THE ELECTROTECHNICAL INDUSTRY REGIONAL VALUE CHAIN IN SOUTHERN AFRICA: A CASE FOR SOUTH AFRICA AND ZAMBIA

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Abstract

The Southern African Development Community (SADC) member states have placed industrial development at the core of the region's integrated development agenda. This report is the outcome of a study that is part of a programme that seeks to identify existing and potential opportunities to further the development of specific value chains among and across SADC member states. This paper specifically explores and assesses regional competitiveness and opportunities in the electrotechnical industry for both South Africa and Zambia. The study offers an in-depth assessment of the structure and status of the electrotechnical value chain in these countries by presenting production and consumption patterns, input suppliers and producers, export markets for products from the sectors, as well as the import patterns in relevant subsectors. This research looks at these themes for the purpose of informing cross-cutting country policy initiatives based on a shared understanding of industrial development challenges at a regional level.

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ABBREVIATIONS AND ACRONYMS

CEC	Copperbelt Energy Corporation
CSO	Central Statistics Office (Zambia)
DRC	Democratic Republic of Congo
dti (the)	Department of Trade and Industry (South Africa)
ECIC	Export Credit Insurance Corporation
EMF	Electromotive Force
EPCM	Engineering, Procurement, Construction and Management
ERB	Energy Regulation Board of Zambia
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GW	Gigawatt
GWh	Gigawatt-hour
HS	Harmonised System
IEA	International Energy Agency
IPAP	Industrial Policy Action Plan
IPPs	Independent Power Producers
IRENA	International Renewable Energy Agency
IT	Information Technology
kV	Kilovolt
LEWA	Lesotho Electricity Supply Industry
LHPC	Lunsemfwa Hydro Power Company
MCL	Maamba Collieries Ltd
MNC	Multinational Corporations
MVA	Mega Volt Amp
MW	Megawatt
NEC	Ndola Energy Company
NERSA	National Energy Regulator of South Africa
NIP	National Industrial Policy
NWEC	North Western Energy Company
OEM	Original Equipment Manufacturer
PIDA	Programme for Infrastructure Development in Africa
PPPFA	Preferential Procurement Policy Framework (South Africa)

PV	Photovoltaic
R&D	Research and Development
REFiT	Renewable Energy Feed-in (Zambia)
REIPPP	Renewable Energy Independent Power Producer Procurement
RERA	Regional Electricity Regulators Association of Southern Africa
RIDMP	Regional Infrastructure Development Master Plan
SADC	Southern African Development Community
SAEEC	South African Electrotechnical Export Council
SAPP	Southern African Power Pool
SARS	South African Revenue Service
SPV	Special Purpose Vehicle
TDP	Transmission Development Plan
TIPS	Trade & Industrial Policy Strategies
TCO	Total Cost of Ownership
UAE	United Arab Emirates
ZAMEFA	Zambia Metal Fabrications
ZESCO	Zambia Electricity Supply Corporation
ZIPAR	Zambia Institute for Policy Analysis and Research
ZPC	Zengamina Power Company

1. INTRODUCTION – SCOPE AND INTENTION OF THE STUDY

This report focuses on the electrotechnical industry, a sector of the economy that spans commercial enterprises engaged in the design, manufacture and marketing of machinery, apparatus and supplies for the generation, storage and utilisation of electrical energy. This is, sectorally, an industry covering electrical engineering, information technology (IT), telecommunications and electronics. This report is concerned with opportunities for further high-value addition in two Southern African countries: Zambia, where advanced and sophisticated manufacturing can be developed further; and South Africa, where production could be boosted around strong production capabilities. The report also looks at how performance of the industry in the two countries can be enhanced from a regional value chain perspective noting that, as the industry is wide and varied, the research project reduced its initial scope to focus on the electrical machinery and components that serve as inputs to the power and energy sector. This narrowing is relevant as the industry predominantly supplies the key components needed to keep electricity flowing through the electrical distribution system – common electrical equipment includes electric switchboards, distribution boards, circuit breakers, electricity meters and transformers.

This report is the product of collaborative research between Trade & Industrial Policy Strategies (TIPS) and the Zambia Institute for Policy Analysis & Research (ZIPAR) to build a shared understanding of the opportunities and bottlenecks in the electrotechnical value chain. This is ultimately to inform cross-country policy initiatives based on a shared understanding of industrial development challenges at a regional level.[1]

In line with the terms of reference, it offers an in-depth assessment of the structure and status of the electrotechnical industry by examining inputs used in power utilities in both countries with a focus on new power generation projects. South Africa and Zambia were selected because of the presence of some public utilities (Eskom and Zambia Electricity Supply Corporation, ZESCO) in power generation within SADC and the considerable demand for electrotechnical components by these firms. These factors highlight the potential for significant cross-border collaboration and growing input supplier capabilities.

The core objective is to provide an overview and analysis of the structure, key functions and characteristics of the electrotechnical value chain operating in and between South Africa and Zambia. The research also examines the end markets, with a focus on the main power utilities (Eskom and ZESCO) in their procurement of electrotechnical components for new projects and maintenance of existing power stations; the status of the supplier markets; and key issues in the production process. The study examines the utilisation of electrotechnical inputs by power utilities, in-country production capabilities, the source market in the region, and the key opportunities and constraints in the value chain.

[1] In pursuit of this, a series of studies have been undertaken with funding from the Department of Trade and Industry (the dti) to assess regional competitiveness and opportunities of selected value chains. These build on earlier work on regional development and integration across various economic sectors. This includes studies by the Centre for Competition, Regulation and Economic Development (CCRED), Corporate Strategy and Industrial Development (CSID), Administração de Infra-estruturas de Água e Saneamento (AIAS) and University of Zambia on inputs to infrastructure in Mozambique (Baloyi and Zengeni, 2015), mining machinery in South Africa and Zambia (Fessehaie, 2015); soy value chain in South Africa, Zimbabwe and Zambia (Takala-Greenish et al., 2015). It also draws on lessons from UNU-Wider studies on regional integration and growth: supermarkets (Das Nair and Chisoro, 2015, 2016 and 2017); implications for local suppliers in Zambia (Ziba and Phiri); animal feed and poultry (Ncube, Roberts and Zengeni, 2016); mining policies (Fessehaie, 2015); regional transport (Vilakazi and Paelo, 2017).

Beyond the main factors affecting the procurement of electrotechnical products in the region, this research looks at synergies that can be developed to generate a more enabling environment for growing the regional value chain, *potentially* leading to increased productivity and intra-regional trade. The research analyses demand for electrotechnical equipment by main product and the current production capacity in the region though details pertaining to the value chain have only been garnered for two southern African countries.

This approach analyses the main constraints on growth along the value chain and proposes strategies to overcome them. This is in a context of SADC member states having placed industrial development at the core of the region's development and integration approach. Ultimately, the key question that needs to answered is: where can South Africa and Zambian firms best compete against international firm given the capabilities in the region to manufacture electrical machinery and components for new power generation projects?

Some of the key findings in this report include:

- Electricity generation is the main driver of demand for the electrotechnical industry's goods (components and products) and services (solutions, operations and services).
- There are 85 planned electricity generation projects across the SADC region for the next five years (31 are in South Africa and five are in Zambia).
- South Africa operates as a regional base for both South African Original Equipment Manufacturers (OEMs) and international OEMs of electrical machinery and components.
- These OEMs adopt various modalities to enter the Zambian market – some establish a direct presence while others operate through agents.
- The procurement function is controlled by the public utilities (Eskom and ZESCO)
- Engineering, Procurement, Construction and Management (EPCM) firms play an important function as well because they provide turnkey solutions to the public utility companies and Independent Power Producers (IPPs). They also source components from OEMs and components suppliers operating down the industry value chain.
- By leveraging regional value chains, particularly in the copper sector, regional cooperation would increase not only trade flows, but also the skills, knowledge and technological content of the activities taking place in the region.
- While the research has been able to identify one of the major components (transformers) in this value chain (in an analysis of trade data), a business case would need to be developed on the viability of building the value chain for this component, among others.
- For SADC countries to realise their productive potential, greater coordination and integration of national energy and industrial policies will be required in alignment with the corporate strategies of domestic and transnational firms operating across the region. Countries are designing their upstream linkage policies individually within narrow domestic frameworks.

Section 2 of the report describes the methodology and data sources. Section 3 considers the policy environment and regulatory framework governing the power sector and the industrial development of manufacturing power generation equipment and related electrical machinery. Sections 4-6 analyse electricity generation and the electro-technical industry from a global to a regional perspective and focus on South Africa and Zambia from a national perspective. Section 7 is a case study on one of the major components manufactured by the industry, transformers. Sections 8 and 9 detail the overall findings and conclude.

2. METHODOLOGY AND DATA SOURCES

The research methodology uses an approach that emphasises understanding the binding constraints on industrial development and addresses them as central to effective industrial policies. Constraints are understood as arising from both the nature of demand and competition, and supply-side blockages to production. The research team mapped the electrotechnical industry's input-output relationships along the value chain streams. This assessment was carried out at each level of the electrotechnical industry value chain to identify the entry points for producers at both the upstream and downstream product segments, and crucial success factors in final markets and access to final markets. The data collection tools were designed to allow for collection and analysis of the perceptions and experiences in each country from key sector players.

In addition, this research sought to identify viable smaller-scale technologies that could support more broad-based growth and reduce the risks of new investments. To evaluate the key constraints on the electrotechnical equipment value chain in the selected countries, the study drew on available data and, when that proved insufficient, on interviews with industry experts (eg. ZESCO employees) in Zambia and the industry export council in South Africa. An evidence-based approach for this study was adopted, based on compiling industry data from existing and new sources. The data sources include UN Comtrade, Trade Map, Quantec, UNCTAD, Eskom, ZESCO, International Energy Agency (IEA), Statistics South Africa, Southern African Power Pool (SAPP) and the South African Revenue Service (SARS).

The value chain analysis sought to answer the following questions:

- How is the value chain organised?
- How does it function? Who are the main actors?
- What are the key institutions and forms of coordination?
- How "well" is the chain performing, in coordination, competitiveness and intra-regional trade?
- Where are the opportunities to:
  (1) "Relocate" parts of the chain to other countries in the region; and
  (2) Enhance existing intra-regional activities?

To answer these questions, the following activities were undertaken:

- Scope in detail the profile and key drivers of the electrotechnical sector in each participating country;
- Identify the key value chain drivers;
- Assess the level of value chain integration;
- Identify the presence and role of the dominant (potentially lead) firms;
- Identify areas for greater regional collaboration (in both direct and support chain activities);
- Identify areas of duplication across the two country-specific value chains; and,
- Critically assess the role of the broader institutional environment in facilitating or hindering more effective chain performance and regional collaboration.

The selected methodology was chosen to ensure that national trade and production datasets of SADC member states were comparable, and further to ensure that the same value chain approach was applied to both countries.

3. POLICY AND REGULATORY FRAMEWORK

3.1 Industrial development in the region

Developing integrated regional value chains opens opportunities for industrialisation across a region. The challenge is to develop practical measures to support collaboration based on a fair division of labour and production activity, and to ensure that as production expands, it is competitive internationally at the regional level. While the latter would rely on the presence of local/regional capabilities and well-priced inputs, another crucial step for a regional value chain from a regional perspective is to reduce the cost of logistics (including regulatory delays and fees) while at the same time ramping up transport and communications infrastructure.

Industrial policies further matter for regional industrial development. On this, the South African government has an assortment of industrial policy tools which it draws on to develop the manufacturing capability available in the country. These tools or instruments include manufacturing enhancement programmes, supplier/enterprise development initiatives, competitive supplier development programmes and designations. Various iterations of the Industrial Policy Action Plan (IPAP) put significant emphasis on leveraging public procurement for domestic manufacturing and creating decent and sustainable job opportunities. IPAP also recognises the capital and operational expenditure by government and state-owned companies, which emanates from the public infrastructure build programme as the main opportunity to resuscitate local manufacturing capacity and capability.

A further policy consideration, from the demand-side, is the approach taken by the different regional governments to local content. On this, and for Zambia, Fessehaie and Rustomjee (2018) detailed an important conflict around legislation and regulation aimed at increased local content. Different policies and organisations within the Ministry of Commerce, Trade and Industry, the Ministry of Mines and Mineral Development, and the Zambia Development Agency have or are developing separate approaches to local content measures, which creates policy uncertainty. An example of policy incoherence is the divergence between the ministry responsible for industry, which wants mandatory local content provisions, and the Zambia Development Agency, responsible for foreign direct investment (FDI), which regards local content measures as blunt instruments and favours a gradual, targeted approach to localisation, coupled with support for manufacturers.

Local content policy mismatches are a separate issue for regional development. Fessehaie (2015) highlighted policy incoherence at a regional level that continues to be a bottleneck for regional collaboration. Yet, specifically, OEMs face conflicting local content policies in South Africa and Zambia and the dti's Export Credit Insurance Corporation (ECIC) local content requirements for a South African exporter into Zambia clashes with increasingly stringent localisation requirements set by the Zambian government.

The Zambia Development Agency is charged with FDI promotion through Multi-Facility Economic Zones. These create incentives for foreign firms that are not always consistent with a localisation agenda, for example through duty-free import incentives. At the same time, Zambia's national import tariff system discourages local assembly with duties on inputs and components, and often zero-rated imports of assembled equipment. Finally, industrial policies do not provide incentives for local manufacturers to upgrade their technological capabilities and skills. As a result of weak policy frameworks, and possibly to avert mandatory

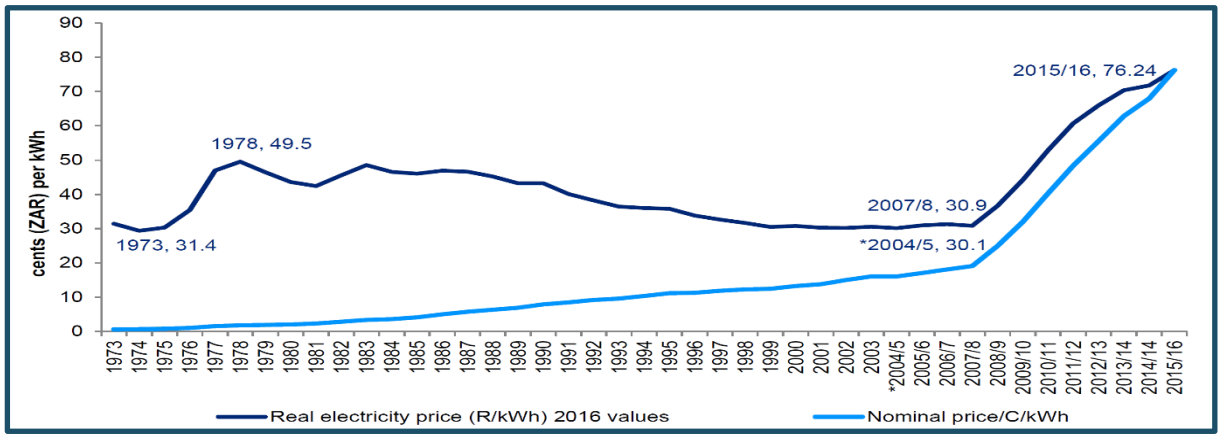
regulations, the private sector has taken the lead, with domestic manufacturing interests setting up a local content programme (Fessehaie and Rustomjee, 2018).[2]

Reciprocal and harmonised incentives schemes within SADC would provide a better framework to promote regional investment, strengthen regional value chains and achieve mutually beneficial outcomes. There is recognition of some of the issues at hand. Thus, the government of Zambia is working towards removing administrative barriers to business entry and operation in order to facilitate industrial development in priority sectors listed in its National Industrial Policy (NIP) document. While the NIP focuses on eight manufacturing subsectors as priority drivers of industrialisation, these include mineral beneficiation and engineering products.[3] By linking mineral processing and beneficiation and engineering, the electrotechnical industry's goods and services is a key sector in Zambia. Indeed, the manufacturing of electrical components and machinery such as cables and transformers require key inputs from the copper industry in which the country has a comparative advantage.

3.2 Policy issues affecting electricity generation in the region

In Africa, the cost of electricity supply differs widely among different customer categories. The common denominator is that the cost of supply is lowest for large-scale industrial users, whereas that to residential users is significantly higher. More electrical networks have to be built, maintained and operated to supply smaller customers than those that are required for larger customers on higher voltage networks. The average price of power in Africa is twice that of other developing regions, but the supply of electrical power is unreliable throughout the continent.

Figure 1: Trend in average electricity prices realised by Eskom per kWh (1973-2016)



Source: Eskom and Deloitte (2017)

The current tariff structure is the greatest barrier for more investments and implementations in the power sector, as the tariffs are often politically driven and low in comparison to the cost of power generation. For example, from 2008 the trend in electricity prices in South Africa took a dramatic turn (Figure 1) when the power supply crisis that had been threatening

[2] It is unlikely that private-sector initiatives will be able to address the structural constraints to manufacturing competitiveness. The latter requires a comprehensive approach, with effective and coordinated public interventions to address access to finance, engineering, technical and vocational skills and infrastructure development.

