assembly	604	6.3
Nacelle Castings & Forgings	994	10.3
Nacelle Exterior		
Nacelle Interior	935	9.7
Total	**BOP: 5387 (56.1%)** **Manufacturing: 4220 (43.9%)** **Combined: 9607**	

Note: tower data excludes concrete towers and may be optimistic given increase in turbine size

1. Assuming these are all steel lowers which may not be the case as concrete towers have become well established in South Africa

Benefits of renewable energy local manufacturing – job creation (4)

For the particular scenarios modelled for the PV localisation study, manufacturing is estimated to contribute substantially for job creation (in term of FTE). However, it is worth noting that the commercial/industrial and residential sectors are expected to be substantial job creators, albeit not necessarily manufacturing jobs.

Estimate of job creation potential for different levels of adoption of solar PV (EScience et al. 2013).

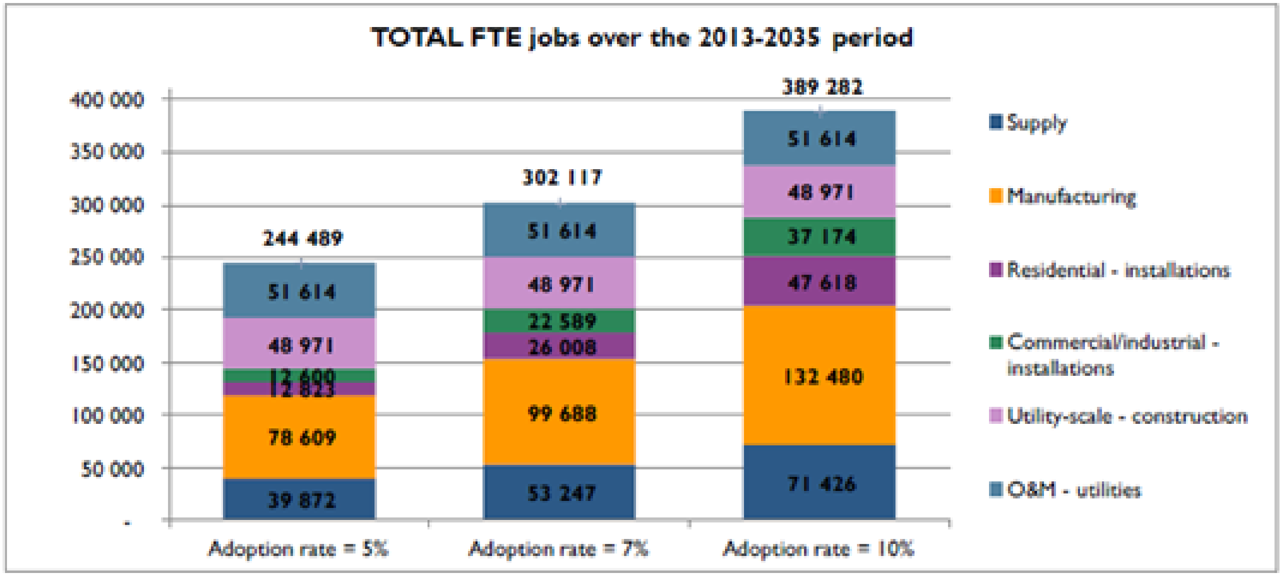
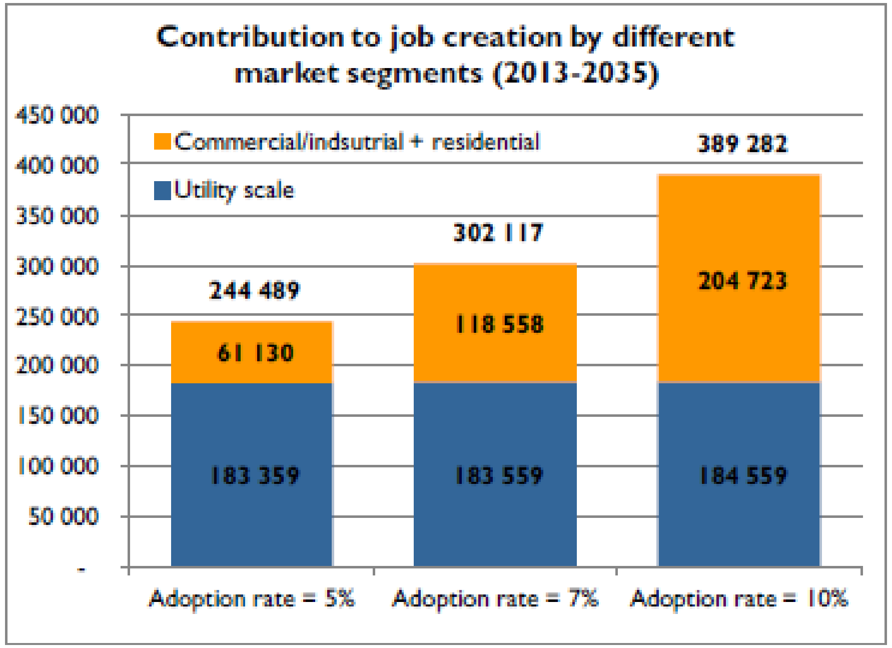


Figure 2-14: Job creation potential along the value chain for the scenario with trackers

Source: EScience et al. (2013).

Contribution to job creation by different market segments (EScience et al. 2013).



Source: EScience et al. (2013).

Small scale embedded generation (SSEG)

Status quo: small scale embedded generation (SSEG)

The small scale embedded generation market is dominated by solar PV (95%+).
70% of the market in terms of installed capacity is in the commercial and industrial sector.

Definition of small scale embedded generation

- Generation of less than 1MW
- Installed behind the electricity meter
- On a load site

Status and prospects

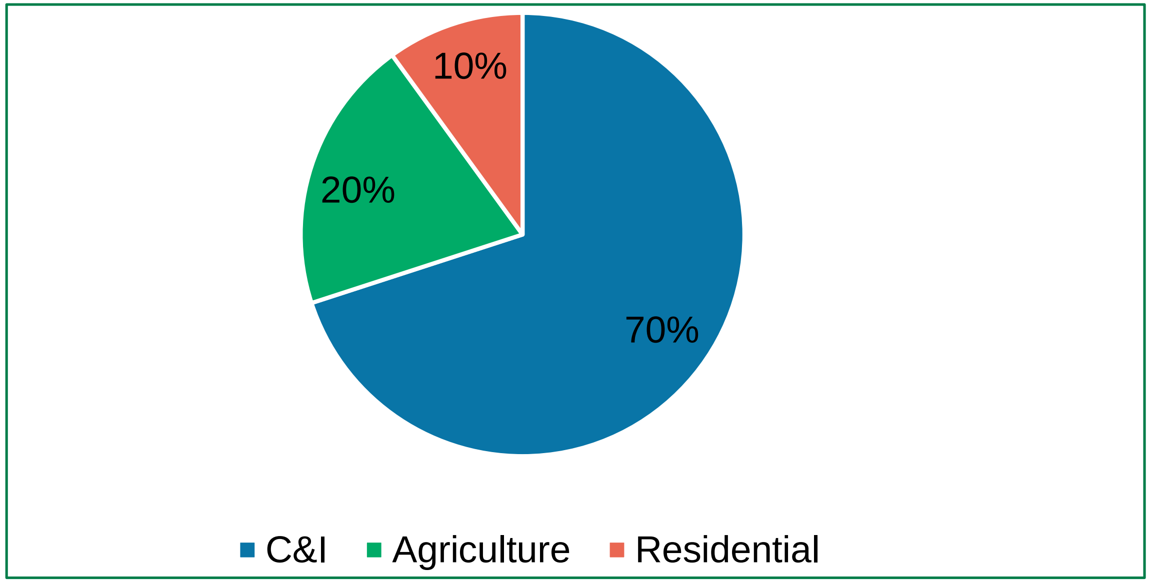
- Current installed capacity of $\pm 1GW_p$
- In the last 12 months, which includes a period of lockdown due to Covid-19, $250MW_p$ of SSEG was installed in South Africa.
- The more typical installation rate is $500MW_p$ per year.
- Estimate: 7.5 GW of installed capacity by 2035
- In terms of installed capacity, the market is split as follows: commercial and industrial sector (70%), agriculture (20%) and residential (10%).

Capital cost and tariff range for SSEG systems

kWp	The capital (kWp)	PPA tariff
< 100 kWp	R 12,000 – R 15,000	0.90c – R 1.20
< 500 kWp	R 9000 – R 13,000	0.80c – R 1.00
> 500 kWp	R 8,000 – R 12,000	0.60c – 0.90c

Source: GreenCape (2020)

SSEG market segmentation



Source: GreenCape analysis

SSEG: Solar PV local component manufacturing (1)

The SSEG market is driven private sector demand and decisions are made on price. There is less than 5% local content in SSEG systems.

- The PV modules, inverters and mounting make up more than 70% of the system cost

Capital cost for components in SSEG systems

Component	<100kWp (R/kWp)	100kWp to 500kWp (R/kWp)	>500kWp (R/kWp)
PV modules	4000 – 7500	4200 – 5500	4000 – 5100
Metering	150 – 350	50 - 200	30 – 200
Protection and switches	450 – 2700	350 – 2500	350 – 2000
Inverter	950 – 1500	700 – 2400	700 – 2000
Mounting and Structures	450 – 1700	400 – 2000	400 – 1700
Engineering	150 – 850	70 – 1500	40 – 1000
Construction	500 - 2000	750 - 1500	650 - 1200

Source: GreenCape analysis

SSEG: Solar PV local component manufacturing (2)

South Africa is primarily producing the balance of system inputs into local rooftop solar PV.

.