[3] The other sectors are processed foods, textiles and garments, blue economy, pharmaceuticals, wood and wood products, leather and leather products, and mineral processing and beneficiation.

for several years reached a critical point, forcing Eskom to introduce loadshedding, followed by a green light to embark on a massive build programme to increase power generation capacity. But at this point electricity tariffs were at long-term-lows and Eskom had neither the cash reserves nor the future revenue streams to cover the cost of the new build. To enable Eskom to begin raising the capital it required, the National Energy Regulator of South Africa (NERSA) approved several sharp increases in annual tariffs and, in the five years between 2008 and 2013, electricity prices more than doubled in real terms (inflation-adjusted) rising by a cumulative 114% while nominal prices rose by 191% over the same period (Deloitte, 2017).

In 2014/15 NERSA approved an average tariff for Eskom of 67.7c/kWh but Eskom estimated that full cost recovery based on "normalised" costs would have required an average tariff of 83.9c/kWh. The normalised costs excluded higher-than-anticipated fuel costs that were incurred to avoid loadshedding – all costs above a business-as-usual load factor of 3% were excluded, although in Eskom's view these abnormal costs were still "prudently and efficiently" incurred. In addition, to reflect Eskom's commitment to realising cost-efficiencies, R10 billion worth of costs were already removed from primary energy and operating and maintenance costs. Despite the exclusion of abnormal costs and committed cost-efficiencies, electricity tariffs were still 20% below full-cost recovery in 2014/15 and Eskom faced a R35 billion revenue shortfall in that year (Deloitte, 2017).

This is changing, with countries such as South Africa, Tanzania, Kenya, Ghana and Nigeria implementing cost-reflective tariffs to sustain their electricity infrastructure and attract private investment. Also, across the sub-region, countries have established independent regulatory agencies for their power sectors. Implementing a cost-based tariff structure will have a lasting impact on public utilities, private power producers, and domestic, industrial, and mining consumers in the target economies. Key to success will be a pricing regimen that does not push the cost of electricity beyond what is affordable for industry and households, which would risk dampening demand. Although low electricity tariffs have historically provided South Africa a competitive advantage, the lower return on investment and paucity of funds have crippled the development and maintenance of the electricity infrastructure; while the more recent electricity price hikes have pushed energy-intensive users to the brink with firms either reducing capacity or closing down. The stagnant demand in South Africa's electricity industry bears witness to this conundrum.

Many Sub-Saharan African countries have in the past two decades been migrating to market-based and liberalised power sectors. Liberalisation has been restricted to a "top-down" approach, however, wherein only electricity generation is open to competition, while transmission and distribution remain managed by state-owned enterprises. Still, IPPs are steadily emerging as the fastest-growing source of investment in the sub-continent power sector. Development of the Renewable Energy Independent Power Producer Procurement (REIPPP) programme in South Africa showcases the private sector's willingness to invest in the power sector. Independent regulation is also being rolled out to insulate tariff-setting from political influence and improve the climate for private investment through more transparent and predictable decision-making. Countries have established independent regulatory agencies for their power sectors. The Regional Electricity Regulators Association of Southern Africa (RERA) was established by SADC as a formal association of electricity regulators.

4. GLOBAL AND REGIONAL ELECTRICITY GENERATION AND ELECTROTECHNICAL INDUSTRY – CURRENT AND PROJECTED DEMAND

4.1 Electricity generation

Global

A number of trends are driving the demand for electrical machinery. Global investment in new power generation is a key indicator of growing demand, in turn strongly dependent on economic growth.

That demand is growing globally is well documented. The demand for electricity worldwide was projected to have grown at an annual rate of 2.7% for the period 2007-2015 by the IEA, slowing down to 2.4% a year during the period 2015-2030 as economies mature, and the generation and supply of electricity becomes more efficient. Over 80% of the growth between 2007 and 2030 is expected to be in non-OECD countries. The demand in these countries is expected to grow by 5% a year up to 2015, slowing down to 3.3% a year from 2015 to 2030.

The IEA's World Energy Investment 2018 report indicated that total energy investment worldwide in 2017, including capital spending on energy supply and improvements in end-use energy efficiency, is estimated to have amounted to US$1.8 trillion. This amounted to 1.9% of global gross domestic product (GDP), a lower share compared with the previous two years; however, the power generation sector accounted for most of the decline, due to fewer additions of coal, hydro and nuclear power capacity, which more than offset increased investment in solar photovoltaic (PV).

Noting changes in the composition of power, the most promising markets for growth are emerging economies, where new capacities have to be established to meet the growing demand for electricity. In developed countries, demand for the construction of power generation plants decreased after World War II when sufficient capacities had been installed. Since then, demand for power generation equipment has lost importance and replacement has become the driver of demand. In developing countries, however, many countries suffer from infrastructure deficits, which provides opportunities for new power generation projects and equipment to increase capacity and electrification.

Generally, looking further forward, global demand for energy is expected to climb about 25% by 2040, according to the IEA. Essentially, this demand growth will come from non-OECD nations, particularly the expanding economies in the Asia Pacific region. Continuing urbanisation and a significant expansion of the middle class, particularly in China and India, drive this trend, fuelled by greater access to modern energy in homes, rising industrial demand, and significant increases in personal and commercial transportation needs (IRENA, 2017). Growth in global energy demand will be led by increasing electrification; 55% of the world's energy demand growth over the next quarter century will be tied to power generation to support increasingly digital and plugged-in lives. A consequence of this trend will be a large uptick in demand for many types of energy used to generate electricity, notably less carbon-intensive sources such as natural gas, nuclear, solar and wind as more clean energy options and technologies are explored globally.

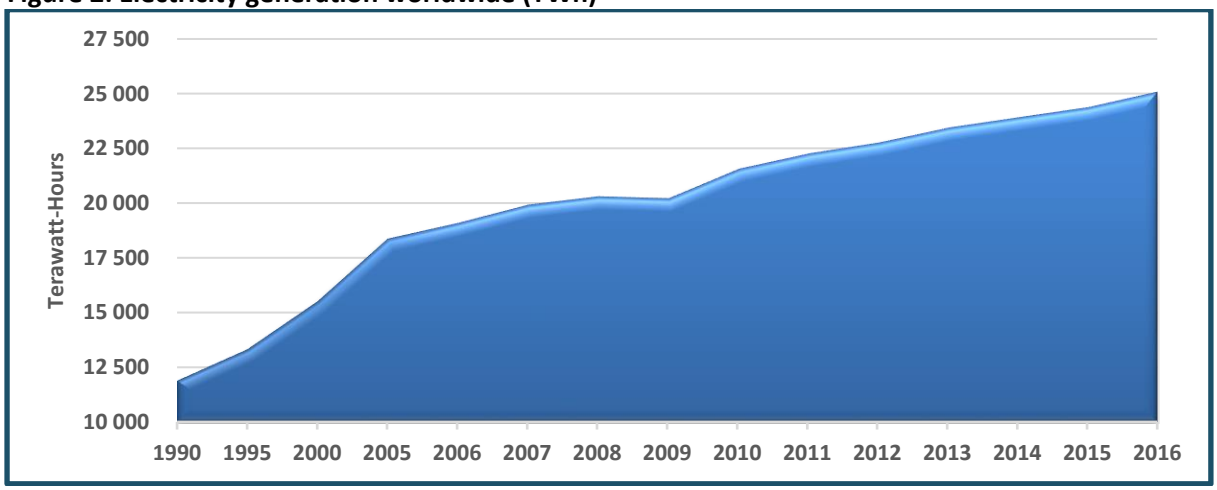
According to IRENA (2017), around a quarter of all electricity was generated from renewables in 2017. The share of renewable power in total energy use would grow from about 20% in

2015 to 40% in 2050, with the remaining renewable energy directly used for heating, cooling and transport. Such a high share of renewable power would create substantial challenges that must be tackled during the transition from mainly coal-based power generation to a more diversified energy generation mix. Electrification of end-use sectors (residential and corporates) will continue to grow, coupled with renewable power. Within transport, railways are the largest users of electricity. Electrifying end-use energy applications (e.g. electric instead of combustion engine vehicles; heat pumps instead of thermal boilers), which has multiple benefits to both society and the overall economy, will also continue to expand.

Economic and population growth coupled with accelerated electrification of the heating, cooling and transport sectors, mean that demand for electricity is expected double between 2015 and 2050 (IRENA, 2017). This growth in electricity demand presents a substantial opportunity for decarbonisation and for new entries of power generation equipment and other electrical machinery suppliers to enter the market.

The volume of electricity generated worldwide has steadily increased over the past decade from 19 092 terawatt hours in 2006 to 25 082 terawatt hours in 2016 (Figure 3). Coal, peat, and oil shale accounted for 40.8% of electricity generated globally in 2014. However, the share of renewables used to produce electricity is increasing. In 2015, a total capacity of 434.86 gigawatts derived from wind power had been installed around the world.

Figure 2: Electricity generation worldwide (TWh)

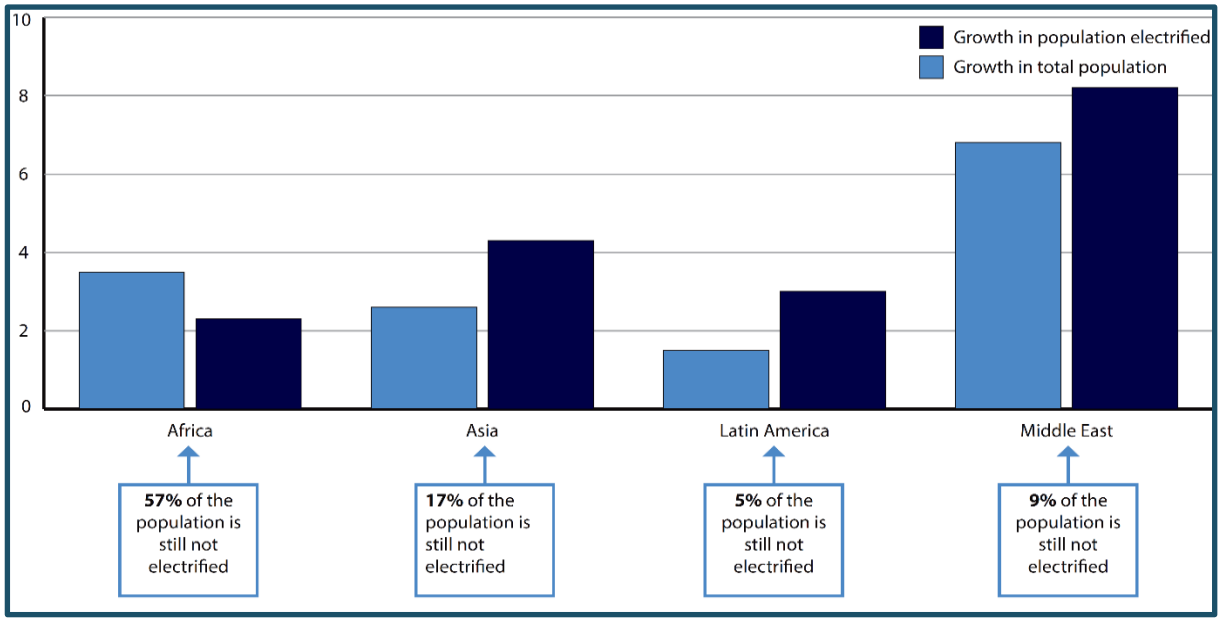


Source: Statista (2018)

Africa

With many regional governments prioritising increase in access to electricity (GRZ, 2017; World Bank, 2009; LEWA, 2018), capital investments in the power sector are projected to increase significantly. According to ESI-Africa (2018) the global power sector is expected to invest US$2.20 trillion in power generation between 2017 and 2021 on the continent. This is because Africa has fallen far behind other developing country regions in building installed generating capacity. Africa's capacity has developed at only about 3% annually over the last three decades. This has been below the region's GDP growth rate averaging 5% since 2010. The rate of access to electricity in Africa has also stagnated as population growth has exceeded growth in new connections. No other developing region has a mismatch of this kind, with such a large percentage of the population without access to electricity (Figure 2). About 57% of Africa's population remains without access to electricity.

Figure 3: Rate of electrification versus population growth and share of population without electricity access in 2015 (percentage)



Source: UNECA (2015)

Demand in Africa has shifted from large coal and oil-fired power plants towards gas power generation, combined heat and power stations and the substitution of fossil fuels with bio-fuels that poses different requirements on burning processes. Moreover, different techniques have been developed for renewable power generation, in particular wind, solar, wave and geothermal electricity generation. The demand for electricity is set to increase considerably on the African continent and the demand for power generation will be driven by increasing generation capacity, the refurbishment of existing plants and the replacement of outdated plants by new power generation technologies (IEA, 2018). Moreover, new power generation technologies are by far more capital intensive than traditional large coal or gas fired plants per one gigawatt (GW) installed power. Additionally, capital costs are driven upward due to low capacity utilisation, in particular of wind and solar power generation.

It is projected that electricity demand in Sub-Saharan Africa will increase at a compound average annual growth rate of 6% (IEA, 2018). The cost of addressing Sub-Saharan Africa's power generation subsector needs has been estimated at US$31.7 billion a year while existing investment is far below what is needed (ECIC, 2017).

Being expensive and technically complex, Africa's energy infrastructure projects have demanded outside assistance from large international energy players such as contractors from China, which have revolutionised energy development on the continent. The IEA revealed that between 2010 and 2015, Chinese firms contributed 30% of the utility-scale new power generation capacity built in Africa. Furthermore, they are expected to install about 28 000 kilometres of new electricity transmission along with distribution lines. Nearly 56% of the additional generation capacity developed, under construction or scheduled by Chinese companies in Africa this decade is from renewable sources, with large-scale hydropower being the majority. Projects in planning or under construction subsequently equate to a renewable ratio increase of two-thirds.

The SADC region

A total of 30 646 MW is planned to be commissioned between 2017 and 2022 (Table 1) in the SADC region. The SADC Regional Infrastructure Development Master Plan (RIDMP) Energy Sector Plan has identified 73 power projects that will increase generation capacity from the current estimate of 60 000 MW and ensure that the projected demand of 96 000 MW is surpassed by 2027. A total capacity equivalent to 4 180 MW was commissioned in 2016 with projects from Public Utilities and IPPs put into place.

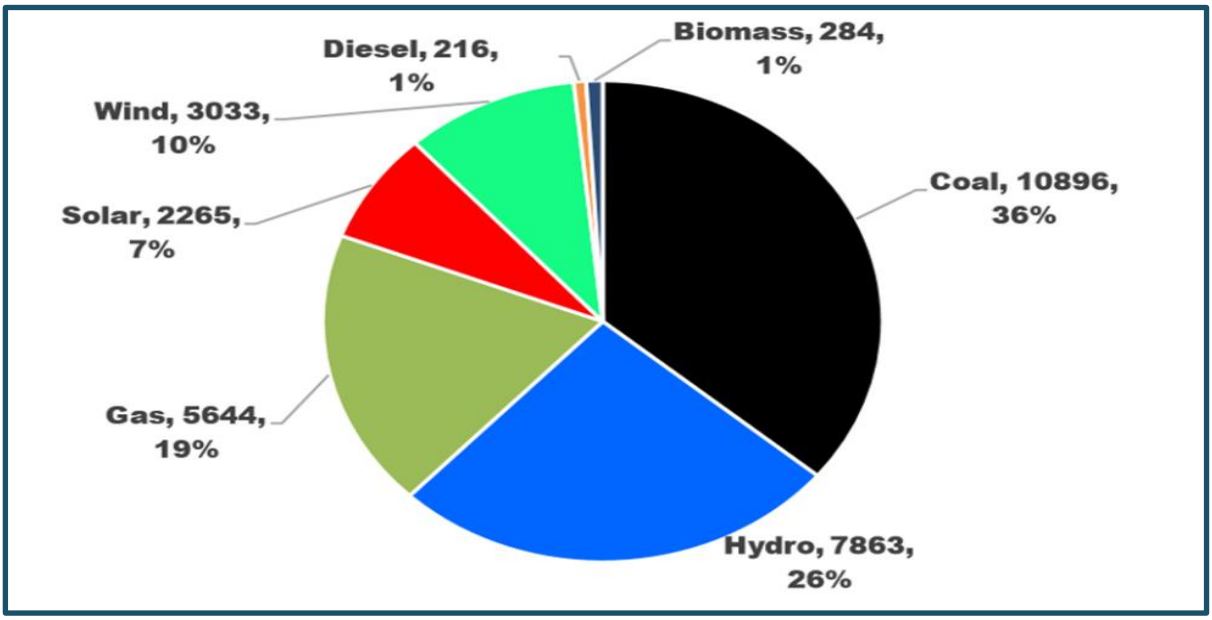
Table 1: Committed generation capacity (MW) per country in the SADC region (2017-2022)

No	Country	Committed Generation Capacity, MW							
		2017	*2018*	*2019*	*2020*	*2021*	*2022*	Total	% Share
1	Angola	1727	1269	0	0	0	0	2,996	9.78%
2	Botswana	120	-	-	300	-	-	420	1.37%
3	DRC	150	-	-	360	-	1,500	2,010	6.56%
4	Lesotho	-	20	-	-	-	-	20	0.07%
5	Malawi	36	12	132	340	310	100	930	3.03%
6	Mozambique	40	130	30	-	-	550	750	2.45%
7	Namibia	60	-	37	-	800	-	897	2.93%
8	RSA	1,128	3,037	4,035	2,028	3,044	1,516	14,788	48.25%
9	Swaziland	-	-	12	-	-	-	12	0.04%
10	Tanzania	120	305	1,260	565	50	675	2,975	9.71%
11	Zambia	15	113	300	790	930	-	2,148	7.01%
12	Zimbabwe	120	540	630	600	810	-	2,700	8.81%
TOTAL		3,516	5,426	6,436	4,983	5,944	4,341	30,646	100%

Source: SAPP (2017)

In terms of the generation mix, renewables contributed 21% (886 MW) of the total generation capacity in 2017.