Status of local manufacturing for SSEG components

Components	Manufactured locally at scale for SSEG market
PV modules	No
Metering	No
Protection and switches	Yes
Inverter	Yes[1]
Mounting and Structures	Yes
Wiring	Yes
Balance of system[2]	Some

Source: GreenCape analysis

1. There are two local inverter companies doing small inverters. The size of the inverters produced range from from 1-12 kW (Microcare) and 4 – 500 kW (MLT drives (EScience et al., 2013).
2. Balance of Systems products include: DC/AC disconnects, junction boxes, combiner boxes, circuit breakers, fuses, load centres, rapid shutdowns, surge devices.

SSEG: small scale wind opportunity and local manufacturing

There is a very limited small scale wind market locally, as small scale wind struggles to compete with solar PV on price and ease of implementation. However, there is one South African company is manufacturing primarily for the export market.

- Small turbines of 60kW have been installed by a small German company (Windstrom) in 2016.
- The Viking group (aquaculture) has installed 2 x approx. 800kW in the Western Cape

The Kestrel Wind is a local manufacturer and market leader

- Production is primarily for export to other countries
- Grid-connected solution is available in e300i (1KW) and e400i (3kW) 250V DC system sizing.

kWp	The capital (kWp)
10 – 20 kWp	R 30,000 – R 45,000
21 - 200	R 20, 000 – R 30, 000

Source: GreenCape analysis

Regulations and technical standards in South Africa are designed around solar PV. **(NRS097, municipal grid connection, Environmental Impact Assessment (EIA))**

Status of industrialisation in South Africa: battery storage

Four key opportunities for local manufacturing in the lithium-ion batteries value chain have been identified. .

- An extensive localisation study for the lithium ion battery value chain has been done by Trade and Industrial Policy Strategies (TIPS).
- This is due for completion December 2020 and publication in January 2021.
- Insights from this study will be incorporated when available.

Country comparisons

Supporting information for general insights

Support mechanisms for the development of renewable energy (1)

There are a range of supporting mechanisms that enable the growth of local renewable energy markets at different scales and could thus catalyse local renewable energy manufacturing.

Types of renewable energy policies and measures adopted globally (IRENA, 2017c)

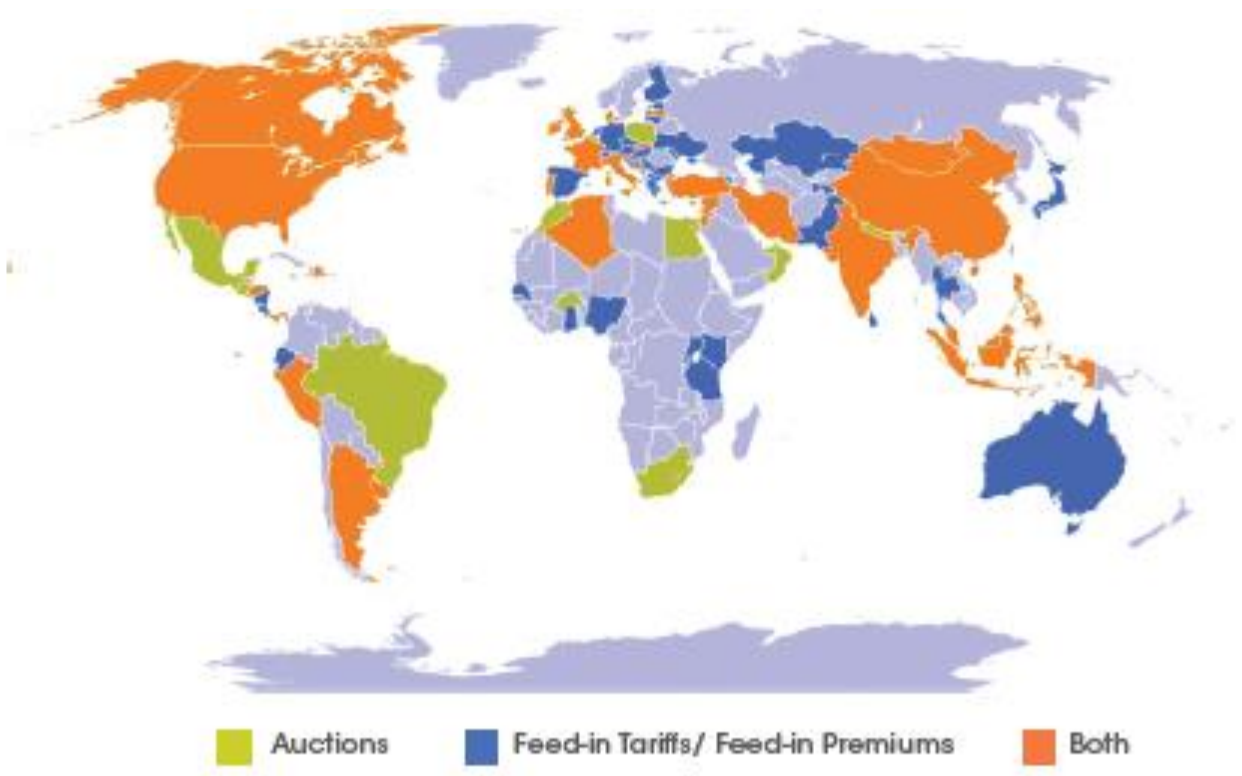
NATIONAL POLICY	REGULATORY INSTRUMENTS	FISCAL INCENTIVES	GRID ACCESS	ACCESS TO FINANCE[a]	SOCIO-ECONOMIC BENEFITS[b]
◆ Renewable energy target ◆ Renewable energy law/ strategy ◆ Technology-specific law/ programme	◆ Feed-in tariff ◆ Feed-in premium ◆ Auction ◆ Quota ◆ Certificate system ◆ Net metering ◆ Mandate (*e.g.*, blending mandate) ◆ Registry	◆ VAT/ fuel tax/ income tax exemption ◆ Import/export fiscal benefit ◆ National exemption of local taxes ◆ Carbon tax ◆ Accelerated depreciation ◆ Other fiscal benefits	◆ Transmission discount/ exemption ◆ Priority/ dedicated transmission ◆ Grid access ◆ Preferential dispatch ◆ Other grid benefits	◆ Currency hedging ◆ Dedicated fund ◆ Eligible fund ◆ Guarantees ◆ Pre-investment support ◆ Direct funding	◆ Renewable energy in rural access/cook stove programmes ◆ Local content requirements ◆ Special environmental regulations ◆ Food and water nexus policy ◆ Social requirements

Note: a) Instruments that support access to finance are crucial for deployment, considering the high upfront cost of some renewable energy technologies, and they are discussed in Chapter 3.
b) Some policies and measures can ensure the socio-economic benefits of renewables and help fulfil development goals discussed in Chapter 6.

Support mechanisms for the development of renewable energy (2)

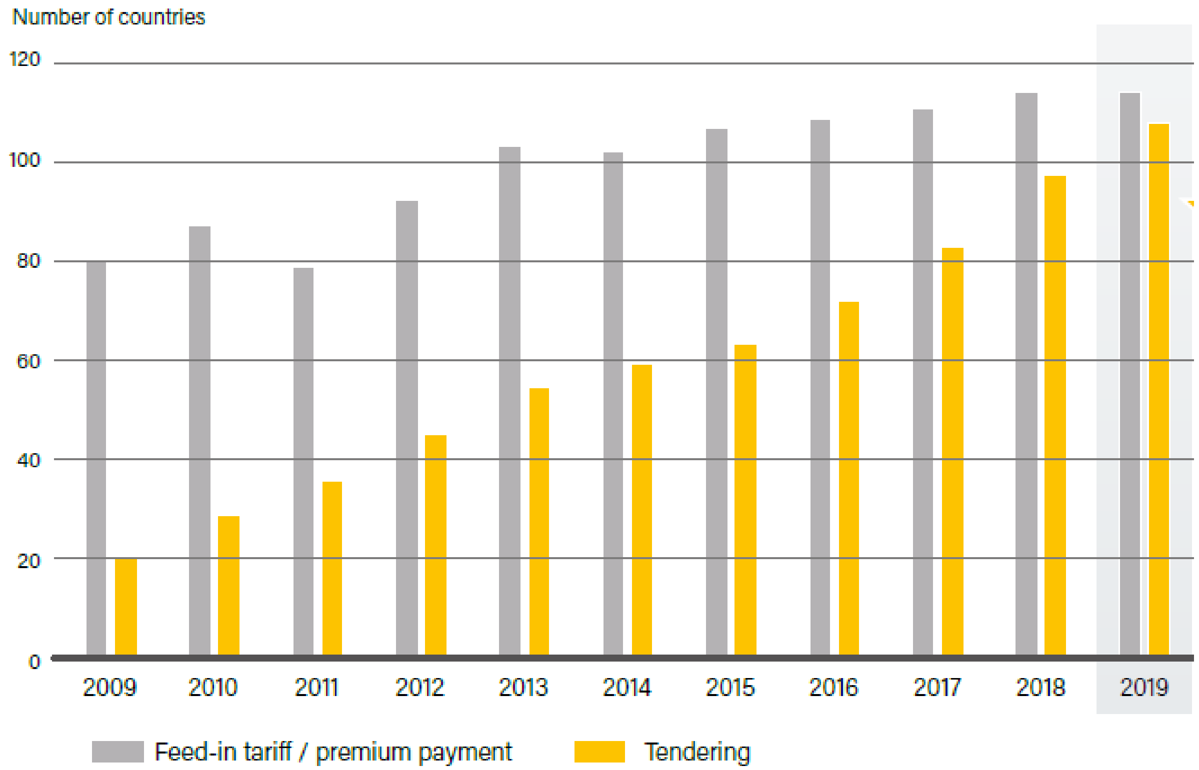
There has been an increase in the number of countries that use tenders/competitive auctions, but, in 2019 there were still more countries with feed-in tariffs than countries with auctions/tenders

Renewable energy development mechanisms globally (IRENA, 2013)



Source: based on REN21 data, 2013

Cumulative number of countries with different mechanisms (REN21, 2020)

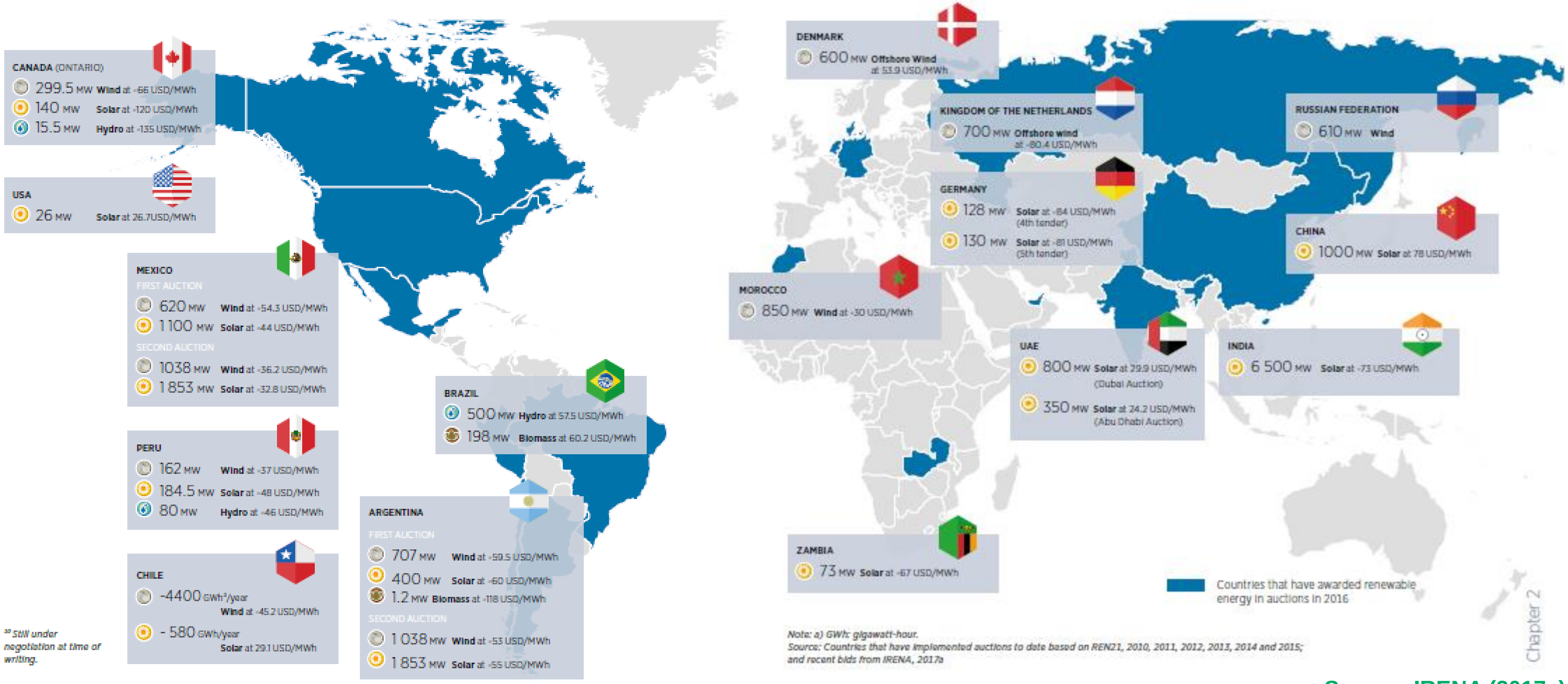


Note: A country is considered to have a policy (and is counted a single time) when it has at least one national or state/provincial-level policy. Some countries have used both policies.

Source: REN21 Policy Database. See endnote 2 for this chapter.

2016 Snapshot: scale and distribution of auctions/tenders globally

In 2016, the capacity auctioned ranged as follows: Wind: 162 – 1745 MW (Peru, Argentina); Solar 26 – 6500 MW (USA, India[1]), Hydro: 15.5 – 500 MW (Canada, Brazil), Biomass: 1.2 – 198 MW (Argentina, Brazil). The typical annual build in the IRP 2019 is Wind: 1600 MW; solar: 1000 MW



Source: IRENA (2017c)

1. Next largest were Mexico and Argentina with solar auctions for 1100+1853 = 2953 MW and 400+1853 = 2253 MW, respectively.

South African in the context of auctions in Sub-Saharan Africa (SSA)

By 2018, SA had the largest auction programme in SSA: 6300 MW multiple RE programme vs 20-100 MW individual solar PV projects[1] and most stringent LCRs (min 40% vs 5-20%) consistent with market scale, expected ability to provide products & services, and relative emphasis on cost-effective pricing (Kruger *et al*. 2018)

Main features and outcomes of renewable energy auctions in Sub-Saharan Africa (Kruger et al. 2018)

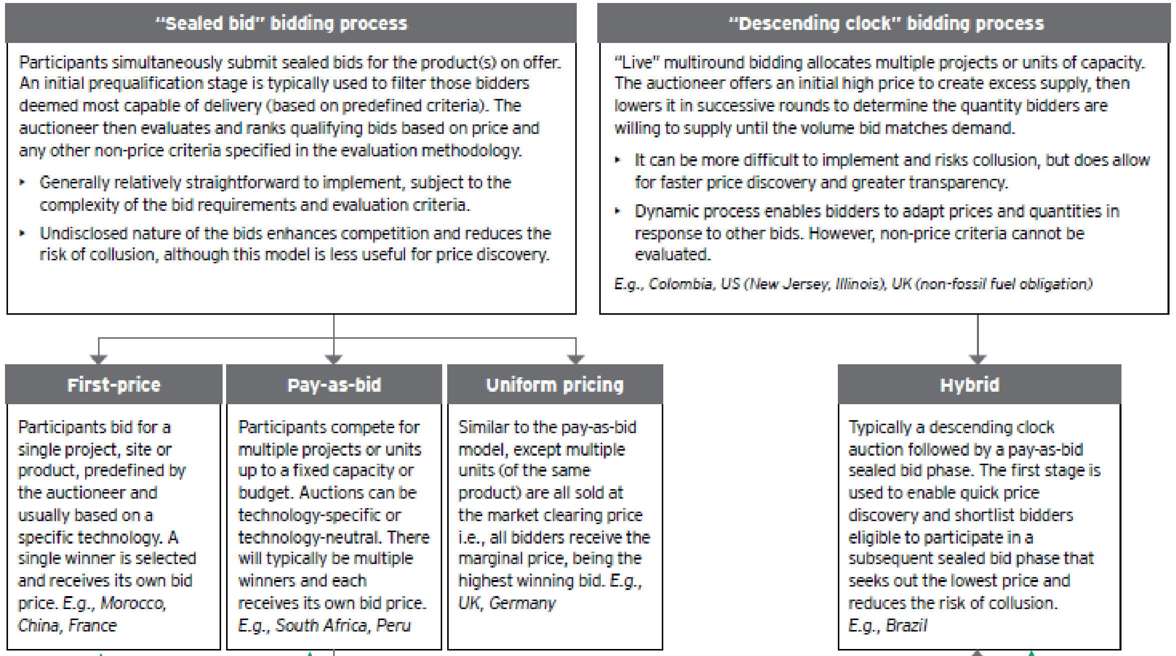
	South Africa*	Uganda*	Zambia*	Ghana	Namibia*	Malawi	Ethiopia	Senegal
Year	2011 - 2018	2014	2016	2016	2017	2017	2017	2018
Auction Demand	6,300 MW (4 rounds) Multiple RE	4 x 5 MW Solar PV	2 x 50MW Solar PV	1 x 20MW Solar PV	1 x 37 MW Solar PV	Max 80 MW Solar PV (4x sites)	1 x 100 MW Solar PV	2 x 30 MW Solar PV
Site Selection	Developer	Developer (3km - grid)	Selected by govt.	Developer (input from offtaker)	Selected by govt./ utility	Substations identified by govt.	Selected by govt.	Selected by govt.
Local Content	40% min	None	None	20%	None (but 30% local share-holding)	5% develop ment & construction 20% O&M	15%	None
Evaluation	70:30 Price: Economic Develop-ment	70:30 Price: Technical	Price	Not clear	70: 30 Price: Technical	Price	70:30 Price: Technical	Price
PPA	20 Years	20 Years	25 Years	20 Years	20 Years	25 Years	20 Years	20 Years
Guarantees	Sovereign	Sovereign & Liquidity	Sovereign & Liquidity	Sovereign & Liquidity	None	Sovereign & Liquidity	Sovereign	Sovereign & Liquidity
Winning Price (USDc/ kWh)	4,7*	16,37	6,02	11,47	6,02	7,35 – 10,35 (TBC)	Below US$c6 (TBC)	4,7
Currency	ZAR	US$/EUR	US$	US$	NA$	US$	US$	US$
Financial Close	Yes	Yes	Yes/No	No	Yes	No	No	No

1 Note: other technologies have been enabled via feed-in tariffs schemes (e.g. hydro and biomass in Uganda) and there are a number of large scale non-auction/non-FiT wind investments in SSA (e.g. Kenya, Ethiopia) where procurement has been done through mechanisms such as direct negotiations

Auction types, design considerations and trade-offs

Many factors need consideration in auction design leading to great variability in auctions globally. Auction design is thus important when comparing the approach to and relative success of establishing local manufacturing in different countries via auctions.