Figure 4: New Generation Capacity, MW (2017-2022)



Source: SAPP (2017)

In the medium term, power generation projects using renewable energy technologies are estimated to amount to 44% of new generation capacity to be installed (Figure 4) through the commissioning of 57 renewable energy projects in the region. The market demand for machinery and services supplied by the electrotechnical industry will be driven by these projects in the region over the medium to long term.

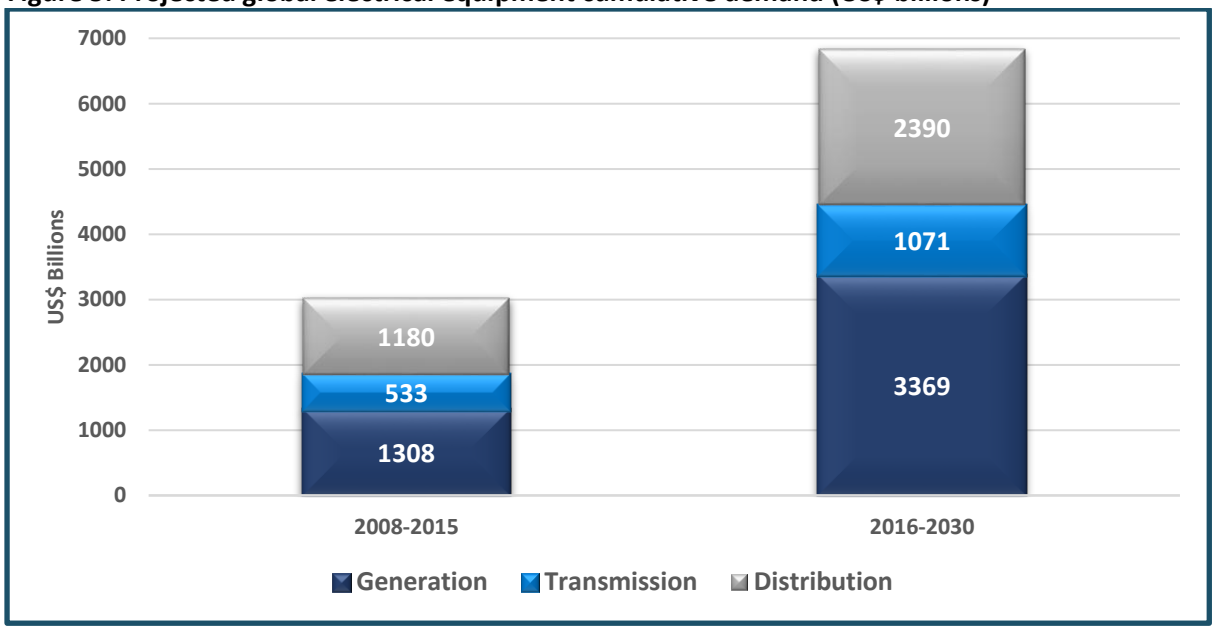
4.2 Electrotechnical industry

Global demand for electricity generation, transmission and distribution equipment rose to US$177 billion in 2017. The global electrical machinery equipment industry consists of the following two segments:

- Global heavy electrical machinery equipment market — power generating equipment, including wind turbines, and other heavy electrical equipment such as power turbines, heavy electrical machinery intended for fixed-use and large electrical systems.
- Global electrical machinery components and equipment market — such as electric power cables, transformers and electrical switchgear, and transmission line towers. Interestingly, however, the biggest segment of the electrical machinery and equipment market is in this segment notably with the sales of power cables, which generates sales of more than US$60 billion a year, or 30% of the electrical machinery and equipment industry sales.

Geographically, Asia-Pacific and Europe together account for more than 70% of the global market, with Asia-Pacific's share being 45%. This region is expected to see the strongest demand in the future due to the region's strong expected economic growth rates.

Figure 5: Projected global electrical equipment cumulative demand (US$ billions)



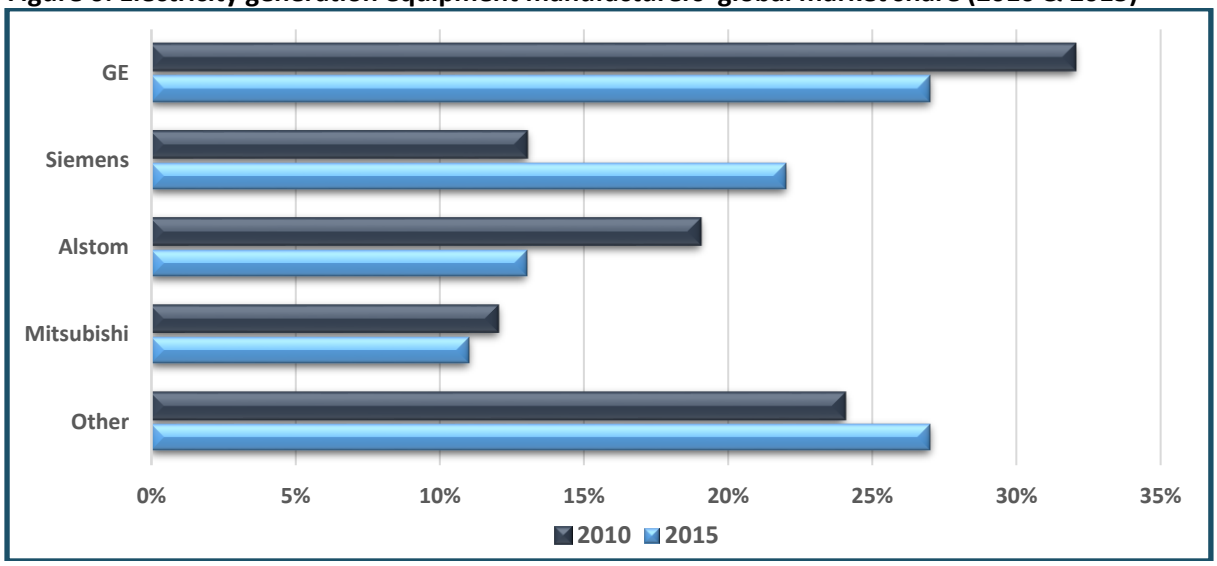
Source: IEA World Energy Outlook (2011)

Globally, sales growth is projected to accelerate relative to the 2007-2012 performance, aided by both continued strong growth in electricity consumption in developing regions and economic recovery in developed countries. In 2011, the IEA estimated that the global market for electrical machinery and equipment is expected to increase from more than US$3 trillion (2008-2015) to US$6.8 trillion (2016-2030). This translates into a 2% compounded annual average growth rate over the long term (Figure 6).

However, according to Who Owns Whom (WOW 2017b), the global market for electrical machinery and equipment is expected to reach an estimated US$304 billion by 2022 and is forecast to grow at a compounded annual growth rate of 6.2% from 2017 to 2022.

Globally, growth rates have been less than impressive in recent years in the electrical equipment market, but there is scope for expansion in certain geographical areas, such as the emerging markets in the Asia-Pacific region. Robust economic growth in emerging countries such as China and India, combined with rapid urbanisation and strong growth in fixed investment spending in these countries, is expected to boost the demand for electrical equipment in these countries. This boost is in turn supported by deregulation in the power sectors of most countries, with an increase in the number of independent power distributors and operators that are capable of supplying services at different points in the power sector value chain. In developed countries, rising ecological concerns and investment in alternative sources of power generation should benefit the heavy electric power equipment segment such as the wind turbines.

Figure 6: Electricity generation equipment manufacturers' global market share (2010 & 2015)



Source: Marketline (2011) and Statista (2018)

The global electrical machinery market for power generation is a mature industry with sales growing in the low single digits each year. The industry is dominated by a few multinational corporations (MNCs), namely Alstom, General Electric, Mitsubishi and Siemens, which together hold about 73% of the total market share by value (Figure 7). High fixed costs and low switching costs for buyers intensify rivalry between players. These large conglomerates tend to snap up smaller electrical equipment manufacturers because it is an industry where scale matters in relation to margins (Marketline, 2011).

The reason scale matters is because manufacturing is capital intensive with high fixed costs related to building the factories needed to manufacture electrical machinery and equipment. Further, because the industry uses materials like steel, aluminium and copper, which can have volatile prices, scale and diversification can help to mute the impact of commodity prices.

The large size of the companies is further explained by the fact that exit barriers are high, with the divestment of specialised assets being a costly necessity. However, many of the large

market players operate in diversified markets, meaning they are less reliant on revenues from electrical components and equipment sales.

As large manufacturers benefit from economies of scale, electrical equipment is a hard market to set up in. To succeed in this market, newcomers need to be able to compete with established companies, meaning that large-scale operations need to be set up. This means large capital outlay. Yet, it is possible for small companies to enter this market by occupying a niche position: different buyers may need a variety of different products. Technology and production development is essential here to compete successfully (Marketline, 2018).

A global push to change the way electricity is generated and used is forcing MNCs, such as General Electric and Siemens, to rethink their strategies. Electrical machinery manufacturers that can find a new niche to thrive in – whether gas, wind, or transmission –will fare better than those too reliant on carbon intensive energy sources, such as coal. The power generation market has become more diversified, driven by the need to reduce the effects of climate change. With further emphasis on carbon efficiency and energy security, alternative energy generation is likely to continue to grow and will require investment in suitable generating infrastructure, including wind turbines.

Overall, growth rates have been modest in recent years; however, there is scope for expansion in certain geographical areas (e.g. the emerging markets of Asia-Pacific for reasons already detailed) as well as growth in fixed investment spending (especially in infrastructure, such as roads and electricity generation). These prospects have become enticing for new entrants.

What is the situation in the SADC region? Electrical components are imported. China is currently the largest supplier of electrical machinery and equipment and parts thereof. The second largest supplier to the regional economic block is South Africa. On average, SADC member countries imported 9% of their total annual imports of electrotechnical products over the period 2011 to 2015 from South Africa. The top three major source countries over the five-year period have been China, United Arab Emirates (UAE) and Germany. Although SADC is the largest export market for South Africa, South Africa accounts for a very small share of trade in the sector. The low proportion of South Africa's exports to the SADC region relative to the regions overall imports would, in fact suggest opportunities for increased market access and the substitution of imports from other major markets such as China, Germany, the UAE, United States, France and Vietnam.

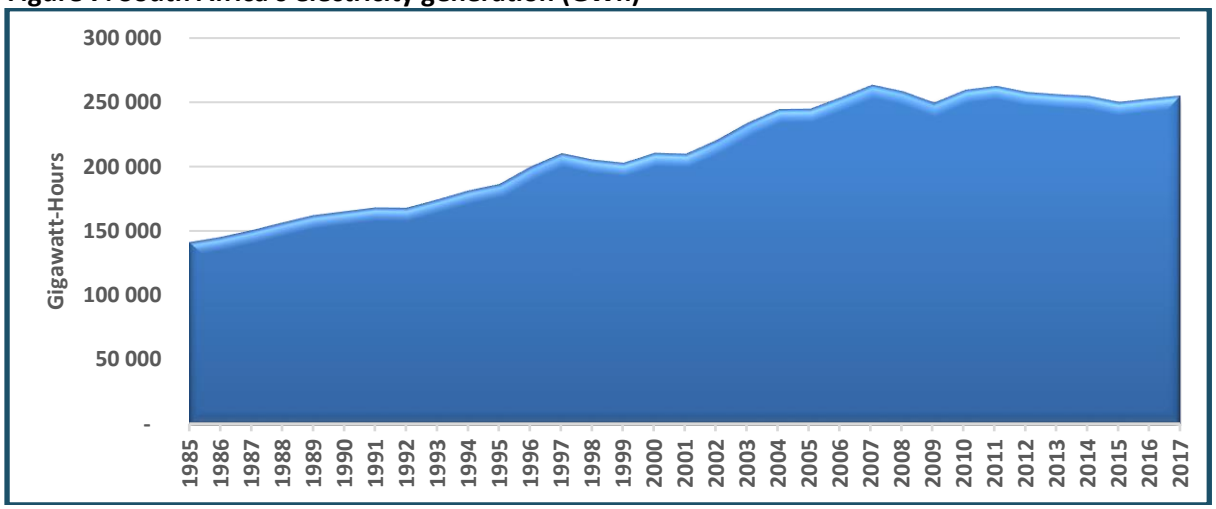
5. SOUTH AFRICA'S ELECTRICITY GENERATION AND ELECTROTECHNICAL INDUSTRY

The South African electrotechnical industry comprises the electrical engineering, electronics, IT and telecommunications industries (the dti, 2010). The industry covers a broad range of products and services that contribute directly to the sector itself as well as the broader manufacturing and value-added technology sector in South Africa. The industry plays a crucial role not only in the development of manufacturing nationally and in ensuring that South Africa is able to compete at a technologically advanced level on the global stage, but also in underpinning many other sectors that are critical to South Africa's development and success in the global environment. One of these main sectors is in energy.

5.1 Electricity generation

Energy generation in South Africa increased significantly over the past three decades at an average annual growth rate of 1.9%. Figure 8 is indicative of the growth and stabilisation of the trend when the average annual growth rate of electricity generation declined by 0.3% between 2007 and 2017. This decline was due to lower demand for electricity caused by a number of factors. These include, among others, lower economic growth; improved energy efficiency by large consumers to cushion against rising tariffs; fuel switching to liquefied petroleum gas (LPG) for cooking and heating; fuel switching for hot water heating by households; and the closing down or relocation to other countries of some of the energy intensive smelters (DoE, 2018). The forecasted electricity demand outlined in the updated Integrated Resource Plan of 2018 indicates that with an assumed annual GDP growth of between 1.3% to 3.2%, demand for electricity will increase annually by 1.2% to 2.0% by 2030 and 1.2% to 1. 7% by 2050.

Figure 7: South Africa's electricity generation (GWh)

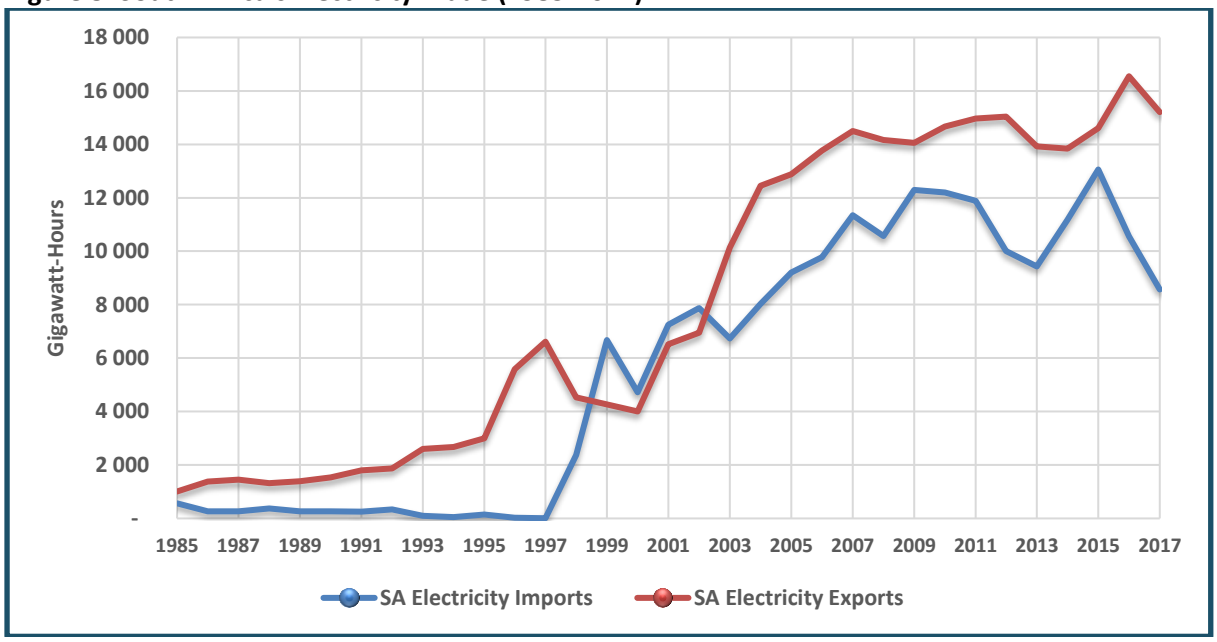


Source: Stats SA (2018)

The South African energy sector is dominated by the national utility Eskom, which is responsible for the majority of generation, transmission and distribution of electricity. South Africa is, however, also home to Africa's biggest IPPs market, which is planned to contribute 30% of South Africa's future generation capacity (DoE, 2018) by 2030. A total of 137 municipal power companies, that buy 40% of electricity generated by Eskom to supply end-users, hold negligible generation capacity. Generation is dominated by coal power; however, this

dominance is expected to decline in anticipation of increased investments in gas and renewable energy technologies. Being an integral part of the SAPP, South Africa imports and exports electricity from and to its neighbouring countries (Figure 9).