Auction types (RECAI, 2015)

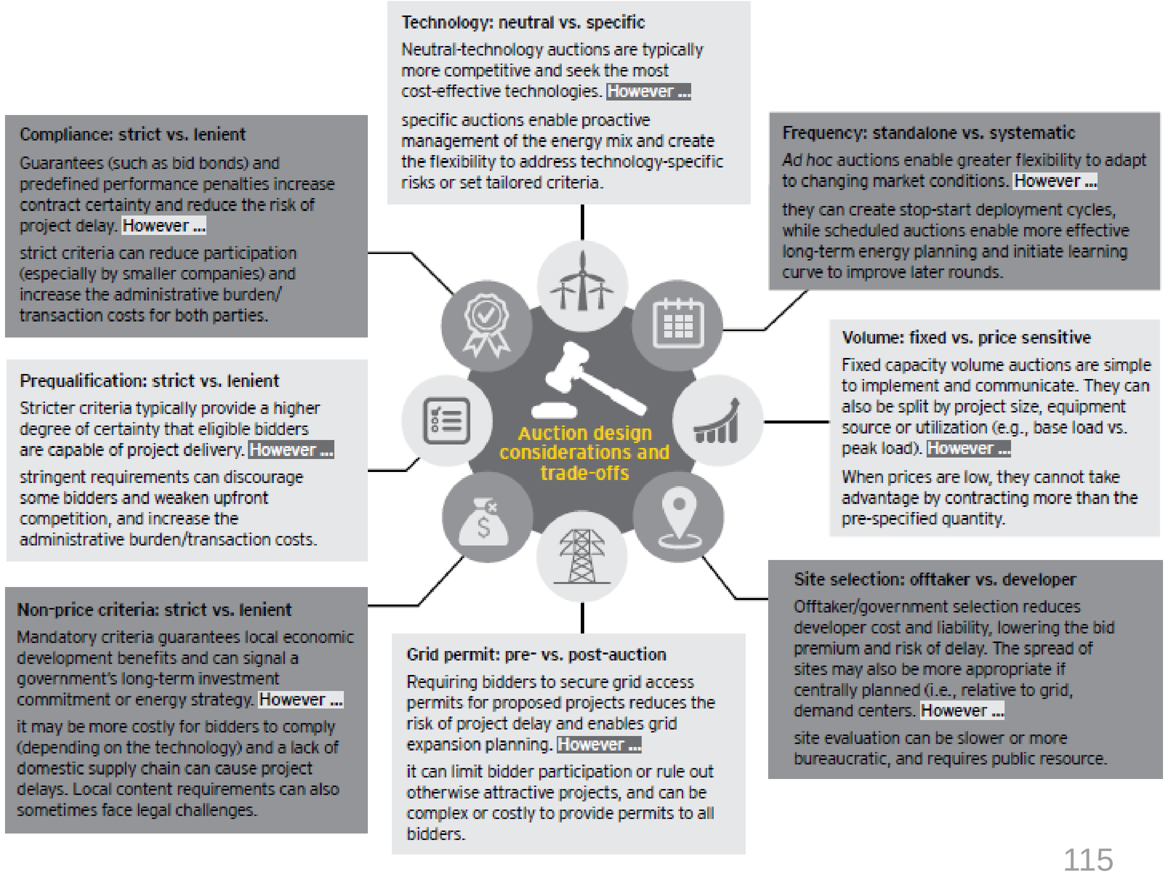


China
Morocco
Turkey

India
South Africa

Brazil

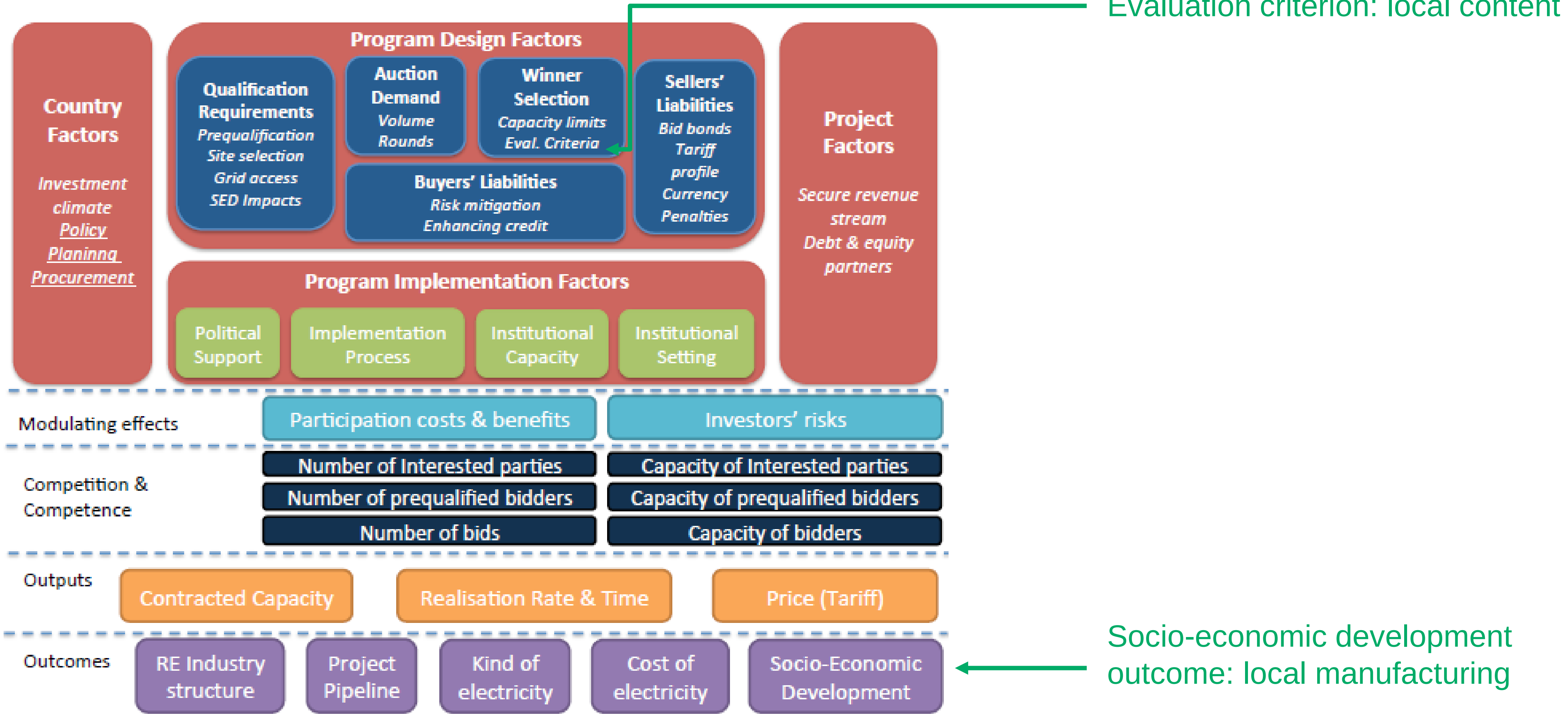
Auction design considerations and trade-offs (RECAI, 2015)



Auction context, design, implementation and outcomes

Alignment of auction design factors, specific local content requirements and other supporting mechanisms influence the nature, extent and success of the establishment of local manufacturing

Integrated Framework for Analysis of Auctions (Kruger et al. 2018)



Effectiveness of local content requirements

A number of key factors determine the effectiveness of local content requirements (LCRs) as an enabler of local manufacturing. These are market size and stability, policy design and coherence, restrictiveness of LCRs and the industrial base

Main determining factors for the effectiveness of local content requirements in auction/competitive bidding processes (Hansen et al 2019)

Factors	Characteristics
Market size and stability	• The level of domestic market demand in terms of auctioned volumes • The degree of predictability and long-term stability of the demand, for example, through target setting and political signals
Policy design and coherence	• The clarity and transparency of the rules and regulations pertaining to the LCRs, including definition and implementation procedures • The extent to which LCRs are aligned with and accompanied by complementary industrial policies supporting local manufacturing in the targeted sectors
Restrictiveness	• The level or percentage of locally produced content required under the LCRs
Industrial base	• The level of technological capabilities in the local supply base, including technical skills, specialization and the production capacity of domestic firms

Source: *authors' own elaboration based on Veloso (2001), Kuntze and Moerenhout (2013); Johnson, (2016).*

Basic conditions needed for effective local content requirements in renewable energy (Ettmayr and Lloyd 2017)

Potential investment loss		Potential investment benefit
Small	Market size and stability	Large
Too restrictive	Restrictiveness of LCR	Proper
Non-existent	Cooperation and subsidies	Existent
Low	Learning-by-doing and technical knowledge	High

LCRS, local content requirements.

Source: Adapted from Kuntze, J. & Moerenhout, T., 2013, *Local content requirements and the renewable energy industry – A good match*, International Centre for Trade and Sustainable Development (ICTSD), p. 11, Geneva, Switzerland.

Effects of government policies on firms' strategic responses

Local manufacturing can be promoted without LCRs when market stability (Kuntze and Moerenhout, 2013) and a combination of consumption support and production support (Haley and Schuler, 2011) is provided. Firms strategies in terms of local manufacturing will depend on the combination of renewable energy consumption and production support mechanisms (Haley and Schuler, 2011).