Figure 8: South Africa's Electricity Trade (1985-2017)



Source: Stats SA (2018)

It should be noted that total electricity imports declined to 8 568 GWh in 2017 with exports reaching 15 201 GWh in that year, resulting in a trade surplus of 6 633 GWh. Through Eskom's Southern African Energy Unit, South Africa imports electricity from Lesotho, Mozambique, Zambia and Zimbabwe and exports electricity to Botswana, Lesotho, Mozambique, Namibia, Swaziland, Zambia and Zimbabwe.

To increase export sales, Eskom concluded new export sale agreements with a number of regional trading partners, ranging from 50 MW to 200 MW. In 2017 Eskom signed a deal with Namibia and in April 2017 Eskom signed a new three-year deal to export electricity to Botswana (WOW, 2017a).

Eskom's Transmission Development Plan (TDP) for the period 2018 to 2027, plans to increase the transmission infrastructure by about 6 700 kms of high-voltage lines and 41 000 MVA of transformation capacity in the next 10 years.

This is part of its commitment to capital investment in infrastructure and why Eskom currently has one of the largest capital investment projects in the country. Eskom is investing in its own infrastructure, while creating a new electricity market in South Africa and it is playing a critical role in the connection of IPPs. Large-scale renewable generation projects in areas such as wind and solar energy are being connected to the grid, as highlighted in Table 2, with the majority of the planned generation projects for the next five years being in renewable technologies.

Table 2: Planned power projects in South Africa for the next five years

Country	Project Name
South Africa (31)	600 MW KiPower Coal-fired Power Plant
	100 MW Redstone Solar Thermal Power
	258 MW Scatec Solar Plants
	141 MW Nxuba Wind Farm
	142 MW Oyster Bay Wind Farm
	142 MW Karusa Wind Farm
	45 MW Aggeneys Solar Plant
	56 MW Konkoonsies II Solar Power Plant
	120 MW Golden Valley Wind Farm
	140 MW Roggeveld Wind Project
	86 MW Droogfontein 2 PV Project
	140 MW Kangnas Wind Farm
	110 MW Perdekraal East Wind Farm
	140 MW Garob Wind Farm
	500 MW Blackbird-Wadamba Wave Energy Facility
	Combined-cycle Gas Turbine Power Plant, Coega Industrial Development Zone
	1500 MW Northern Cape Solar Power Plant
	25 MW Electrical Biomass Power Plant
	400 kV Borutho Substation - Nzhelele Substation Transmission line
	200 MW Aberdeen Wind Farm
	86 MW Orange Solar Project
	75 MW Zeerust Solar Plant
	50 MW De Wildt Solar Plant
	75 MW Waterloo Solar Park
	68 MW Bokamoso Solar Plant
	55 MW Greefspan Solar Power Plant No. 2 Solar Park
	75 MW Sirius Solar Project One
	75 MW Dyason's Klip 2 Solar
	75 MW Dyason's Klip 1 Solar
	100 MW Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility
	30 MW Lephalale Solar PV plant

Source: Programme for Infrastructure Development in Africa (PIDA) (2017)

There are also, as implicit in the trade discussion, cross-border transmission lines to Namibia, Botswana, Zimbabwe, Mozambique, Swaziland and Lesotho, that allow electricity to be traded with the rest of Southern Africa. It is one of Eskom Transmission Group's strategic objectives to increase the capacity of these interconnections to allow for greater volumes of electricity to be traded to reduce upward pressure on tariffs and improve security of electricity supply in South Africa in the longer term.

The Medupi and Kusile power stations are due to be completed during the period covered by this TDP, along with any remaining transmission network reinforcements to accommodate the stations' full output. In addition, further IPPs, renewable and conventional generation as determined by the Department of Energy, will be connected to the network. New loads

need to be connected, which require additional network capacity to load centres around the country.

The planned increase in conventional generation of approximately 15 GW together with 11 GW of renewable energy will ensure access to electricity for more South Africans in their homes, as well as supplies to schools, clinics, hospitals, businesses, mines and industries to promote economic growth and job creation (Eskom, 2018).

5.2 Electrotechnical industry

The progressively complex integrated power generation and distribution solutions, combined with significant diversification, business and technology acquisitions, technology advancements and complex managed power solutions, mean that ascertaining the actual size or value of the local power generation equipment industry is challenging. However, in 2014 the South African Electrotechnical Export Council (SAEEC) reported that South Africa has a dynamic electrical engineering sector (which includes electrical machinery and engineering services in the power sector) that generated revenues of around US$11.6 billion per annum; in 2018 the Council estimated the total market size of industry to be about R253 billion (SAEEC, 2018)[4].

The structure of the local electrical engineering sector comprises service providers for large infrastructure projects complemented by a wide range of product manufacturers and suppliers. The industry is also involved in contract utility management both locally and in a number of other developing countries. South Africa has a well-established electrical machinery manufacturing sector that has been in existence for over 40 years with a critical mass of experienced firms.

South African firms can offer a complete electronics value chain that ranges from design, engineering, manufacturing, testing, implementation and maintenance according to SAEEC (2014). Some firms in the industry provide original design products, thereby saving OEM customers significant non-recurring engineering costs associated with product development. The sector has developed a competitive advantage by being flexible and adaptable in its manufacturing approach and will consider small production runs (the dti, 2010). South African companies have significant local production facilities and several MNCs have set up local centres of excellence for global production. Products developed in South Africa take cognisance of the unique requirements of developing economies and have been designed to meet the needs of developing markets. This translates into support, maintenance and local capacity building being built into the final product offering (SAEEC, 2014). Specifically, South Africa has production facilities for:

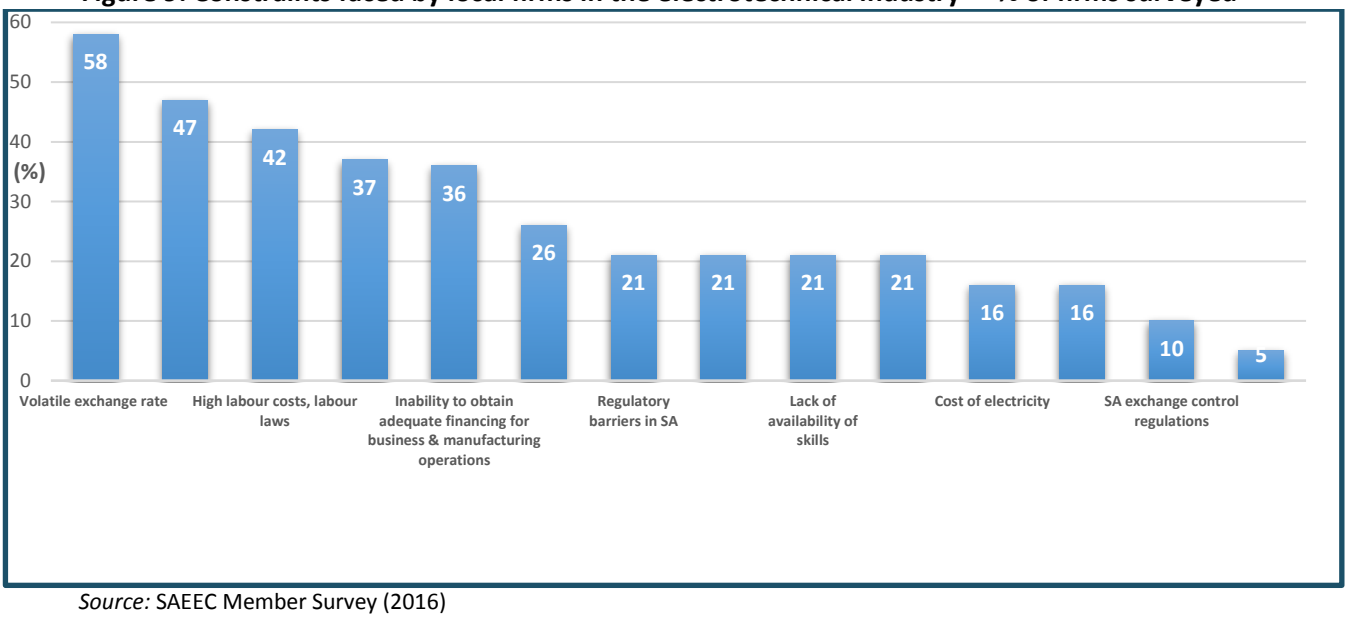
- Generation and transmission line components.
- Mini substations; three-phase step-up and step-down transformers up to 500 kV, 800 MVA.
- The only manufacturer of transformers larger than 200 MVA in Africa.
- Switchgear and cables.

[4] Based on the information received in an interview with the SAEEC. The total market size includes all the subsectors of the electrotechnical industry – electrical engineering, electronics, information technology and telecommunications.

- Inverters and rectifiers.
- Power metering.

There are, however, problems with the sector, although the overall competitiveness of local firms is the main issue leading to the lower levels of trade and declining production. In a firm-level survey conducted by SAEEC, local firms indicated that key issues adversely affecting their trade and output performance are the volatile exchange rate, lack of access to market information and opportunities in the region, as well as high labour and transport costs (Figure 10). As the manufacturing sector in South Africa uses imported machinery and parts, exchange rate fluctuations and a weaker Rand increase the prices of these imported components. A weaker Rand also leads to interest rate increases, making capital more expensive and more difficult to obtain, thereby affecting the cost structures of local firms. Rising fuel costs increase transportation costs and the increasing cost of electricity is also a factor. Conversely, imported finished products are cheaper, making the local manufacturing industry vulnerable to imports. The increasing cost of organised labour and productivity losses through organised strike action is also a contributing cost factor.

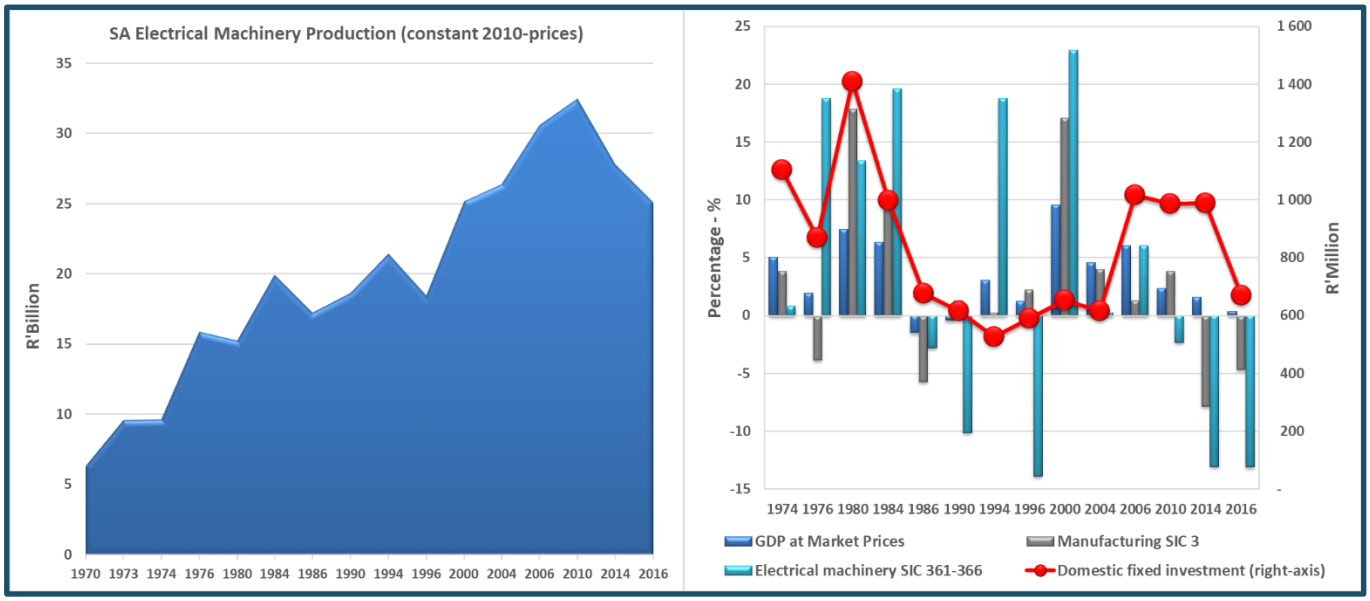
Figure 9: Constraints faced by local firms in the electrotechnical industry -– % of firms surveyed



Source: SAEEC Member Survey (2016)

In terms of South Africa's overall production, electrical machinery output increased by a weighted average annual growth rate of 3.9% between 1970 to 2016, which correlates with the long-term growth in the country's electricity generation. However, it should be noted that after peaking in 2010, South Africa's output in electrical machinery declined dramatically by 23% and investment in the sector falling by 5.5% between 2010 and 2016 (Figure 11). This decline of both production and investment could be explained by the near completion of the major builds of the Kusile and Medupi power stations, which created a significant demand for electrical machinery between 2006 and 2014.

Figure 10: South Africa's Production and Investment in the manufacturing electrical machinery



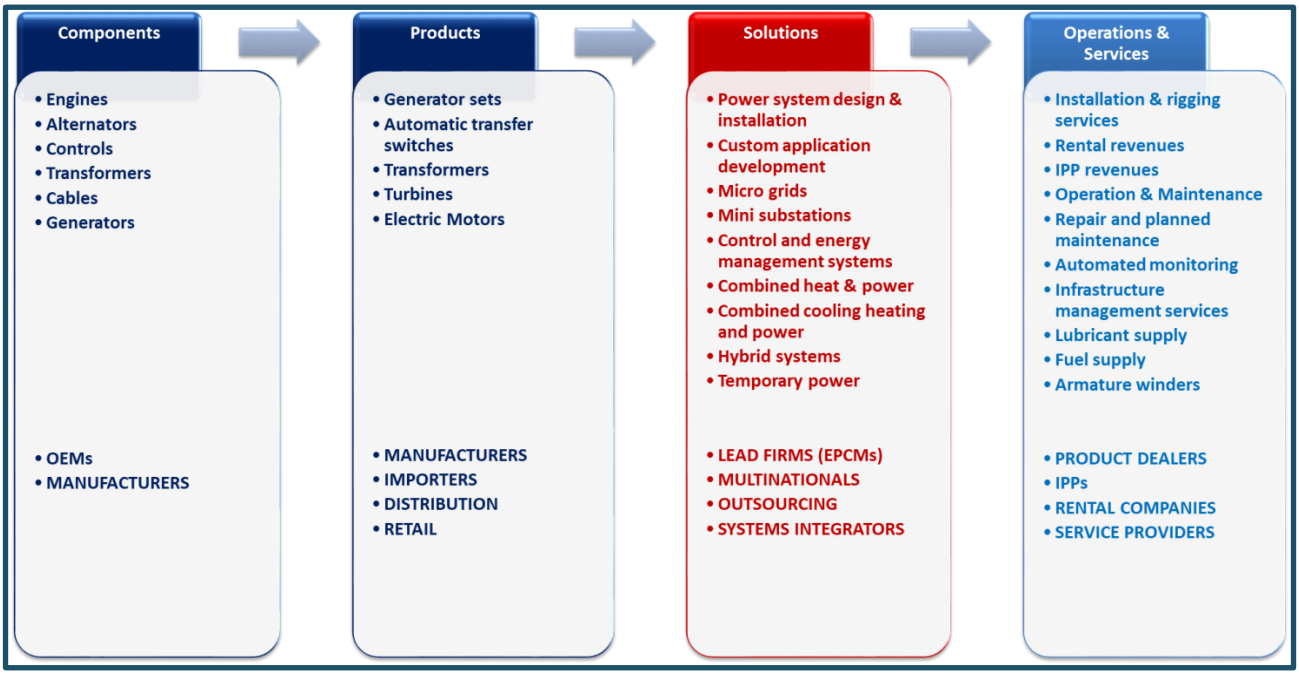
Source: Quantec and South African Revenue Service (SARS) (2017)

The power sector is currently converging, and renewables are beginning to dominate in all spheres of the energy market, driven by multinational corporations from developed countries. New entrants in the renewable generation sphere and new electricity delivery mechanisms, such as micro grids and electric vehicle charging infrastructure, are emerging to become global industry players and local firms supplying electrical machinery would need to adjust to become competitive in the long term. A number of industry players are providing both locally manufactured and imported machinery. These include:

- Global OEMs with significant distribution and service networks and with prime long-term service contracts for energy supply solutions to industry and commerce.
- Large local manufacturers of whole products and solutions.
- Subsidiaries of global multinationals.
- Manufacturers which have exclusive distribution agreements with global multinationals.
- Local manufacturers and assemblers which source engines, alternators and components from various sources and supply whole products.
- Large retail groups that import directly.
- Small specialist manufacturers that manufacture and supply components and services.
- Small importers with no service capability.

The new entrants into the local market are also being acquired by, or merging with, traditional industry players, or aligning with new complimentary entrants to create value chains to rival and compete with traditional global industry leaders. The lead firms of this industry continue to be the EPCM firms that offer their clients (public utilities and IPPs) turnkey solutions by designing, manufacturing and providing aftermarket services to their clients (Figure 12).

Figure 11: Electrical machinery Value Chain schematic in the Power Sector



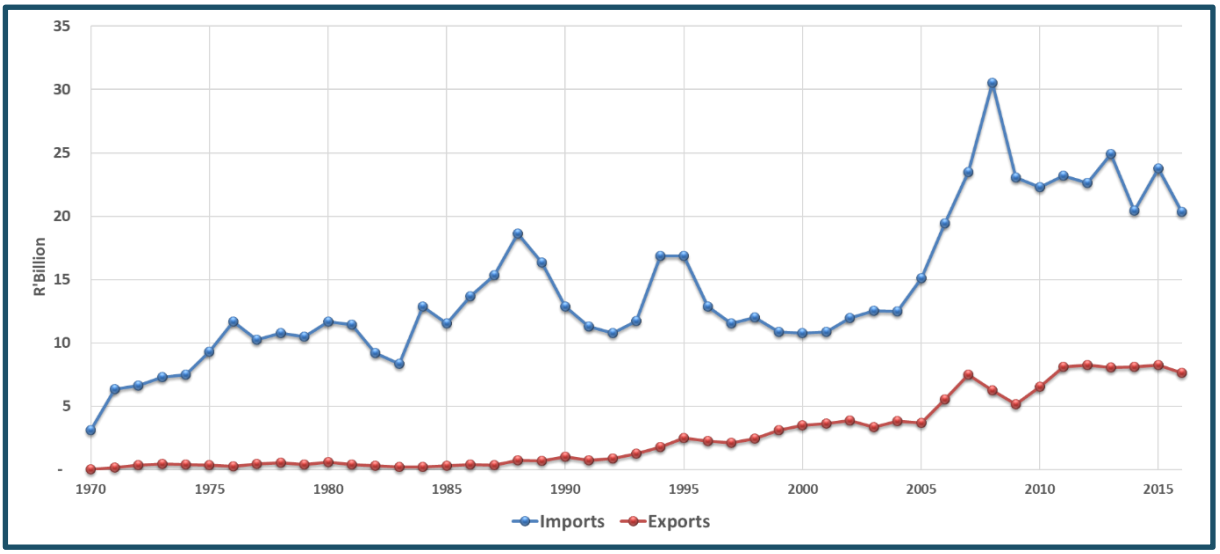
Source: WOW (2017b)

More broadly, South Africa's electrotechnical industry supplying components and services to the power generation sector is a highly competitive environment: the research identified more than 55 firms[5] operating in the local South African market with capabilities along the whole value chain. However, many of these firms depend on the lead firms (EPCMs) operating in the country in gaining access to new power generation projects within South Africa and in providing export opportunities in the SADC region and the rest of Africa. The major multinational companies include Mitsubishi Electric, Vestas, Ciemat, Infineon, GHE Group IREC, Areva, Alstom, Altran and Siemens. Many of these companies are present in the South African market. However, some offer distribution services rather than local production.

A shortage of domestic production is evident by the fact that South Africa has a trade deficit in electrical machinery. This deficit has been persistent over the past four decades (Figure 13). The consumption of imported electrical machinery represents the domestic demand potential of the local economy for electrical machinery. The trade deficit therefore quantifies the opportunity lost to the local manufactures and the extent to which the local industry could have expanded in satisfying this demand. It depicts the extent to which the local industry has lost local market share to international competitors. With this perspective in mind, it should be noted that imports increased dramatically in the years leading up to the global recession, peaking at R30 billion in 2008. After the crisis imports remained moderately stable, fluctuating between R20 billion and R25 billion over the past eight years.

[5] These firms are all members of the SAEEC. See list of firms in Appendix Section 5

Figure 12: South Africa's imports and exports of electrical machinery (1970-2016)



Source: Quantec and SARS (2018)

Local firms manufacturing electrical machinery in South Africa face significant international competition. Evidence of this is indicated by the rising level of imports of the industry's main products and components (Table 3). The top three most traded electrical machinery by South Africa are transformers, generators (or generating sets) and cables.

Table 3: South Africa's electrical machinery trade by product at HS4 level (US$ thousand)

	Code	SA Top 10 Imports of Electrical Machinery	2010	2017
1	'8504	Electrical transformers, static converters, e.g. rectifiers, and	436 887	462 736
2	'8502	Electric generating sets and rotary converters	91 588	435 027
3	'8544	Insulated "incl. enamelled or anodised" wire, cable "incl. coa	292 183	398 065
4	'8536	Electrical apparatus for switching or protecting electrical cir	365 708	364 805
5	'8501	Electric motors and generators (excluding generating sets)	217 255	257 396
6	'8516	Electric instantaneous or storage water heaters and immers	268 344	256 320
7	'8507	Electric accumulators, incl. separators therefor, whether or	139 730	215 826
8	'8542	Electronic integrated circuits; parts thereof	171 581	154 789
9	'8541	Diodes, transistors and similar semiconductor devices; phot	191 528	149 701
10	'8543	Electrical machines and apparatus, having individual functio	125 645	141 896
	Code	SA Top 10 Exports of Electrical Machinery	2010	2017
1	'8544	Insulated "incl. enamelled or anodised" wire, cable "incl. coa	199 700	170 345
2	'8536	Electrical apparatus for switching or protecting electrical cir	136 871	121 621
3	'8504	Electrical transformers, static converters, e.g. rectifiers, and	126 886	101 733
4	'8541	Diodes, transistors and similar semiconductor devices; phot	169 966	77 730
5	'8501	Electric motors and generators (excluding generating sets)	83 209	70 725
6	'8516	Electric instantaneous or storage water heaters and immers	78 818	69 084
7	'8543	Electrical machines and apparatus, having individual functio	36 788	66 084
8	'8507	Electric accumulators, incl. separators therefor, whether or	41 127	52 669
9	'8538	Parts suitable for use solely or principally with the apparatus	58 903	47 428
10	'8502	Electric generating sets and rotary converters	69 796	33 055

Source: Trade Map (2018)

Transformers, generators, cables and switchgears have all shown a rise in imports and a decline in exports since 2010. Local firms in the industry have attributed this recent poor performance in trade to not having significant orders as in the past caused by both, the deeper

penetration of cheaper Chinese products in the local and regional markets and declining demand in niche products that South African firms provide.

In 2017 WOW (2017b) conducted a SWOT analysis of the cables, generators and transformers industries (Table 4) which came to conclusions in line with information gathered from the interviews conducted for this study, as well as with the firm-level survey completed by SAEEC in 2016.

Table 4: SWOT analysis of the cables, generators and transformers industries

Strengths	Weaknesses	Opportunities	Threats
Cables • Products are needed in all industrial sectors. • Recognition by major companies of the importance of R&D, resulting in high levels of innovation. *Generators and Transformers* • All industries in South Africa need electricity and back-up power for their operations. • Multinationals with strong brand power and reliable products are present in the South African market. • Ability to diversify product offering to adapt to economic conditions, changing customer needs and regulatory requirements. • Local products are of a high quality and comply with international standards. • A broad range of local transformers which have been designated by government.	*Cables* • Industry is dependent to a large extent on spending on infrastructure development, which contracts during periods of low economic growth. • Industry is dominated by a few companies that were found guilty of price-fixing, market allocation and collusive tendering. *Generators and Transformers* • The increasing cost of diesel and petrol make generator sets increasingly expensive to operate, exceeding the cost of Eskom electricity. • High carbon emissions of diesel and petrol. • Shortage of qualified and skilled personnel. • Dependent on the welfare of target markets such as the energy, construction, civil engineering, manufacturing and mining industries. • Low import duty on foreign-manufactured generator sets.	*Cables* • Promised increased government spending on infrastructure. • Growth in the African markets. • Expansion by Eskom of coal-based electricity generation and new renewable power generation projects through the REIPPP programme should lead to increased demand for high voltage and other cables. *Generators and Transformers* • Selective municipal load shedding by Eskom could drive organic generator growth. • Limited and anticipated state and private infrastructure spend provides opportunities for renewable and prime and back-up power for the construction and civil engineering industry. • Increasing economic activity in Africa increases demand for back-up power, providing opportunities for generator sets and renewable suppliers. • Ongoing opportunities in the rental power market in South Africa. • Increasing technology reliance increases the need for essential back-up power. • Eskom's need to replace ailing infrastructure and capital expansion projects. • Demand for transformers from IPPs and in the hybrid grid. • Should it occur, the enforcement of higher local content levels.	*Cables* • Further increases in input costs could jeopardise the cost-effectiveness of local manufacturing operations. • Increasing imports of cables from the Far East. *Generators and Transformers* • Alternative electricity generating products gaining popularity and becoming more affordable. Government policy supports the adoption of renewable energy generation solutions. • Emission compliance regulations such as carbon tax could impact on business. • Short to medium-term shortage of qualified and skilled personnel. • Economic conditions reduce ability of customers to invest in generators and transformers. • Continuing significant transformer imports at lower cost. • Increasing input costs. • Eskom and municipal financial challenges. • Increasing availability of global brands. • High duties on South African exports in foreign countries.

Source: WOW (2017b)

The information showed that economic factors, declining commodity prices, reduced investment in energy, manufacturing and mining combined with the increasing shift to renewable energy and gas all negatively impacted the petrol and diesel generator industry. In parallel, Eskom and municipality-level challenges combined with substantial transformer imports have resulted in significant shrinkage in the transformer industry, despite designation and local content thresholds. These factors and Eskom's efforts in preventative maintenance and ensuring grid stability have meant there is no longer a shortage of electricity, but a surplus. Fraud, corruption, gross financial mismanagement in key customer segments, political uncertainty and climate change are all significant influencing factors in these

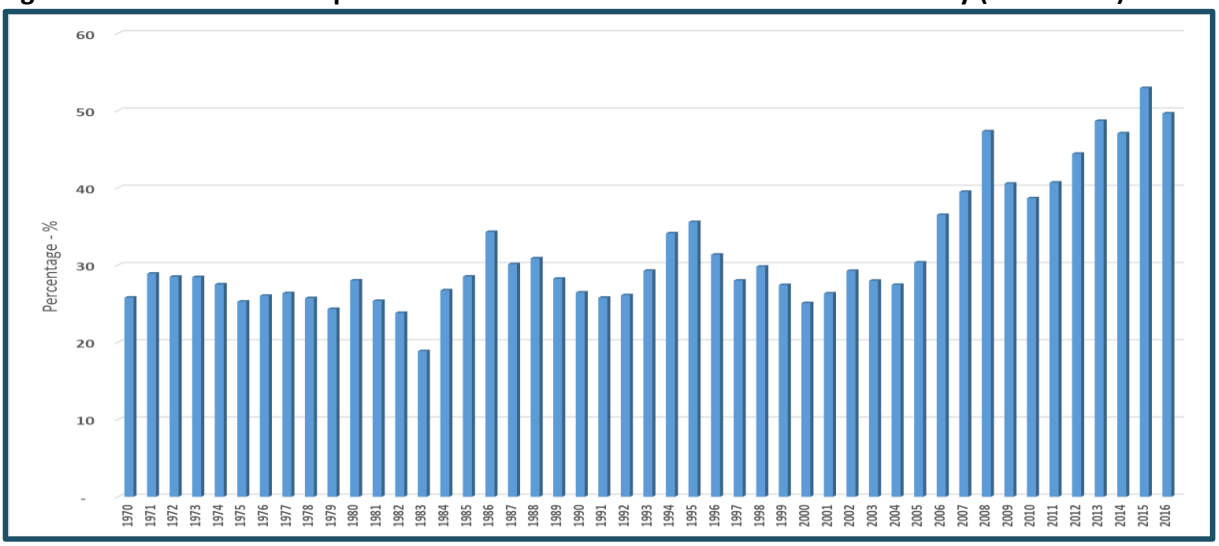
industries. For the cables industry, copper which constitutes about 40% of the cost of cable production has become very expensive – a significant amount of copper is imported.

The following reports the situation of each of the main electrotechnical segments:

1. There are in excess of 50 companies involved in South Africa's cables industry – half of these have some manufacturing capacity in the country. The largest participants include Aberdare Cables, CBI, South Ocean, ARB, Alvern Cables and Voltex. The locally manufactured cables amount to around R12-R15 billion, while the total cable market was worth around R30 billion in 2015.
2. In terms of transformers there are around 15 companies active in the market with the main players being Powertech, Actom, Revive, Zest and Electro Inductive Industries. The industry was worth around R3 to R4 billion in 2015 (R3.5 billion in 2014) and employed 3 000 employees. Domestic demand growth in the period 2009-2015 was on average around 4% per annum and growth forecasts until 2021 are similar.
3. In the case of generators, during the 2008 power crisis the number of players in the industry increased from under 40 to more than 300 suppliers. In 2008, the market was characterised by consumers' preference for price over quality, often choosing cheap, unreliable imports from Asia that flooded the market. Many medium-sized generator suppliers lost market share to these importers. With the global economic crisis in 2009, industrial and manufacturing activity slowed, which reduced electricity demand and subsequently demand for generators fell sharply (WOW, 2013).

The import to domestic demand ratio considers the domestic demand of electrical machinery satisfied by imported electrical machinery. An increase in this ratio indicates a greater degree of imported electrical machinery satisfying local demand, while a decrease in the ratio would entail a greater degree of domestic manufactured electrical machinery satisfying local demand. By the turn of the century, only 25% of local demand was satisfied by imports. By 2015, this doubled as half of the local demand for electrical machinery was driven by imports.

Figure 13: South Africa's import-domestic demand ratio for electrical machinery (1970-2016)



Source: Quantec and SARS (2018)

In 2017, China was South Africa's largest trade partner in electrical machinery imports followed by Vietnam. China's share of South Africa's total imports of electrical machinery was 47.4%; and Vietnam had a 7% share of South Africa's imports of electrical machinery (Table 5). Since 2010, only China and Vietnam have increased their share of imports of electrical machinery into the South African market whereas all the other countries in South Africa's top 10 import markets experienced a decline in their market share over the same period. For exports, eight of the top 10 export markets for South Africa's electrical machinery are in the SADC region. South Africa exports 59% of its electrical machinery to the SADC region and this has been increasing gradually as it stood at 57% in 2010. Namibia, Botswana, Zambia and Mozambique account for 36.4% of South Africa's exports of electrical machinery.

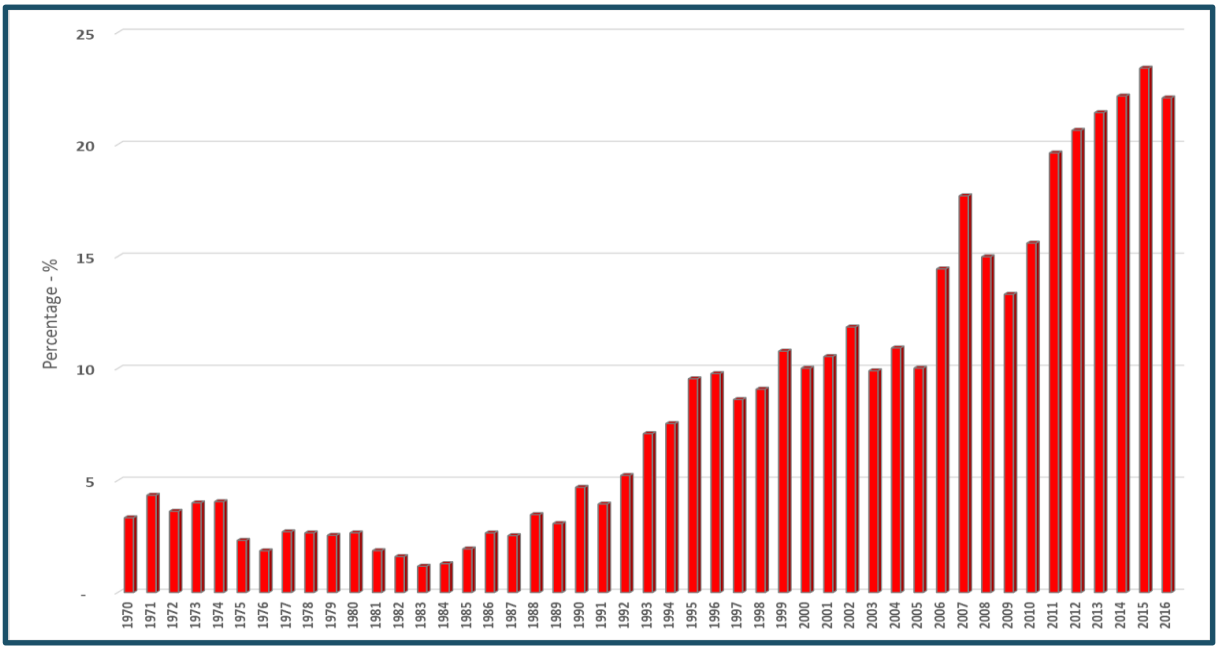
Table 5: South Africa's electrical machinery trade markets (US$ thousand)

SA Top 10 Import Markets		2010	2017	Share 2017
World		**8 712 786**	**8 495 646**	
1	China	2 589 542	4 048 192	**47,7%**
2	Viet Nam	187 236	605 228	**7,1%**
3	Germany	703 190	487 201	**5,7%**
4	USA	488 207	373 094	**4,4%**
5	Spain	68 464	192 280	**2,3%**
6	France	177 112	170 175	**2,0%**
7	Taipei, Chinese	227 267	155 323	**1,8%**
8	Japan	351 170	155 257	**1,8%**
9	Italy	157 749	147 674	**1,7%**
10	United Kingdom	226 687	147 224	**1,7%**
SA Top 10 Export Markets		**2010**	**2017**	**Share 2017**
World		**2 008 427**	**1 802 545**	
1	Namibia	231 981	222 707	**12,4%**
2	Botswana	201 783	207 479	**11,5%**
3	Zambia	117 257	131 516	**7,3%**
4	Mozambique	111 329	93 718	**5,2%**
5	Netherlands	25 464	83 632	**4,6%**
6	DRC	68 916	81 450	**4,5%**
7	USA	67 603	77 197	**4,3%**
8	Lesotho	93 230	73 878	**4,1%**
9	Zimbabwe	106 234	71 032	**3,9%**
10	Swaziland	91 545	61 917	**3,4%**

Source: Trade Map (2018)

The export-output ratio measures the share of locally manufactured electrical machinery that is exported, relative to total output. An increase in the ratio depicts a greater degree of export capability, and a greater degree to which local manufacturers are able to take advantage of the export market. Looking at the relevant data shows that South Africa's exports of electrical machinery relative to total output have been low over the long term. However, since 2010 the ratio increased to record highs over a few consecutive years (peaking at 23% in 2015). A closer examination of the data indicates real output fell by 0.4% and exports grew by only 1.8% over the same period (Figure 15).