Firms' Strategies under Production and Consumption Assistance (Haley and Schuler, 2011)

Countries with Consumption Assistance	Countries with Production Assistance: No	Countries with Production Assistance: Yes
Yes	II • Market Strategies to Access Domestic Markets • Non-market Strategies to Increase Domestic Content & Block Imports • *Proclivity to Import*	IV • Market Strategies of Quality, Differentiation & Service • Non-market Strategies to Maintain Government Assistance & Seek Foreign-Market Liberalization • *Proclivity for Niche Strategies*
No	I • Market Strategies focusing on Comparative National Advantage, Scale, Efficient Production & Market Size • Non-market Strategies to Shield from Pure Competition • *Proclivity for Shielding Non-Market Strategies*	III • Market Strategies to Access Foreign Markets including Expansion of Production Capacity • Non-market Strategies to Maintain Government Assistance, Block Imports & Seek Foreign-Market Liberalization • *Proclivity to Export*

Examples of Consumption Assistance

- Feed-in tariffs
- Tax credits
- Loan guarantees
- Cash grants

Examples of production support mechanisms

- Low interest loans to invest in plants and equipment
- R&D assistance
- Export credits

(based on Haley and Schuler, 2011)

Country comparisons

Comparative analysis

Country summary: South Africa

Aspect	Description
RE Procurement mechanism (see page on auction types for definitions of types of bids.)	Based on Kruger et al. (2018) ▪ Sealed bid, pay-as-bid auctions introduced in 2011. ▪ Fixed total allocation per technology type and caps on project size ▪ Multiple projects of varying size awarded to multiple bidders ▪ Bidders responsible for site selection and grid access
Promotion of industrialisation	Utility scale solar and wind projects through REIPPPP (Morris et al. 2020) ▪ 70:30 split in evaluation on price: economic development (ED) ▪ Local content makes up 25% (7.5/30 points) of ED score ▪ Local content defined in terms of % of project cost (not explicitly use of specific local components) ▪ Increase in local content thresholds and targets in successive bidding rounds (2011-2015): Wind thresholds: 25%-40%; targets: 45% - 65% Solar thresholds 45-65%; targets: 50-65%.
Other supporting mechanisms	▪ Access to general (not specific renewable energy industry) manufacturing support[1] (Morris et al. 2020)
Industrialisation impact	▪ Some local manufacturing capacity established, but not at scale or full scope of value chain to meet projected local annual demand in IRP 2019. ▪ Wind: Two tower manufactures (one steel, one concrete) ▪ Solar: Two solar module manufacturers and one solar cell manufacturer (nearing completion of facility) ▪ Local manufacturing available for several other components (e.g. mounting structures, trackers, cables; fastenings) ▪ Balance of plant manufacturing largely localised, although not all sourced locally for utility scale projects. ▪ Small scale embedded generation market, primarily solar PV and primarily sourcing imported modules.

1. This may include access to grants (e.g. the Manufacturing Competitiveness Enhancement Programme) and the option to apply for exemption from import duties on raw materials/sub-components.

Country summary: Brazil (1)

Aspect	Description
RE Procurement mechanism (see page on auction types for definitions of types of bids.)	Based on Kruger et al. (2018): ▪ Two types of hybrid auctions: new capacity and power reserve auctions starting from 2007 (hydro, biomass), adding wind (2009) and solar (PV) (2014) over time ▪ Technology agnostic and technology specific auctions ▪ Multiple projects of varying size awarded to multiple bidders ▪ Bidders responsible for site selection ▪ Price caps in auctions raised in 2014 and 2015 to encourage bidding (RECAI 2015)
Promotion of industrialisation	Based on Kuntze and Moerenhout (2013); RECAI (2015), Kruger et al. (2018): ▪ LCR based on weight of components ▪ LCR of 60% for wind projects from 2009 (with three years to raise to 70%), and LCRs for solar PV followed in 2014 (60%, with five years to raise this to 70% in 2020). Not a qualification or evaluation criterion, but is a condition of access to local finance (see section on supporting mechanisms) ▪ Earlier feed-in tariff scheme from 2002 had different LC targets for equipment (60%) and services (90%) forming a foundation for the local industry. ▪ High steel prices for local steel were originally considered an impediment to local manufacturing, but requests for deeming of imported steel were rejected based on pressure from the local steel industry. The weights based LCRs for wind resulted in the steel industry becoming one of the key beneficiaries of the renewable energy industrialisation drive.

Country summary: Brazil (2)

Aspect	Description
Other supporting mechanisms	Based on Kruger et al. (2018) ▪ Brazilian National Development Bank (BNDES) provides favourable finance to project developers to enable local manufacturing. This finance, which is provided at less than or about 50% of the rate of commercial banks, is conditional on meeting the LCRs. ▪ Funding of up to 65% (earlier 70 and 80%) of project cost can be obtained from BNDES, with a potential 15% from the Climate Fund. ▪ New capacity auctions have a range of lead times (1, 3, 4, 5, 6 years) depending on type of technology to allow project planning, construction and ramp up of local manufacturing capacity. The 3-, 4-, 6-year lead times auctions are typically for renewables with the “A4” and “A6” auctions specifically introduced to provide further flexibility for renewables.
Industrialisation impact	Based on Kuntze and Moerenhout (2013), Hansen et al. (2019): For wind ▪ Towers, blades and parts of nacelles are produced locally. ▪ LCRs in terms of weight of components together with high LCRs resulted on initial focus on towers and exploration of concrete towers due to price of local steel. ▪ LCR focus on weight limited innovation in other components; meant that low and medium technology component were localised, not high technology components ▪ Local manufacturing done primarily by local affiliates and subsidiaries of foreign suppliers of components ▪ By 2014, there were 4 manufacturers of turbines, 7 turbine assemblers, 13 tower manufacturers, and 13 manufacturers of other components. Solar PV ▪ From initial local manufacturing of modules and frames, LCR resulted in quite diverse set of solar PV system suppliers set up. ▪ By 2017, the Brazilian Solar PV industry association (ABSOLAR) listed 34 local manufacturers: 6 module manufacturers, 10 module assembly, 8 inverter, 6 tracker, 4 junction boxes.

Country summary: Russian Federation (1)

Aspect	Description
RE Procurement mechanism (see page on auction types for definitions of types of bids.)	Based on IFC (2013); Heidemann (2018) ▪ Sealed-bid auction (from 2013) with two evaluation rounds allowing updated bids not exceeding price of original bid. ▪ Bidders have to register as wholesale market participants. ▪ Price caps are put on the capital expenditure for different technologies (cost / kW). Bidders thus compete on capital expenditure needed to develop a facility. ▪ Fixed total allocation per technology type ▪ Multiple projects of varying size awarded to multiple bidders ▪ Site selection by project developer within zones for wholesale electricity market.
Promotion of industrialisation	Based on IEA (2015), Heidemann (2018) ▪ Solar PV: 50% (2014-2015) to 70% (2016-2020) of facility and components locally manufactured ▪ Wind: 35% (2015), 55% (2015) to 65% (2016-2020) of facility and equipment locally manufactured. ▪ Degree of localisation determined by Russian Ministry of Industry and Trade after construction ▪ Three categories, depending on the localisation degree: < 50%, between 50% and 70% or >70%. The price for the supplied capacity is then based on its allocated category. ▪ General rules for the determination of the degree of localisation are applied, unless the project developer applies ahead for a special investment contract ("SPIC"). ▪ Under a SPIC an investor typically commits to establish or modernise the production of specific goods, including goods not yet produced in Russia. ▪ A commitment is also made with regard to volumes of investment and production in line with agreed business and production plans which are then included in the SPIC. ▪ Fulfilment of SPIC obligations is assessed and monitored by the relevant competent authorities. .

Country summary: Russian Federation (2)

Aspect	Description
Other supporting mechanisms	Based Heidemann (2018): ▪ In return for the commitment made under a SPIC, the investor is granted certain incentives (typically tax relief and preferences in public procurement), as well as a special regime for determining the degree of localisation. ▪ SPICs are entered into for a period needed to make the project operationally profitable according to the business plan plus five years, but should not be for a total of more than ten years
Industrialisation impact	▪ Despite a slow start due to stringent localisation requirements and the prospect of having to build a manufacturing facility for one-off projects, a number of joint ventures between leading international, particularly wind energy, companies and Russian companies have established (Global Power Journal 2019) ▪ IP transfer: a key requirement in the Russian context is that the foreign joint venture partner has to transfer IP to the local Russian partner (as a “mandatory export obligation”) (Morris et al. 2020)

Country summary: India (1)

Aspect	Description
RE Procurement mechanism (see page on auction types for definitions of types of bids.)	Based on RECAI 2015, Kruger et al. 2018; ▪ Vast number of auctions at state and federal level (solar in three phases from 2010-2013; 2013- 2017, 2017-2022 as part of Indian National Solar Mission; wind from 2017). There are also auctions for rooftop PV. ▪ Sealed bid, pay-as-bid auctions are most common, with some hybrid auctions (sealed bid, followed by descending clock e-auction). ▪ Site selection and grid access by developer or government depending on auction, with a federal level initiative to develop 25 solar parks initiated to overcome land access issues.
Promotion of industrialisation	Based on Kuntze and Moerenhout 2013, Kruger et al. 2018, ▪ The LCR for solar thermal is 30%. ▪ Initial phase of solar auctions (2010-2013) had LCR that required all crystalline silicon (CSi) solar PV modules (round 1) and all modules and cells (round 2) to be manufactured in India.[1] ▪ This LCR for solar PV was lowered (in response to the US taking a complaint to the World Trade Organisation (WTO) after the second round of these second phase (2013-2017) and auctions split into dedicated content for local content and “open” (no local content), with the former reaching tariffs 6% higher than the latter (Probst et al. 2020).[2] ▪ Further uncertainty in the solar PV market was introduced by the government proposing import duties on solar PV components.

1. Kruger et al. (2018) suggest that the LCR required only 50% of the module content to be locally manufactured.
2. Kruger et al. (2018) suggest that tariffs for those auction with LCR were 10-15% higher than those without.

Country summary: India (2)

Aspect	Description
Other supporting mechanisms	▪ Viability Gap Funding (VGF) to a maximum value of 20% of capital cost of projects. VGF is paid 50% on commissioning and the remaining 50% spread over the first 5 years of operation (Kruger et al. 2018) ▪ However, already in 2015, it was found that fewer projects needed VGF and some solar projects were nearing grid parity (RECAI 2015)
Industrialisation impact	Based on Kuntze and Moerenhout (2013), Hansen et al. (2019), Probst et al. (2020) ▪ The LCRs for crystalline silicon had the unintended consequence of increasing the market share for thin film technologies which did not carry LCRs. Thin film imports dominated the market aided by being 14% cheaper on average than local CSi panels and due to better (commercial) financing for projects available to those projects that did not have LCRs. By 2015, 70% of India' solar capacity used imported thin film panels. ▪ The crystalline silicon module LCR initially helped existing local manufacturers to expand. but did not lead to establishment of new manufacturers. However, the competition from and loss of the local market opportunity to imported thin film, and decline in India's primary export markets for C-Si panels, ultimately lead to heavy losses for established local C-Si module manufacturers.

Country summary: China (1)

Aspect	Description
RE Procurement mechanism (see page on auction types for definitions of types of bids.)	Wind (Kuntze and Moerenhout 2013, Hansen et al. 2019) ▪ Auctions for wind projects from 2003-2009, with FIT thereafter. Solar (Apricum 2019): ▪ Solar FIT from 2012, with first national scale solar auction in 2019. Awards for utility, distributed and self-consumption generation Wind & Solar (Apricum 2019): ▪ First grid-parity projects awarded in 2019. ▪ Period of transition to expected to subsidy-free market by 2021 or soon thereafter.
Promotion of industrialisation	Wind (Kuntze and Moerenhout 2013, Hansen et al. 2019) ▪ Local content (LC) of 20% required as early as 1997 rising to 40% by 2002. ▪ Auctions from 2003 – 2009 with increasing LCRs from 50% (2003) – 70% (2004 onwards). ▪ LC counted 20% (2005) -35% (2007) of bid evaluation ▪ Preference given to projects from Chinese manufacturers ▪ LCRs eliminated after 2009 Solar (Kuntze and Moerenhout 2013) ▪ Local manufacturing for solar PV was aided by considerable subsidies and R&D support.

Country summary: China (2)

Aspect	Description
Other supporting mechanisms	Wind (Kuntze and Moerenhout, 2013) ▪ Very large and growing domestic electricity market. ▪ Financial support for setting up local manufacturing ▪ Joint ventures and technology transfer enabled by additional financial support through Clean Development Mechanism funding ▪ However, limited investment in R&D (by state or Chinese companies) until foreign companies left the market. State R&D funding, which favoured R&D into components still imported (e.g. converters and bearings), was ultimately terminated due to trade rules, but public R&D funding and training, quality standards and procurement of wind from farms in areas requiring larger wind turbines drove innovation by local companies
Industrialisation impact	Wind (Kuntze and Moerenhout, 2013) ▪ Before 2000 Chinese manufacturers had only 10% market share in China with foreign subsidiaries of international wind turbine manufacturers dominating (either directly manufacturing or doing local assembly with Chinese components). By 2009, Chinese manufacturers had 85.3% of market share ▪ When LCRs were eliminated in 2009, most of the international companies left the market leaving the domestic market dominated by the local Chinese manufacturers. ▪ In 2019, Chinese wind turbine manufacturers occupied five out of the top 10 positions in terms of *global* market share (positions 3, 5, 6, 9. 10) (Ren21, 2020) Solar (Ren21, 2019; 2020) ▪ In 2018 and 2019, seven out of the top 10 solar cell and module manufacturers globally were Chinese. These companies shipped 60% and 80% of the cell/module volume in 2018 and 2019, respectively.

Country summary: Argentina

Aspect	Description
RE Procurement mechanism (see page on auction types for definitions of types of bids.)	Based on Kruger et al. (2018) ▪ Initial FITs in 2000s replaced by sealed bid, pay-as-bid auctions in 2016 for solar PV, onshore wind, biogas, biomass, small hydro and landfill gas ▪ Fixed allocation and specified project size range per technology per region ▪ Multiple projects to multiple bidders ▪ Bidders responsible for site selection, but limited to pre-determined regions.
Promotion of industrialisation	A tax credit equal to 20%-30% of local content was also provided (as well as priority access to the government Renewable Energy Fund (FODER) finance), with the provision that projects include at least 60% local content (or can prove that it could not meet this threshold) (Kruger et al. 2018)
Other supporting mechanisms	Based on Kruger et al. (2018): ▪ Priority access to FODER finance (as outlined above).[1] ▪ Innovative guarantee and loan structure under FODER to overcome challenge of no government entity having an investment grading (due to Argentina defaulting on sovereign bonds in 2001). These innovations included a range of financial mechanisms such as payment guarantees (through an escrow account), termination guarantees (backstopped by World Bank), long term loans, interest rate subsidies and equity contributions.
Industrialisation impact	Wind ▪ A number of OEMs set up assembly and encouraged their suppliers (mainly tower manufacturing facilities) to set up manufacturing facilities. However, these gains were not sustained due to the economic recession and discontinuation of the renewable energy procurement programme resulting in factory closures and job losses.

1. (Presumably to assist in improving project viability and independent of local content), projects were also offered a decrease in VAT, exemption from national income tax, returns distribution tax, import duties, provincial and municipal taxes (Kruger et al 2018).

Country summary: Morocco

Aspect	Description
RE Procurement mechanism (see page on auction types for definitions of types of bids.)	Based on Kruger et al. 2018 ▪ Competitive sealed bid, pay-as-bid tenders introduced in 2010 ▪ Individual projects of fixed technology and capacity ▪ Single winner for single or multiple projects ▪ Site selection and grid access by government including setting up of large scale solar parks.
Promotion of industrialisation	Based on RECAI, 2015, Kruger et al. 2018 ▪ Pre-qualification for bidding involves a number of requirements including a local content requirement of 30% of capital cost. ▪ Flexibility in how local content is made up allows bidders to make local manufacturing offers (Morris et al. 2020)
Other supporting mechanisms	▪ Concessional financing through the Moroccan solar energy agency (MASEN) which aggregates funding from international finance institutions, for project financing, provides guarantees and takes an equity stake (typically 25%) to enable governance across project life cycle (RECAI 2015).[1]
Industrialisation impact	▪ At least one wind OEM has set up a blade factory which was part of its local content offer during bidding. The factory serves the European and MENA and was expected to create 700 jobs (Hochberg 2016). 70% of the production of the facility is exported (Sanchez 2020) ▪ Local manufacturing potential for CSP collector assembly and mounting structures as well as PV mounting structures and cables was identified (Kost et al. 2012), but the extent to which this has been realised is not known. (The BOP elements were identified as most readily localised; hence it is assumed that most of the 30% local content requirement is typically met by BOP elements (e.g. civil and electrical works))

1. MASEN takes on the role for education, training, and R&D (research and development,). The focus of training is primarily on technicians for operation and maintenance. MASEN also partners with another local government agency to act as a recruitment agency for developers (IRENA 2019)

Country summary: Turkey (1)

Aspect	Description
RE Procurement mechanism (see page on auction types for definitions of types of bids.)	Based on KALI Energy Solutions (2017) ▪ Two systems operate: the Support Mechanism for Renewable Energy Resources (YEKDEM, with substantial uptake from 2013) and Renewable Energy Resource Areas (YEKA) / Renewable Energy Zones (REZs) (based on regulations published in 2016). The YEKDEM is a feed-in-tariff applicable to public and private licenced power generators. The YEKA/REZs system is for large and utility scale projects. ▪ In the YEKDEM, licenced generators apply annually to sell power at the YEKDEM price or can sell at the free market price, if preferred. ▪ The YEKA/REZ system is an auction system. A ceiling price per technology is provided and bidders may need to comply with a number of requirements (e.g. local and foreign ownership structures, conditions for joint ventures etc.) Following an initial screening on price, auction prices are determined in a “descending clock”, “winner-takes-all” bidding process for a particular allocation per project type as single or multiple projects ▪ Site selection, permitting and grid access are enabled by designation of renewable energy resource areas (YEKA/REZ).
Promotion of industrialisation (1)	Based on KALI Energy Solutions (2017): ▪ For the YEKDEM, two tariffs apply: a fixed tariff and a variable tariff. The variable tariff provides a premium per component locally produced per technology type (wind, solar PV, solar CSP, hydropower, biomass, geothermal) that can be applied for annually for a period of 10 years[1] of the plant life after commissioning.[2] ▪ A 50% import tariff was also placed on import of solar panels (Livingston 2018) *(continued overleaf)*

1. There are also sources that indicate that a LC threshold of 55% local content is required to access the premium tariff and this is available for 5 years only. This may be an update to the system since the publication of the literature sources.
2. For example, in the initial tariffs for solar PV, there are five categories of sub-component (PV panel integration and solar structure mechanics, PV modules, PV module cells, inverter, focussing material to collect solar rays onto PV module) which attract a premium from 0.5 (focussing material) – 3.5 (PC module cells) US$ cents/kWh (pwcTurkey, 2012).

Country summary: Turkey (2)

Aspect	Description
Promotion of industrialisation (2)	▪ One of the key objectives of the YEKA/REZ system is to enable the local manufacturing or local procurement of the high technology renewable energy components and technology transfer. There are two options to choose from: Allocation on Condition of Local Manufacturing (ACLM), where only locally manufactured components are used and manufacturing has to be set up, or Allocation on Condition of Using Locally Manufactured Equipment (ACULME), where all components are procured from existing local manufacturers. The options can be combined depending on the Specifications of the specific auction. There are further specifications defining a Locally Manufactured Product for ultimate certification including that the product should have a "ratio of local contribution" of 51% or higher, and should either be entirely manufactured or obtained in Turkey or major steps of the manufacturing process and the activities that provide economic value add to the product should take place in Turkey. The formula used for "ratio of local contribution" is structured so that raw material contributions also count, thus the use of local material inputs also becomes significant. If the origin of these materials does not meet the requirements of the specification and do not obtain a Locally Manufactured Product Certificate, then those materials or components are considered (the equivalent of) imported. ▪ In the YEKA/REZ scheme with ACLM, there may also be additional obligations such requirements for knowledge- and technology transfer to local partners and a commitment to establish a research and development (R&D) centre.
Other supporting mechanisms	Based on KALI Energy Solutions (2017): ▪ In the YEKA/REZ scheme there are special renewable energy, investment incentives, R&D support mechanisms (for ACLM projects) and industrial zone incentives. ▪ There are four types of investment incentives which together aim to: – Increase the manufacturing of products intermediate goods with low, if not no, production capacity and high import dependence – Support investments that involve high and mid-high technology with the purpose of enabling technology transfer – Increase the investments to underdeveloped regions, – Reduce regional development disparities – Improve the efficiency of the supply of components – Promoting investments for clustering

Country summary: Turkey (3)

Aspect	Description
Industrialisation impact	Based on Livingston (2018). ▪ Despite what may be considered some of the strictest LCRs in the world and the high risk of the "winner takes all" auction process for the YEKA/REZ system, Turkey has seen very effective localisation off the award of large projects with considerable local content requirements and obligations on the limited number of winners. In part, Turkey's geographic position to serve the European and MENA[1] region markets has assisted in building the business case for potential bidders/investors ▪ The YEKDEM has seen a proliferation of small solar panel manufacturers to serve smaller licenced installations, as well as a large degree of localisation of solar (cell, module, invertor, tracking) and wind components (blades, tower, generators) for large and utility scale projects ▪ The YEKA/REZ system has been successful in the establishment of more technically advanced portions of the solar value chain in particular, including local manufacturing facilities for ingots and wafers, with further auctions and incentives expected to drive the replication of this success for the onshore and offshore wind value chain.