Figure 14: South Africa's export-output ratio for electrical machinery (1970-2016)



Source: Quantec and SARS (2018)

The sale of South African electrical machinery in the rest of Africa[6] is not limited to electricity utilities and a significant portion of sales in Africa are to private companies. Other South African suppliers to the power sector that export to the rest of Africa are supplying mining and industrial companies.

Export contracts are sourced in a variety of ways, including through tenders that are advertised in the South African press. However, local OEMs and component suppliers also benefit from being associated with well-known EPCM firms to access regional markets and power projects in Africa. As mentioned, EPCM firms provide power utilities and IPPs with a broad range of services. When operating under lump sum turnkey or EPCM arrangements, EPCMs are sub-contracted by the utilities and IPPs to develop greenfield and brownfield projects.

Under these arrangements, EPCMs are responsible for the procurement of electrical machinery to be integrated into complete systems. EPCM firms are predominantly based in South Africa. With South African-based OEMs, they generally participate along the entire value chain, from product development to aftermarket sales. All OEMs are involved in marketing and distribution of their products and services. Driven by increasing demand for full package solutions that EPCMs offer, some South African OEMs use their marketing and distribution activities strategically to offer a broader product portfolio. The lack of information on regional opportunities is one of the main barriers to entry identified by local firms and could point to a need for trade and investment support agencies such as InvestSA and Trade and Investment South Africa at the dti to collaborate with SAEEC to create a guide to entering the regional market. The volatile exchange rate and lack of financing could also point to the need to provide some trade finance and/or insurance facility from ECIC, both to support trade and to mitigate against currency risks.

[6] See Appendix Section 4 for South Africa and Zambia's main trade partners in electrical machinery.

6. ZAMBIA'S ELECTRICITY GENERATION AND ELECTROTECHNICAL INDUSTRY

6.1 Electricity generation

Like the South African industry, the Zambian electrotechnical industry encompasses electrical engineering, electronics, IT and telecommunications. The sector covers a broad range of products and services that contribute directly to the sector itself as well as inputs into the mining and power sector in Zambia. In the power sector, the electricity subsector is the major consumer of the electrotechnical industry. Having set out the scene, it is worth bearing in mind that Zambia's electricity sector is mainly dependent on hydropower (ERB, 2017): as of 2017, the total installed generating capacity was approximately 2 900 MW and only 300 MW was coal, with the remainder being hydro (ZESCO, 2017). Even though the domination of hydro power lowers the cost of production, it makes the sector highly susceptible to the effects of climate variability and change. Notably in June 2015, the country experienced a severe power deficit estimated at 760 MW as a result of the poor rainfall recorded in the 2014/15 rainy season (and the low water levels in the Kariba Dam reservoir). Electricity supply was then rationed (load shedding), contributing to Zambia's recent economic downturn.

To cushion the impact of a power deficit, Zambia had to import power from the SAPP, Eskom, Electricadade de Mocambique EP, Aggreko and Karpower. A total 422 MW was imported from these utilities in 2016 at a cost of US$469 million. Furthermore, because the electricity sector is dominated by hydro technologies, the government has been pushing for diversification from hydro. In July 2018, the government launched the Renewable Energy Feed-in (REFiT) policy which aims at enhancing the diffusion of renewable technologies. This push for diversity and plans for expanding the electricity generation capacity in the sector could create value addition opportunities for local manufacturing firms and also enhance regional trade within the SADC region.

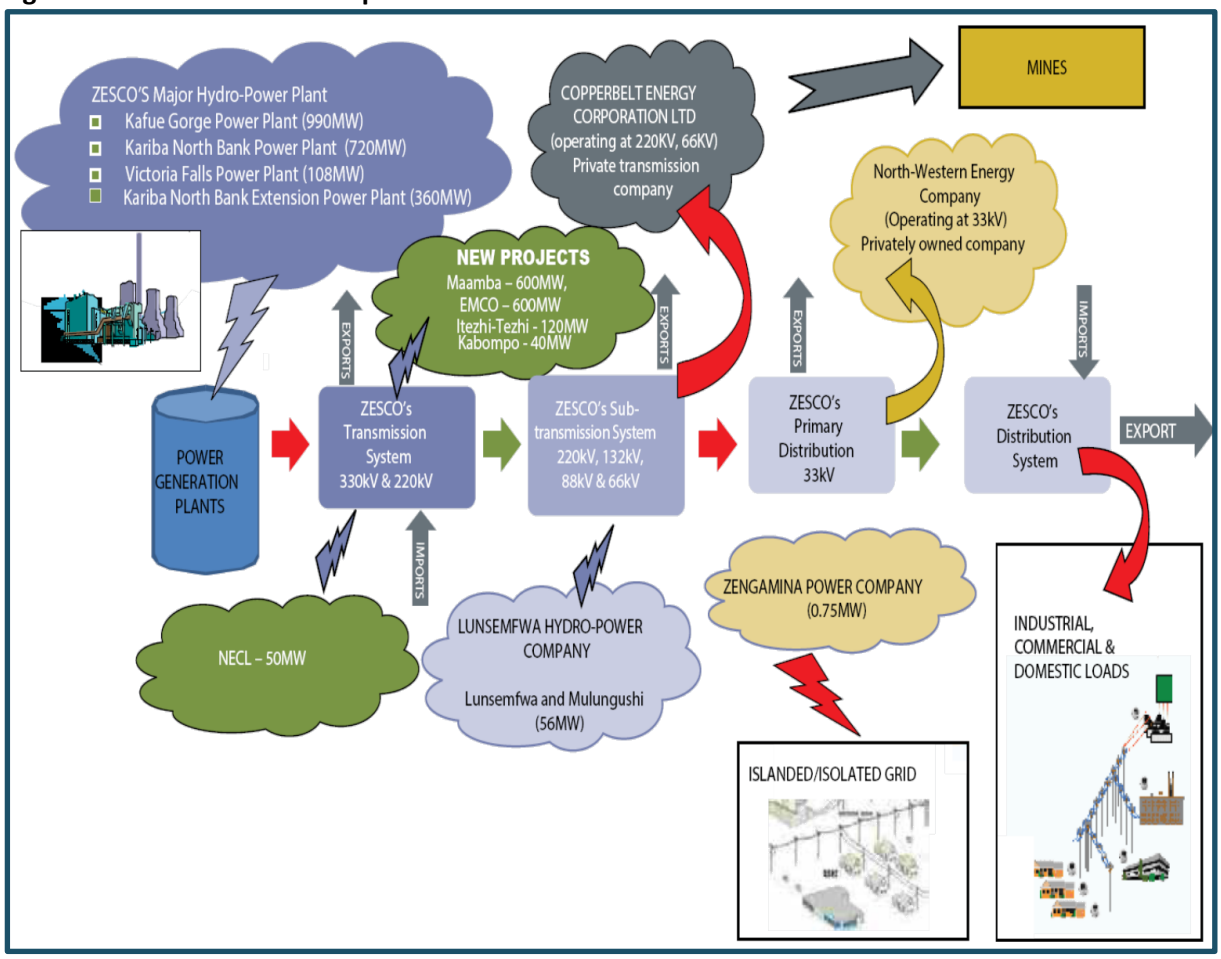
Having set out the current state of power generation in Zambia, some key players in Zambia's electricity industry are:

- ZESCO – a state-owned entity involved in generation, transmission, distribution and supply of electricity.
- Copperbelt Energy Corporation (CEC) – a privately-owned company involved in the transmission and distribution of electricity to the mines and other customer categories.
- Lunsemfwa Hydro Power company (LHPC) – a privately-owned company which is involved in generation and transmission of electricity to the national grid.
- Zengamina Power Company (ZPC) – a privately-owned generation company operating an isolated grid involved in generation and distribution of electricity.
- North Western Energy Company (NWEC) – a privately-owned company involved in distribution and supply of electricity.
- Ndola Energy Company (NEC) – a privately-owned company in generation of electricity.
- Maamba Collieries Ltd (MCL) – a privately-owned company in generation of electricity.
- Itezhi-Tezhi Power Corporation – jointly owned by Tata Power and ZESCO Limited in a 50:50 share ownership in generation of electricity.

- Kariba North Bank Extension – a Special Purpose Vehicle (SPV) company wholly owned by ZESCO involved in generation of electricity.

The role of some of the players listed is shown in Figure 17 which schematically represents the power sector value chain.

Figure 15: Zambia's electrical power value chain schematic



Source: ZEB (2015)

Zambia's electricity sector is a semblance of a monopoly: ZESCO, a vertically integrated parastatal drives the key functions of generation, transmission, distribution and supply in the country. While the electricity supply industry was liberalised in 1995, and a few IPPs have come on board, the sector has failed to attract the necessary private sector investments required to expand and ultimately diversify the energy generation capacity. One of the commonly cited impediments to increased investment in the industry are the end-user tariffs which are not cost reflective.

For instance, in 2015, Energy Regulation Board of Zambia (ERB) observed that a tariff of $c 10.40 per kWh would be a good step towards a cost reflective tariff, from a subsided average tariff of $c 6 to $c 7 per kWh. Further, ZESCO purchases electricity from domestic IPPs at an average of $c 11 per kWh and imports electricity at an average of $c 13 per kWh. This essentially entails subsidies of between $c 4 and $c 7 per kWh. In an effort to move towards cost-reflective tariffs and to reduce the subsidies, the ERB approved in May 2017 a tariff increment of 75%, which nevertheless still excludes the mining sector (the largest consumer of electricity). A cost of service study has also been recently launched to determine

the true cost of generating, transmitting, distributing and supplying electricity. The results of which will be the basis of migrating towards cost-reflective tariffs and also help in the tariff adjustment negotiations with the mining sector.

Hydropower plays such a prominent role in the project pipeline because it is perceived as a more affordable option for power generation, with a low levelled cost of electricity.[7] Out of the five identified new power generation projects planned in Zambia for the medium term, three are from hydropower technologies (Table 6).[8]

Table 6: Planned power projects in Zambia for the next five years

Country	Project Name
Zambia (5)	Kariba Dam Rehabilitation Project, Zambezi River
	Batoka Gorge Hydropower Project
	100 MW Kumi Kumi Zuba Solar Park
	50 MW Muchinshi Solar Power Project
	40 MW Kabompo Gorge Hydropower Plant

Source: PIDA (2017)

The introduction of new power sources into the mix, combined with improving weather conditions to enable higher hydropower output, has resulted in improved power supply in the country. This will support the mining, construction and manufacturing sectors, which will help sustain Zambia's economic recovery and is expected to drive real GDP growth to come in at 4.5% in 2018 and 5.3% in 2019.

The prospect for further power mix diversification has been boosted by the Energy Regulation Board decision to allow power utility ZESCO to increase electricity tariffs by 75% for the year 2017/18. This will narrow the gap between the tariffs and the true cost of electricity generation in the country, which will help improve the attractiveness of the sector to investors. This will also reduce the financial burden on ZESCO, leaving the utility to invest capital in other areas of the power sector – for example, the transmission and distribution sector.

The country has been successful in mobilising investment into its domestic solar sector, through the World Bank's Scaling Solar initiative. The auction-based regulatory framework is now in its second phase, after contracting close to 100 MW of solar capacity during the first stage, and has been met with strong interest from international renewables companies, including EDF Energies Nouvelles, Engie Afrique SA, Total, Scatec Solar and Mitsui (BMI, 2018).

6.2 Electrotechnical industry

Mapping the value chain of the power sector would help in identifying specific aspects of the industry which offer opportunities for value adding activities. These activities, in both Zambia

[7] This matters since Zambia has very low electrification rates compared to South Africa. The most recent estimates indicate that, overall, only 31% of households in Zambia are connected to electricity. In the rural areas, this proportion is a low 4.4% (CSO, 2016).

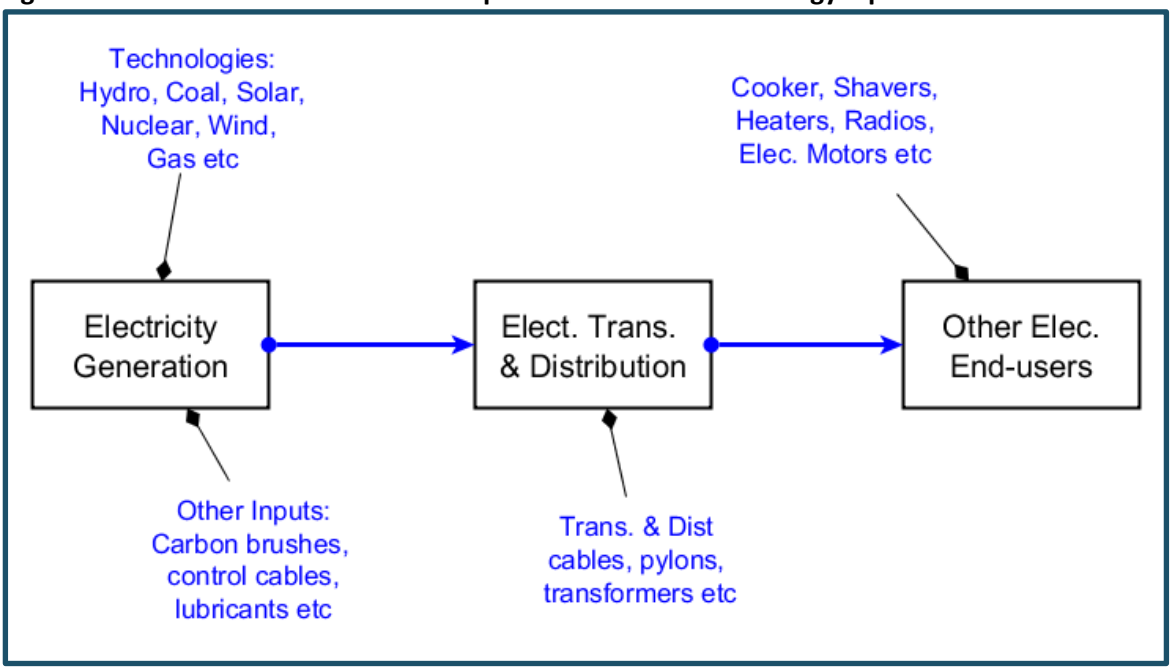
[8] The lower-cost nature of the technology is particularly important in Sub-Saharan Africa where there is often an absence of cost-reflective electricity tariffs on offer to developers and purchasing power remains low among the population.

and South Africa, would lead to stronger manufacturing sectors and better trade relations between these two countries.

Examples of such electrotechnical commodities are control cables, switch gears, carbon brushes and electricity generating technologies.

From 2010 to 2015, China was the main source for both South Africa and Zambia's electricity generating commodities[9] and Figure 17 shows a generic value chain schematic in the power sector, outlining the technologies and main components traded and manufactured within the SADC region.

Figure 16: Value chain schematic of the power sector and technology inputs



Source: Authors' conceptualisation of the value chain

Currently, Zambia imports the bulk of its electrical machinery while South Africa manufactures some technologies. Furthermore, apart from the inputs into electricity production, there are other electrotechnical commodities that are essential to the delivery of electricity to the end-users, including commodities such as transformers and transmission cables. Both countries (South Africa and Zambia) have some level of manufacturing capabilities of these transmission and distribution commodities.

Table 7 highlights the top traded electrical machinery and equipment linked to the electrotechnical industry in Zambia.

[9] See Section 1 in the Appendix for the classification of commodities.