1. MENA = Middle East and North Africa

Country case studies

Renewable energy contribution to a Just Transition

Background

Steps to support a just transition and the role of green jobs

Creating localised green jobs, including through decentralised energy and energy efficiency are key just transition implementing measures identified from international just transition case studies. Understanding the country context is important when looking to learn from other countries. Just transition experiences to date are primarily from wealthier countries, so adaptation to the developing country context, and specifically to the local context, is critical.

Steps to initiate or support just transition processes (Zinecker et al., 2018)

Understanding the context	• Map the political economy of an energy transition • Use detailed analyses of positive and negative impacts of an energy transition (at national, regional or even plant level)
Identifying champions	• Facilitate international and regional exchange and peer learning between countries at different stages of energy transition processes, including engagement with labour, businesses, civil society, especially for developing country contexts • Round tables at the country level to start or enhance a conversation on a just transition between all concerned stakeholders • High-level dialogue between countries in similar situations to promote the idea of a just transition at the highest levels of government (e.g., at the EU, OECD or G20 level or bilaterally)
Making the case	• Develop communications strategies for just energy transitions • Set up inclusive processes for “two-way communications” • Train government officials in communications
Implementing just transition measures	• Promote localized green jobs, including in decentralized energy and energy efficiency, and link this explicitly to the energy transition • Mobilize additional funding to promote visible and tangible just transition measures, and communicate about the benefits • Share best practices of just transition measures

Enabling just energy transitions

Renewable energy infrastructure and supply chains can contribute to diversification of regional economies in transition areas, particularly where these can build on related existing industries and businesses. Public procurement and sustainable infrastructure projects are key measures for job creation. Public and private sector skills development is important for the redeployment of workers and the creation of income opportunities for workers, their families and communities.

Measures to enable just energy transitions (Zinecker et al., 2018)

Measure	Examples	Desired impact
Macroeconomic and structural policies (long-term)	• Diversifying the economy and businesses • Removing barriers to renewable energy or energy efficiency	• Attracting investment to affected regions • "Related diversification" by developing economic activities that are related to existing industries
Public sector policies for job creation (short to medium term)	• Public procurement, sustainable infrastructure projects, public regulations	• Stimulating job growth in regions that will face job declines • Fighting the "environment vs. jobs" narrative
Active Labour Market Policies	• Employment services, providing information and matching services • Early retirement schemes	• Support unemployed workers and workers at risk of unemployment • Retain income and purchasing power in the affected areas
Skills development and retraining	• On-the-job-training in companies • Training courses • Relocation expenses and assistance	• Support the redeployment of workers in stable and well-paying employment • Create income opportunities for workers and their families
Social protection	• Social security systems, unemployment benefits, retirement	• Reduce the negative impact of job losses, provide income support to families
Community renewal and regional economic diversification	• Provide funding for community projects • Support to regions based on an assessment of their potential strengths • Building up local entrepreneurial networks	• Help anticipate losses in revenue and economic activity in communities that are highly dependent on fossil fuel-related work sites • Make regions more attractive and create a sense of belonging

Contributing to a Just Transition in South Africa: economic diversification

Utility scale and small scale renewable energy infrastructure and renewable energy manufacturing are proposed as key enablers of socio-economic development in coal-mining and coal-based power generation regions in South Africa.

Options for economic diversification, sector jobs resilience plan: coal value chain. (Patel 2020)

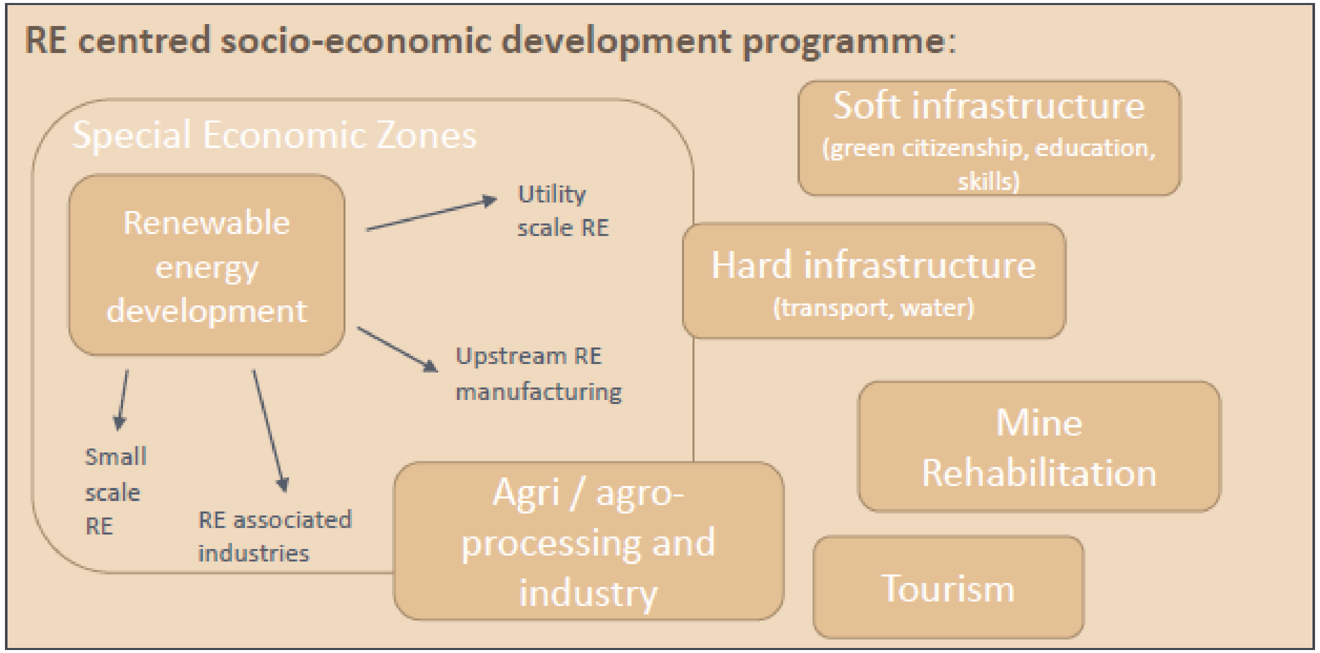
Potential options

- **Mining rehabilitation**
  - Restored land for agriculture (maize and soya)

  Mpumalanga has a high proportion of arable land which can be leveraged

  Other options include repurposing slag heaps (adventure sports), open-cast mines (lakes); mines (museums); land (shopping centres/services/parks)
- **Renewable Energy**
  - SEA for wind and solar PV Phase 2 identified solar PV potential for eMalahleni
  - Adjacent vulnerable municipalities should be included in further generation plans or developed to supply into RE VC by developing the skills (maintenance and repair, manufacture of components)
- **Coal waste beneficiation**
  - Fly ash recycling: Eskom and Sasol potential to sell waste ash and reduce storage costs
  - Ash can be used to improve land, manufacture bricks and cements

Extract from a proposed Just Transition model (Tyler 2020)



Contributing to a Just Transition in South Africa: job creation (example)

Manufacturing contributes about 8% of the job years for a solar PV plant (of 86 MW). 48% of the job years across the full value chain requires skilled workers (i.e. Grade 11-12/vocational education). This example illustrates both the potential inherent in renewable energy technologies such as solar PV and highlights that skills development and retraining would be needed to enable transition of workers in existing coal-based employment to take up new opportunities including those in renewable energy

Key insights regarding jobs created and skills required for solar PV plants (Hartley et al. , 2020)

KEY POINTS:

- From the surveys conducted, a typical 86 MW solar PV power plant value chain created 950 jobs and 3,670 job years over the lifetime of the project.
- The construction phase had the highest share of jobs created in the value chain; 63% of total headcount jobs and 47% of total job years were obtained during this phase. Operations and maintenance (O&M) created 1,575 job years (43% of jobs years) over the life time of the project. The remainder jobs (386 job years) were created during the development and manufacturing phases of the project.
- 66% of head count jobs and 48% of job years required skilled workers to achieve the required task. 76 jobs (8% of total jobs) and 470 jobs years (13% of total jobs years) were created for unskilled labour over the lifetime of the projects assessed.

Jobs created and skills needs for an 86 MW PV plant (Hartley et al. , 2020)

Project phase	Project activity	Number employed	Skill level	Period (years)	Job years
Manufacturing	Module assembly	186	Skilled (vocational)	1	186
Development	Developer employees	10	High-skilled (university)	1.5–2	20
	Permitting phase (consultants)	15	High-skilled (university)	1.5–2	30
	Ancillary services	5	High-skilled (university)	1.5–2	10
	EIA process	3	High-skilled (university)	1.5–2	6
	From development to sale	25	High-skilled (university)	1.5–2	50
	EPC	15	High-skilled (university)	1.5–2	30
	Banking	18	High-skilled (university)	1.5–2	36
	Construction management team	9	High-skilled (university)	1.5–2	18
	Total	**286**			**386**
Construction and installation	Civils (site clearing, foundation, basic construction, etc.)	211	Semi-skilled	1.5–3	633
	Construction team from various contractors and EPC	65	Skilled or high-skilled	1.5–3	195
	Electrical	6	Skilled or high-skilled	1.5–2	2
	Structure erection, excluding civils	202	Semi-skilled or Skilled	1.5–3	606
	Grid work	52	Skilled	1.5	78
	Transportation of equipment	65	Unskilled	1.5–3	195
	Total	**601**			**1,709**
Operations and maintenance	Control centre (projects in process)	20	High-skilled (university)	25	500
	Grass-cutting	11	Unskilled	25	275
	Operations and maintenance	32	Semi-skilled or Skilled	25	800
	Total	**63**			**1,575**
Sum-Total	**950**				**3,670**

Country case studies

Country case study: Germany (Ruhr) (1)

From Halsey, R. (2020)

Step	Description
Context	**Accepting the need for transformation to enable opportunities to be grasped** The Ruhr valley went through two phases of transition – one unplanned during the period of 1957 – 2018, and the current planned phase (2018 onwards) The Ruhr valley in Germany accounted for 80% of coal mining employment (473 600 direct employees) in Germany prior to 1957 and was dominated by coal and steel production. Although some measures were taken to support affected workers during coal mining decline (e.g. the Ruhr Coal vocational Training Society which assisted with training and placement), the resistance to change by the coal and steel industries until the 1990s hampered effective transformation. Due to the measures taken, there were 1000 renewable energy related companies in the Ruhr by 2014 and the Ruhr now employs 15% of the renewable energy workforce in Germany. The more planned phase out of the remaining coal-based power stations (across Germany as a whole) started in 2018 with the view to phasing out the remaining 43.9 GW of capacity by 2038 affecting about 25 000 workers.
Champions	**Adapting by local industry supported by an enabling local government** Local companies branched into environmental technologies, plant engineering and control services. Past pressures on pollution reduction provided a foundation for companies in clean technologies. Facilities were converted into new clean technology manufacturing plants (e.g. a steel plant site evolved into a solar cell manufacturing plant; previous expertise in coal mining equipment manufacture was leveraged to provide gearboxes for wind turbines (now supplying 30% of wind gearboxes worldwide); a coal power plant constructor pivoted to constructing biomass generators.) Local authorities promoted “sunrise industries” so that environmental technology became the main new employer (about 100 000 people by the mid-2000s).

Country case study: Germany (Ruhr) (2)

From Halsey, R. (2020)

Step	Description
Case	The initial need for transformation came from a combination of cheaper imports of coal and oil, and concerns about air pollution. Later, EU drivers were EU policies relating to emissions, a move towards renewable energy and termination of coal subsidies.
Measures	Initial phase: A number of support measures related to worker shift management to avoid layoffs, bridging salaries to enable early retirement and skills development, training and placement centres. Investment in higher-education institutions and technology centres to lay the foundations of a knowledge-based economy as an alternative to a resource-based economy Investments into transport infrastructure and logistics to enable the mobility of people required for a knowledge-economy. Public-private partnerships with citizen engagement was used to convert industrial wastelands into spaces for leisure and tourism, contributing to the liveability of the area. For the current transition, a national multi-stakeholder negotiation process (the “Coal Commission”) was established. This has made a number of recommendations including a capacity reduction pathway, support for mining regions and support for workers. The Commissions suggestions have been taken up in a “Coal Exit Law” adopted in 2020, that, among others, allocates EUR 49.35 billion for regional business and worked support mechanisms.

Key enabling factors

- End of resistance to / acceptance of the need for transition
- Communication and collaboration between different levels of government, businesses, unions and communities
- Adaptation by local businesses to take up opportunities in the renewable energy and clean technology value chains
- Public-private partnerships and inclusive, citizen engagement

Country case study: Canada[1] (1)

From Zinecker at al. (2018)

Step	Description
Context	**Strong commitment to phase-out of coal with regional impacts** In 2018, Canada committed to phase-out of coal-fired electricity by 2030 to contribute to Canada's goal of 90% of its electricity coming from non-emitting sources by 2030. 42 000 people employed directly and indirectly in coal industry in Canada. Many jobs would have been lost independently of coal-phase out due to aging coal fleets and coal not being cost competitive with gas and renewable energy. Other drivers included strict national emission standards introduced in 2011 and carbon pricing in 2019. Task force for Just Transition for Canadian and Coal Power Workers and Communities launched. Task force made up of labour, private sector, NGO, academic and local government representatives, with specific mandate to engage affected local workers and communities in particular and provide recommendation to Canadian Government. Remaining coal based power generation occurs in particular parts of the country making the impact on workers highly regionalised.
Champions	**Cross-party support and engaged labour leadership** Strong support for clean energy at government, NGO and academic level for environmental and health reasons. Economic case also strong due to cost competitive nature other fuels and renewables. Canada was a founding member of the international Powering Past Coal Alliance focussed on creating a global shift from coal-based electricity to renewable energy. Canada's labour leadership was supportive contingent on the development and mandate of the Task Force and support to workers and communities. A worker-focussed organisation published a proposal to build Canada's renewable energy workforce; manufacturing of renewable energy products; positioning existing sector unions, contractors and developers within the energy sector, and renewable energy and industrial-scale efficiency projects.

1. Canada has had some earlier successes in terms of transition in coal-based regions that informed the measures presented here. However, the impact of interventions presented here still needs to be fully demonstrated.

Country case study: Canada (2)

From Zinecker at al. (2018)

Step	Description
Case	**Health, and attendant economic, benefits and climate change commitments** Estimated benefits of coal phase out included 260 avoided premature deaths, 40 000 fewer asthma episodes, 190 000 fewer days of breathing difficulty and reduced activity resulting in an estimated economic health benefit of CAD 1.2 billion from 2019-2055. Coal phase-out was also estimated to made a substantial contribution to Canada’s commitments under the Paris Agreement .
Measures	**Focus on supporting communities; high-level support and inclusive processes.** Strong focus on impacts on communities and workers. Support programs included economic diversification, re-employment, retirement bridging, retraining and relocation. National level programme to support research on clean energy technologies for job skills development, for export of clean energy technologies developed in Canada, and investment in clean energy development and deployment.

Key enabling factors (Zinecker at al. 2018)

- Clear commitment to consider and address negative impacts on workers and communities
- Involvement of affected stakeholders in formulating the recommendations, with excellent composition of the task force bringing together decision-makers from labour, NGO, business and regions
- Inclusive process and listening as a key part of the just transition process, with visits to every affected community
- High-level support from the Prime Minister and Minister of Environment

Country case study: India[1] (1)

From Zinecker at al. (2018)

Step	Description
Context	**Rapidly growing renewable sector with employment benefits** India has committed to reducing the carbon intensity of its GDP by 33-35% by 2030 (from 2005 baseline) In 2018, 79% of electricity generation was from coal. 75% of the coal used in India is produced locally. About two thirds of coal consumed nationally is burned in thermal power stations. India has embarked on an ambitious renewable energy build aiming for 175 GW installed capacity by 2022 (up from the target of 160 GW by 2020). Coal production and power generation is done in the central and east areas of the country, while the south, west and north are better suited to renewable energy. Nationally, coal production provides employment to about 1.2 million labourers. Renewable energy deployment is estimated to have created 432 000 jobs by 2017, with a further 300 000 expected to be needed to meet the 2022 renewable energy target. Renewable energy creates more upfront jobs in construction and manufacturing. Thermal generation requires more ongoing employment in operations and fuel supply. Overall, renewable energy deployment is expected to result in a neutral or positive gain in net employment nationally, but an uneven distribution of gains and losses across regions.
Champions	**Committed national government with support and action from private sector companies** National government engagement with unions National and regional renewable energy targets Government owned coal mining company diversifying operations by building renewable energy infrastructure (commencing with 1000 MW solar power projects).

1. As India is in the early stages of its energy transition the case study presents interventions and proposed interventions so their impact in terms of Just Transition still needs to be fully demonstrated.

Country case study: India (2)

From Zinecker at al. (2018)

Step	Description
Case	**Becoming a global renewable energy leader** Renewable energy has become cost competitive with coal, making a strong case for expanding renewable power generation rather than coal-based power generation. Further support added to the case for reform due to environmental and health concerns. Coal is responsible for an estimated 1.3 million deaths per year, mainly due to polluting coal based power plants. It is also estimated that eliminating harmful emissions from coal-based power stations could save 11 million years of life in India.
Measures	**Early dialogue and laying down of foundations** Diversification of coal companies. Innovative use of coal mines (e.g. exploring floating solar PV for collapsed mines). Decentralised energy in affected areas to create job opportunities. Tax breaks and technology hubs to help redirect coal supply chain companies to cleaner technologies. Retraining of coal workers for new job opportunities. Council for Green Jobs established in 2015: more than 70 courses enabling sustainability related careers via private institutions.

Key enabling factors (Zinecker at al. 2018)

- Develop a positive narrative for an energy transition and job opportunities
- Involve workers organizations, regions and businesses early on in an inclusive dialogue on a just transition
- Develop impact assessments for different scenarios at the regional and national levels, including both job losses and job gains, as well as mitigation measures
- Continue to support green jobs training, also in collaboration with coal companies
- Support localized industries, including decentralized renewables, that can counterbalance a loss of jobs and industries in coal regions

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Thank You

sarem@greencape.co.za
www.green-cape.co.za

Who we are

GreenCape is a non-profit organisation that drives the widespread adoption of economically viable green economy solutions.

We work with businesses, investors, academia and government to help unlock the **investment** and **employment** potential of green technologies and services, and to support a transition to a resilient **green economy**.

GreenCape was established in 2010 to support the development of the green economy in the region.

Vision

GreenCape's vision is a thriving prosperous Africa mobilised by the green economy.

Mission

We work at the interface between business, government and academia in order to identify and remove barriers to economically viable green economy infrastructure solutions in developing countries, thereby catalysing their replicable and large-scale uptake to enable each country and its citizens to prosper.

Ambition

In the next 5 years, GreenCape aims to be globally relevant in driving the uptake of green economy infrastructure solutions in the developing world context.