Table 7: Zambia's electrical machinery trade by product at HS4 level (US$ thousand)

	Code	ZAM Top 10 Imports of Electrical Machinery	2010	2017
1	'8504	Electrical transformers, static converters, e.g. rectifiers, and	20 121	35 120
2	'8544	Insulated "incl. enamelled or anodised" wire, cable "incl. coa	23 746	31 362
3	'8537	Boards, panels, consoles, desks, cabinets and other bases, e	8 558	30 030
4	'8501	Electric motors and generators (excluding generating sets)	11 842	15 078
5	'8536	Electrical apparatus for switching or protecting electrical circ	14 118	14 884
6	'8507	Electric accumulators, incl. separators therefor, whether or r	10 203	13 460
7	'8535	Electrical apparatus for switching or protecting electrical circ	4 058	10 616
8	'8538	Parts suitable for use solely or principally with the apparatus	1 248	8 284
9	'8502	Electric generating sets and rotary converters	1 844	6 796
10	'8543	Electrical machines and apparatus, having individual functio	1 053	6 576
	Code	ZAM Top 10 Exports of Electrical Machinery	2010	2017
1	'8544	Insulated "incl. enamelled or anodised" wire, cable "incl. coa	39 556	20 086
2	'8504	Electrical transformers, static converters, e.g. rectifiers, and	700	1 384
3	'8502	Electric generating sets and rotary converters	353	1 345
4	'8501	Electric motors and generators (excluding generating sets)	552	1 064
5	'8547	Insulating fittings for electrical machines, appliances or equi	9	869
6	'8548	Waste and scrap of primary cells, primary batteries and elec	16	641
7	'8511	Electrical ignition or starting equipment of a kind used for spa	312	348
8	'8536	Electrical apparatus for switching or protecting electrical circ	296	300
9	'8537	Boards, panels, consoles, desks, cabinets and other bases, e	34	166
10	'8543	Electrical machines and apparatus, having individual functio	24	112

Source: Trade Map (2018)

On the ground, two categories within the electrotechnical industry in Zambia focus on the power sector: the manufacturing firms, and the electricity generating and supply firms. Zambia has, indeed, some capabilities in the production of electrotechnical components. Manufacturing firms, such as Zambia Metal Fabrications (ZAMEFA), Zambia Electro-meter and Morganite,[10] offer commodities that are used as inputs into the electricity production and consumption processes. More broadly, with exports signalling production capabilities, Zambia has been exporting electrical machinery and equipment and parts thereof; albeit a very small proportion relative to the imports of the same products by SADC member countries. On average, Zambia has exported 0.7% of the total imports of electrical machinery products of SADC member countries per annum over the period 2011 to 2015.

In terms of imports, following South Africa's strong production capabilities and its footprint in the region for the export of electrical machinery and equipment and parts thereof, over 30% of Zambia's imports of electrotechnical products are imported from that partner. South Africa has been Zambia's largest supplier of electrical machinery and equipment and parts from 2011 to 2016. However, in 2017 Zambia's imports from South Africa were surpassed for the first time by imports from China.

Other major suppliers that constitute the top five markets include Hong Kong, Sweden and India (Table 8).

[10] ZAMEFA was established in 1968. It is one of major consumers of locally produced copper. Some of the products are telecommunications cable, control cables, copper shapes and low and medium voltage cables. Zambia Electro-meter is a joint venture between ZESCO and Egypt's Elsewedy Limited. The producers of metering units, compact fluorescent bulbs and electric transformers, among others. Morganite Zambia is a private company that specialises in manufacturing electrical switch gears and carbon brushes. It participates in both local and regional markets. It has been in existence since the 1960s.

Table 8: Zambia Electrical Machinery Trade Markets (US$ thousand)

Zambia Top 10 Import Markets		2010	2017	Share 2017
World		**247 654**	**443 673**	
1	China	33 291	151 309	**34,1%**
2	South Africa	104 305	148 241	**33,4%**
3	Hong Kong	8 886	25 224	**5,7%**
4	Sweden	7 097	19 265	**4,3%**
5	India	7 334	7 923	**1,8%**
6	United Kingdom	5 286	7 900	**1,8%**
7	Finland	3 972	7 706	**1,7%**
8	Netherlands	1 046	7 098	**1,6%**
9	United Arab Emirates	20 485	6 983	**1,6%**
10	Viet Nam	203	6 691	**1,5%**
Zambia Top 10 Export Markets		**2010**	**2017**	**Share 2017**
World		**45 672**	**58 735**	
1	United Arab Emirates	46	26 482	**45,1%**
2	South Africa	37 402	12 509	**21,3%**
3	DRC	4 251	6 304	**10,7%**
4	Kenya	796	3 499	**6,0%**
5	Tanzania	795	3 144	**5,4%**
6	Uganda	-	1 847	**3,1%**
7	Zimbabwe	129	1 247	**2,1%**
8	Ghana	2	576	**1,0%**
9	Netherlands	116	542	**0,9%**
10	Singapore	-	525	**0,9%**

Source: Trade Map (2018)

In effect, core questions that this research attempts to answer are whether regional demand could stimulate local production; and whether the supply-side constraints can be sufficiently addressed to achieve competitiveness against imports from global markets which provide more than 50% of the region's demand for electrotechnical components. Ensuring a more integrated regional market will not in itself support a competitive regional value chain unless national and regional supply constraints are addressed. Evidence from the interviews conducted with local firms in Zambia has shown that the main constraints centre on skills, institutional capacity, industrial finance and infrastructure.

Among the main constraints to the sector's growth in Zambia, they include limited access to key domestic markets and government procurement; limited beneficiation and diversification; low levels of investment; limited access to affordable long-term finance and prevalence of outdated technology.

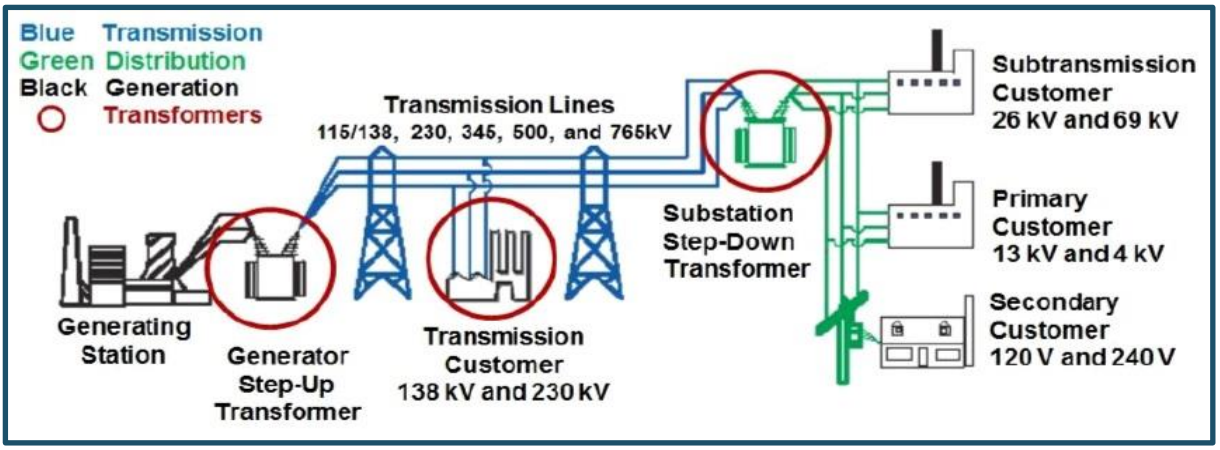
Other constraints identified were limited access to appropriate manufacturing-related technical skills to meet industry needs, especially in engineering related fields; unfavourable tax policies; lack of targeted investment promotion; inadequate policy consistency and coherence; and underdeveloped conformity assessment and quality infrastructure and services. Further, stiff competition from imports constrained the growth of the manufacturing sector and its contribution to GDP, job and wealth creation (MCTI, 2018). The constraints highlight the need for government to exploit provisions in the regional and international trade and integration arrangements that enable parties to put in place measures that foster the growth of the local industrial base, including developing infant industries along the electrotechnical value chain.

7. ELECTROTECHNICAL COMPONENT CASE STUDY – TRANSFORMERS

The evidence uncovered in the trade analysis of electrical machinery products highlighted the importance of transformers as one of the main components in the power sector. Transformers form an integral part of the electricity distribution value chain. Broadly, the electric energy delivery process entails generation, transmission and distribution of electric energy. The transformer industry plays a critical role in all three main stages (generation, transmission and distribution) of the value chain. More technically, a transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors – the transformer's coils. A transformer is made up of three main components; *the transformer core, windings and tanking*. They are also fitted with numerous other accessories, which could include components such as radiators, fans, cables, pumps and valves. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction. Larger power transformers operating at high voltages may be wound with copper rectangular strip conductors insulated by oil-impregnated paper and blocks of pressboard.

The process of how transformers work is initiated at the generation phase, in which electricity is produced at power stations across the region. The electric current produced at the generation phase has a voltage too low to transmit over long distances. Transmitting electricity at high voltages reduces the load loss and, as a result, voltage has to be increased to ensure efficient transmission with minimal losses. In transferring the electricity from the point of generation to the nearest grid, the voltage is increased by "step-up transformers". The electricity is then transmitted to the provincial or municipal grid via a "step-up" or a "step-down" transformer (Figure 18). A similar process applies when electricity is transmitted and distributed across borders through SADC's regional power pool infrastructure.

Figure 17: The role of transformers in an electric power grid

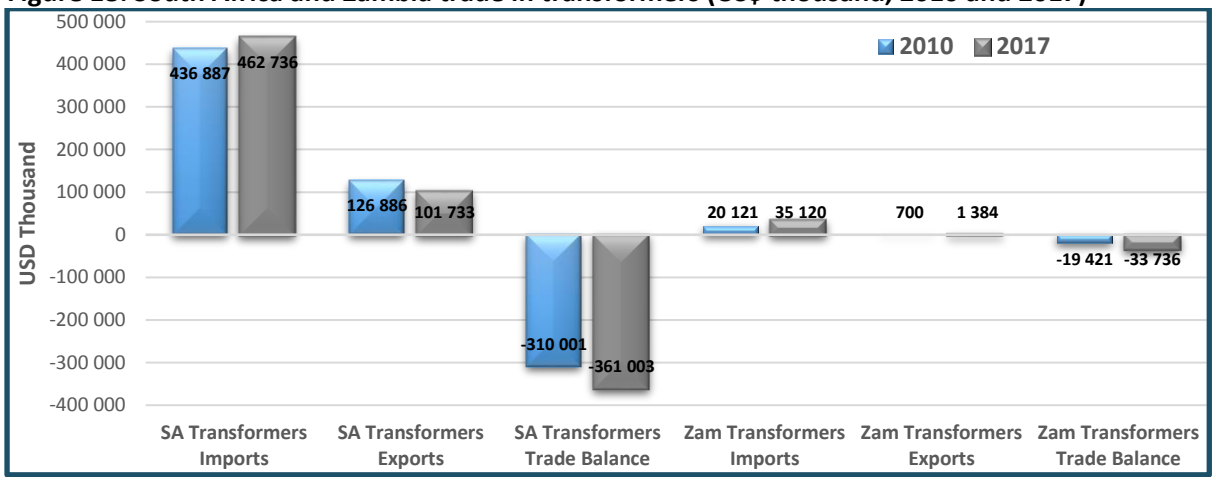


Source: Department of Energy (2018)

In South Africa, the transformer industry is under immense pressure in both the local and export markets. Domestic manufacturers have suffered from low demand volumes, owing to Eskom and municipalities opting to import fully manufactured transformer units. In Sub-Saharan Africa, South Africa is one of the few countries with local transformer manufacturing capacity, thereby offering local industry opportunities to explore regional exports; however,

local manufacturers are finding it difficult to compete on price with their international counterparts (Chibanguza, 2016:43). This lack of competitiveness is manifest in growing imports. South Africa and Zambia have consistent deficits in the trade of transformers (Figure 19). The data, however, also indicates that, even with import growth outpacing exports, Zambia has seen an increase in exports compared to South Africa experiencing a decline.

Figure 18: South Africa and Zambia trade in transformers (US$ thousand, 2010 and 2017)



Source: Trade Map (2018)

In South Africa alone, WOW (2017b) reported in 2012 that Eskom had a fleet of about 120 major transformers at its power stations countrywide. It also had 399 transmission transformers in service and 343 970 distribution transformers in operation. While there is growing demand for transformers, locking this demand into local production is difficult. The demand for transformers has two dimensions:

- The demand for new capacity installed as a result of an expanding power grid; and,
- The replacement of the current fleet of transformers at the end of their life cycle.

In the power transformers and large distribution transformers segment (Class 3-4),[11] most competition is from international suppliers. In the small and medium distribution transformer segments the competition is mainly local, although these companies face increasing competition from international companies. South African transformer manufacturers have the capacity to deliver between 50% and 60% of market demand for medium and large power transformers. Exports to other countries are significant but, as the data has indicated, the sector has lost market share to China in its major export markets. There are fewer than five transformer manufacturers in Africa outside South Africa. Key competition for South African transformer companies in East Africa is from India, and in West Africa, mainly from India, China and Europe. Future African demand for transformers should remain strong, with infrastructure a key item on the agenda of most countries and significant investment from the BRICS (Brazil, Russia, India, South Africa, China) countries, America and Europe. While economic growth in Africa represents an opportunity for local sector companies, entrants from China and India are increasingly competitive in the lower power classes.

In assisting local firms to compete in the region, Eskom is considered a valuable reference customer. Companies that deliver goods and services to Eskom contend their association has

[11] See Section 6 in the Appendix for the classification of transformers

improved their ability to capture and deliver business in Africa. Certain countries and their respective utilities companies look to Eskom for specification guidance. If local firms have consistently supplied Eskom with components and are considered as preferred suppliers by the utility company, they stand a better chance of receiving orders from other regional utilities that use Eskom specifications. South Africa's local transformer industry has been advocating for the designation[12] of transformers as this would increase the volumes manufactured by local producers. This would increase their capacity utilisation, influencing their total factor cost and ultimately enhancing their ability to be price competitive against international competitors on the continent and globally (Chibanguza, 2016:44).

Developing a regional value chain of manufacturing transformers in SADC opens an opportunity around collaboration between South African and Zambian firms to produce the winding sub-component of a transformer in Zambia. Windings are cylindrical components and consist of a number of turns and layers of a copper conductor, typically covered by paper insulation or enamelled. Winding designs vary for each class of transformers. With Zambia's competitive advantage in producing copper and efforts of increasing beneficiation of its natural resource through mineral processing and fabrication, coupled with South Africa's manufacturing capabilities, a partnership between South African and Zambian firms could be pursued as a form of import substitution of transformers in the region. This example provides initial evidence for further investigation to determine the feasibility of developing a bankable project between the two countries creating a regional value chain in the transformer market.

Between 2010 and 2014 South Africa demanded transformers on a relatively steady basis to cater for electrification, capital expansion of its transmission and distribution network, the replacement programme for ageing transformers and sudden failures, and as replacement of capital spares. WOW (2017b) estimated total annual transformer sales to be at R8 billion and that local firms have the capacity to deliver between 50% and 60% of domestic market demand for medium and large transformers. Over that period Eskom spent over R4.7 billion[13] on procuring transformers from the local and international market. Future demand projections (from 2015 to 2020) for transformers for use in Eskom, municipalities and other public entities together with private sector use (in industries such as mines and manufacturing) were calculated to exceed R5 billion[14] (the dti, 2015).

Although the demand for power transformers remains relatively constant, the industry requires a high degree of customisation at a device level. These units are also physically large, thereby increasing logistics and transport costs, making local production more viable. Therefore, with the continued expansion of the power grid in Zambia, an opportunity also exists to develop capacity to manufacture transformers locally. A supplier development strategy, targeting the small and medium transformer segment that is in line with the country's mineral beneficiation programme is key to unlocking the existing potential for local and regional production of transformers.

[12] The South African Preferential Procurement Policy Framework (PPPFA) is a lever available to government to designate sectors, products and/or components for local manufacture thereby sending a market signal to procuring entities to find local suppliers and to encourage investment in the designated sectors. Section 9 of the revised regulations provides for the dti to designate sectors in line with national development and industrial policies for local production (National Treasury, 2015). Sectoral designation in essence brings together the strength of public procurement and local content regulation in a single industrial policy instrument.

[13] See Appendix Section 6.

[14] See Appendix Section 6

8. MAIN FINDINGS FOR SOUTH AFRICA AND ZAMBIA

8.1 Electrotechnical industry dynamics – challenges and opportunities

The SADC region is rich with a vast array of energy resources and these remain largely untapped, mainly due to a lack of regional integration (TIPS, 2017). The deepening of regional energy integration in the SADC region offers a platform to fast-track progress towards electricity sustainability and regional industrialisation. Existing initiatives, structured around the SAPP and the RERA, notably provide the necessary building blocks for regional integration to meaningfully help countries meet their energy challenges.

However, this cannot be left to utilities and regulatory bodies alone. Many avenues are available for regional institutions to play a driving and supporting role to achieve inclusive governance of the sector and leverage countries' vast experience. Indeed, regional integration is not an end in itself, but a means to achieving a sustainable development pathway in the region.

With low level of access to electricity in the region (excluding South Africa), increasing access rates would have significant impact on the demand for electrotechnical products, particularly those used in power generation and distribution. Apart from projected growth as a result of increase in electricity access, increases in electricity demand through economic growth is projected. This also offers opportunities for electrotechnical industrial growth.

The regional market is important to South Africa's electrotechnical industry; in particular Zambia is South Africa's largest export market and South Africa is Zambia's largest source of electrical machinery in the region. The analysis of trends in regional trade points to an integrated regional value chain, in which South Africa plays a supply-hub role for the rest of the SADC region.[15] In 2010 the dti conducted a subsector assessment in a form of a SWOT analysis of the power and energy sector in South Africa, which covers some of the elements already raised in this report and drawing attention to a few other strong sectors (Table 9).

Table 9: Department of Trade and Industry SWOT analysis of power electronics in South Africa

STRENGTHS	WEAKNESSES
• Local manufacturers are producing more robust wind turbine systems • Strong local demand which is likely to grow because of the renewable-energy feed-in tariff (REFiT) and the energy crises • Relatively low labour costs give transformer manufacturers an advantage as the process is hard to automate • Extensive mining and mineral beneficiation industry provides local demand for sensors and systems	• Import electronic components • Difficulty in obtaining capital • Lack of skilled engineers, technicians and artisans • Lack of funding for securing new markets
OPPORTUNITIES	**THREATS**
• Renewable energy systems • Transformer manufacturing • Sensors and systems unique to the large South African economy, e.g. mining and minerals beneficiation	• Strong international competition • Increased use of nuclear power • Procurement policies which are not locally and regionally focussed could lead to loss of domestic manufacturing capabilities

Source: the dti (2010)

[15] In South Africa's top 10 export markets for electrical machinery, eight are within the SADC region.

With a total market size of US$106 billion (from 2010 to 2015) and imports accounting for over 83% demand for electrical machinery, the SADC region has sufficient market to develop an industrial base that can produce electrical machinery (products and components) to be consumed within the region. For instance, even with a well-developed industrial base in South Africa, the country imports at least four times the total exports. This suggests there is room for industrial development in the region.

However, for such industrial development to happen, regional coordination and strategic placements of anchor manufacturing firms in different countries across the region is required. Furthermore, apart from focusing on the local markets, the region's industrial base could also play a major role in export markets in other parts of Africa and outside of the continent.

In the long term, the increase in electricity generation in the SADC region has led to a significant expansion of demand for electrotechnical equipment and allied services. However, over the past few years this demand has been serviced by imports from outside of Africa. Public utilities have focused their procurement strategies on reducing Total Cost of Ownership (TCO) and require suppliers to help them reduce operational costs, increase productivity, and improve workers' health, safety and environmental management. Therefore, the implications for the electrical machinery and equipment industry are many-fold:

- OEMs are expected to offer "solutions" rather than merely sell products, which in turn requires partnership with the public utility companies and continuous investment in product and process upgrading. OEMs invest considerably in research and development (R&D) and product improvement as well as pursuing acquisitions of innovative firms. Mergers and acquisitions are also pursued to enter new markets, reduce competition and broaden product portfolio. After-market services are crucial to reduce TCO for buyers and to increase/stabilise revenues for the OEMs.
- OEMs in South Africa's electrotechnical industry have historically developed on the back of strong demand from the power sector for technological solutions and have been characterised by high levels of investment in R&D and human capital. Notwithstanding changes post-1994 to the power sector and the macroeconomic environment, South African OEMs have found niche markets in which they are globally competitive. Erosion of R&D and the skills base over the past few years constitutes the most pressing challenges for the long-term competitiveness of the sector.
- OEMs' operations in South Africa tend to have high local content, because South African OEMs are highly embedded in the local electrotechnical inputs cluster and operate at every stage of the value chain, from product design to marketing. International OEMs also sub-contract part of the manufacturing process to local manufacturers. Conversely, very little innovation or manufacturing takes place in Zambia, despite the local content requirements placed by the Zambian government. Local subsidiaries, agents and traders are sometimes involved, with various degrees of value-added content, in after-market sales.

From the 1990s onward, following the end of state ownership and import substitution policies, Zambia's industrial inputs cluster shrank significantly in size and value-added content. While the entry of new investors, including from Asia, injected much needed capital into its copper mining sector, few local suppliers managed to gain access to these new market opportunities.

Without the support of interventionist industrial policies and faced with competition from imports, most manufacturers struggled and exited the supply chain. Many suppliers turned into importers of electrical machinery as subsidiaries, agents and traders. The challenges to upstream linkage development range from weak firm technological competencies, low skills base, scarce access to finance and a very high cost of production structure.

From a policy perspective, both Zambia and South Africa are increasingly committed to increasing local content in the electrotechnical industry. More recently suppliers, under the umbrella of their business associations, have been spearheading a more ambitious local content initiative which is receiving support from IPPs, the government and donors. South Africa's industrial policy, while not directly targeting regional content, is facilitating some categories of suppliers with support such as skills development and credit facilities.

In both Zambia and South Africa, the private sector has to play a major role if regional value chain policies are to succeed. Countries within SADC have had different product standards. Hence, there has been low trade among themselves. This has led governments to start the process of harmonising the standards, offering new opportunities to local firms that are fully certified and using such standards to tap into the regional market.

End-user firms interviewed for this report are open to buying locally manufactured commodities for electricity production and supply. They see some immediate benefits to their company operations – e.g. in the form of increase electricity sales – and consider that general employment opportunities would come from using locally manufactured commodities.

While the promotion of local content policies would seem counter-intuitive to trade integration, many policymakers and such policies would not cover all industry requirements. However, with such policies, local industries could have an opportunity to break into markets when this is not currently possible.

8.2 Opportunities on the African continent

The power generation subsector in Sub-Saharan Africa presents opportunities for South African companies in the construction of new fossil-fuelled and renewable energy plants. Given Africa's vast reserves of gas and other renewable energy sources, the opportunity to construct gas-fired power plants and renewable energy plants can reduce the countries' reliance on coal. When natural gas production is used for domestic electricity generation, increasing supply will help to further support new planned gas-fired power plants, helping along the way to meet goals of expanding output and demand for electrical machinery. New conventional gas discoveries in Mozambique, Tanzania and off the coast of Angola hold a great deal of promise as well.

Further opportunities exist in brownfield projects including in refurbishments, repowering and life extension programmes. Many countries in the SADC region and the rest of Africa have embarked on rehabilitation programmes because these can be implemented faster than programmes seeking to increase capacity. Licensing and due diligence steps are fewer than those of a greenfield project. Examples of such programmes are the rehabilitation and extension programmes of Hwange and Kariba power stations in Zimbabwe and Zambia. In addition, Inga I and II are being refurbished to provide electricity to the Democratic Republic of Congo (DRC) national grid.

Rural electrification is a priority for most Sub-Saharan African countries, including South Africa and Zambia. Small projects falling under rural electrification could potentially be faster to implement due to their shorter licensing process and construction times. However, the grid extension at this level comes at a cost. Solutions proposed for remote rural areas take in the costs of decentralised off-grid and fuel transportation costs, including mini grids, stand-alone off-grid solutions, and concentrated solar power, which can be used for power generation and water heating. Nonetheless, rural areas are susceptible to technical skills gaps that hamper the uptake of power generation projects that see experts depart following initial installation and thus potential failure in the longer term. Retaining local levels of expertise is a prerequisite for sustainable implementation of projects in rural areas, rendering the policy around localisation critical for power generation projects for rural electrification.

Despite vast opportunities presented by various envisaged power infrastructure projects, funding remains a key challenge. Governments in Africa have historically financed a sizeable share of the continent's infrastructure development on balance sheet, and infrastructure rollout has been constrained by budgetary restrictions. Furthermore, local banks are often unable to supply the loans needed for long-term infrastructure investment. Sub-Saharan Africa governments have initiated an innovative template for infrastructure financing, which includes involving a combination of public-private partnerships, specialist infrastructure funds, equity financing for private infrastructure developments, public bonds placements and sovereign wealth funds. However, for now, fiscal constraints have pushed governments to look for the private sector (such as IPPs) to take the investment lead.

9. CONCLUSION

The electrotechnical industry is heavily reliant on the demand for electricity generation from a global, regional and national perspective. As governments pursue public-private partnerships to scale up investment in generation capacity, transmission and distribution this will unlock opportunities for the electrotechnical industry. While there has been an increase in private-led external investment and financial support provided by development finance institutions such as the African Development Bank, the business environment and policy framework in many African countries is still not sufficiently robust to attract the level of private investment required to install the additional capacity.

The power sector in Africa offers unique potential and attractive investment opportunities across the value chain including in generation, transmission and distribution, and retail. Even though South Africa and Zambia have experienced a challenging period over the past few years in their electrotechnical industries, the planned power generation projects highlighted in this report present an opportunity for growth and development of a regional network of local manufacturers between the two countries. This would require a collaborative effort by South Africa and Zambia for industrial development initiatives focused on promoting increasing levels of trade and investment between the two countries, and greater consideration of building long-term productive relationships to complement and upgrade existing investments and capabilities through technology and skills transfer.

This report has illustrated that domestic investment in local manufacturing of electrical machinery has not kept up with the demand of electrification or remained competitive against foreign EPCMs and OEMs (the displacement of local manufacturing by predominantly Chinese imports). Given large existing reserves of primary electricity sources, opportunities to construct new power plants abound. There are also opportunities in the refurbishment and rehabilitation of existing plants and rural electrification using off-grid technologies.

At the retail level, demand-side management technologies, including prepaid meters, energy efficient appliances, and smart-grid solutions, offer further trade opportunities for local companies. Although opportunities are varied in the transmission and distribution subsector, the poor performance of long-standing state-owned monopolies is the biggest limiting factor for investment.

Also, the procurement policies of public utilities (such as Eskom and ZESCO as well as IPPs) would need to align their practices along with the industrial policy objectives of both countries, which focus on the national and regional development of local manufacturers of electrical machinery and equipment. Localisation through designation of key components for power generation projects such as Transformers and the development of bilateral linkages in their value added manufacturing process should be considered.

The outlook for the electrotechnical industry in its capability of weathering the current regional economic climate remains positive despite the numerous challenges. The need and demand for electrification where none exists remain high. Estimates suggest that by 2030 developing countries will need to double their electrical power output to meet rising demand, which bodes well for electrical equipment manufacturers and suppliers.

While opportunities abound, having continued access to finance will be critical for success. The most critical issue is the ongoing requirement to fund the increasing need to enhance and expand the transmission and distribution network to accommodate renewable energy generation and set up costs for new manufacturing facilities in South Africa. The adoption of smart grid technology and energy storage is acknowledged as the main market driver for the electrotechnical industry supplying the power sector over the medium term.

These dynamics motivated the investment case for the power sector, making it an undisputable choice for continuous investment into the growth of the sector. Expansion in generation capacity naturally requires expansion in the distribution and transmission capacity of the power grid, and consequently the expansion of the electrotechnical industry, as the need to transmit electricity from point of generation to the end consumers will continue to expand.

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10. APPENDIX

1. Electrical equipment according to harmonised system classification

For ease of analysis, the electrotechnical commodities of Chapter 85 of the Harmonised System (HS) were classified into three group:

i. **Generation**
   Commodity codes: 8502, 8503, 8505 and 8535
ii. **Transmission**
   Commodity codes: 8504, 8537, 8538 and 8544
iii. **End-Use**
   Commodity codes:
   Industrial: 8501, 8507, 8508, 8514, 8515, 8532, 8533, 8536, 8539, 8543, 8545, 8546, 8547, 8548
   Other: 8506, 8509, 8510, 8511, 8512, 8513, 8516, 8517, 8518, 8519, 8520, 8521, 8522, 8523, 8524, 8525, 8526, 8527, 8528, 8529, 8530, 8531, 8534, 8540, 8541 and 8542.

2. Generation projects commissioned in 2016 and planned projects in other SADC member states

Table 10: Generation projects commissioned by public utilities and IPPs in the SADC region (2016)

No	Utility	Country	Name	Type	Capacity [MW]
1	RNT	Angola	Cambambe 1 & 2	Hydro	350
2	RNT	Angola	Cambambe 3 & 4	Hydro	350
3	RNT	Angola	Cambambe I Rehabilation	Hydro	80
4	IPP	South Africa	OCGT	Gas	670
5	IPP	South Africa	Renewable	Wind	414
6	IPP	South Africa	Renewable	PV	360
7	IPP	South Africa	Renewable	CSP	100
8	IPP	South Africa	Renewable	Other	7
9	ESKOM	South Africa	Ingula 1,2,4	Water Pumped Storage	999
10	NamPower	Namibia	Ruacana	Hydro	15
11	IPP	Mozambique	Gigawatt	Gas	100
12	IPP	Mozambique	Nacala Power Ship	Gas	75
13	IPP	Zambia	Maamba Colliery	Coal	300
14	TANESCO	Tanzania	Kinyerezi I Extenstion	Gas - GT	150
15	IPP	Zimbabwe	Dema	Diesel	200
16	IPP	Malawi	Diesel	Diesel	10
TOTAL					4180

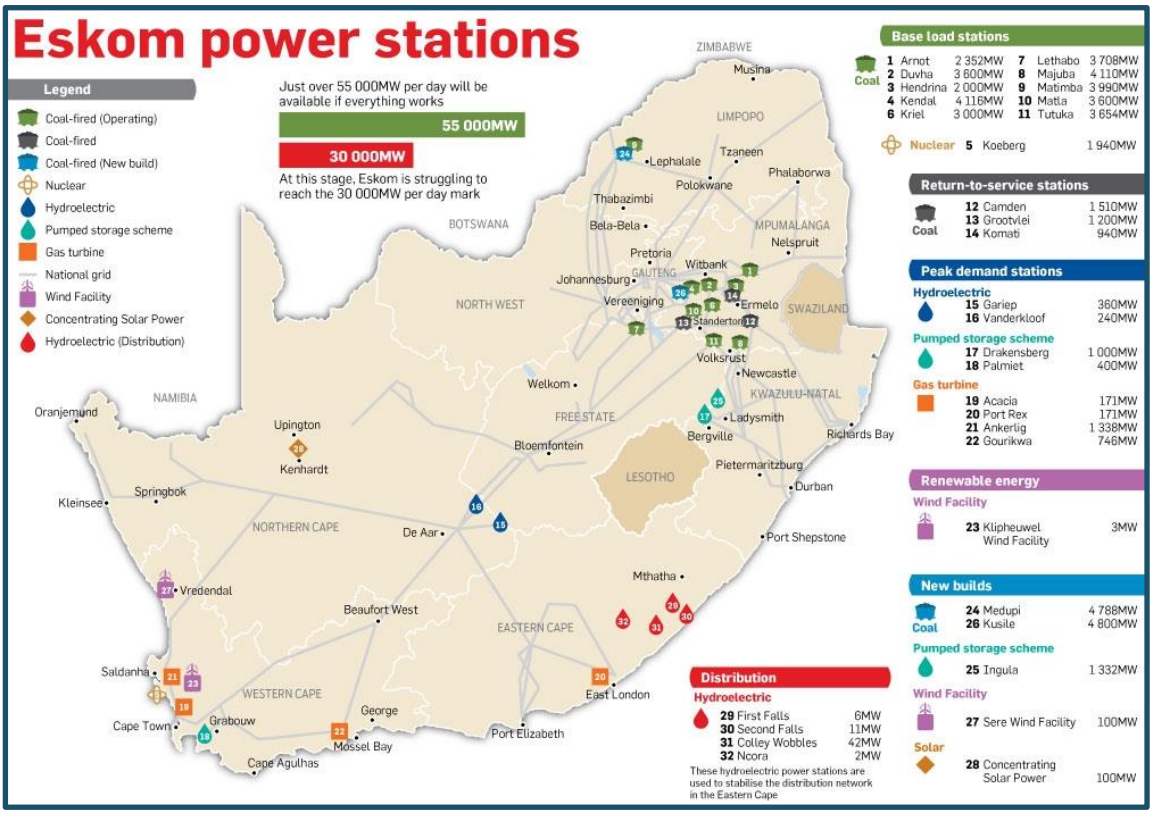
Source: SAPP (2017)

Table 11: Planned power projects in other SADC countries for the next five years

Country	Project Name
Angola	42 MW Chicapa 2 Hydropower Plant
	Nzeto-Mbanza Kongo Power Transmission Line
Botswana	300 MW Sechaba Coal Power Plant Project
	300 MW Morupule B Power Station IPP Expansion (Unit 7&8)
	50 MW Coal-bed Methane Power Plant, Lesedi CBM Project
Lesotho	35 MW Letseng-La-Terai Wind farm
Madagascar	120 MW Aksa Enerji Fuel-oil Power Plant
Malawi	21.8 MW Tedzani Hydropower Plant Expansion Project
	35 MW Luweya River Hydro Power Plant
	Mozambique - Malawi Interconnection Project
Mozambique	1500 MW Mphanda Nkuwa Hydropower Plant Project
	40 MW Kuvaninga Energia Natural Gas-fired Power Project
	Ncondezi Coal thermal power plant Phase I
	Ncondezi Coal thermal power plant Phase II
	180 MW Lurio River Hydroelectric Power Plant Project
	75 MW Palma Natural Gas Fired Power Plant
	416 MW Lupata Hydropower Plant
	210 MW Boroma Hydroelectric Dam, Zambezi River
	600 MW Chemba I Hydropower Plant, Zambezi River
	400 MW Chemba II Hydropower Plant, Zambezi River
	1000 MW Chemba Hydropower Plant, Zambezi River
	60 MW Alto Malema Hydropower Plant Project
	600 MW Moatize Coal-fired IPP Project
	150 MW Jindal Africa Power Station
	Mozambique - Malawi Interconnection Project
	2000 MW Benga Thermal Power station
	300 MW Ncondezi Coal Thermal Power Plant Project
	1250 MW Cahora Bassa Norte (Cahora Bassa Phase II), Zambezi River
Namibia	1050 MW Kudu Combined-Cycle Gas and Steam Turbine Project
	Okakarara Solar Power Plant, Otjozondjupa
	300 MW Baynes Hydropower Plant
	500 MW Sperrgebiet Wind Farm
	108 MW Lower Orange Hydroelectric Power Scheme
Swaziland	200 MW Zoetic Energy Hydroelectric Dam Project
Zimbabwe	100 MW Zvishavane Solar Power Plant
	600 MW Gwayi Coal Fired Power Plant
	100 MW Solar Power Plant, Harare
	400 MW Sinosteel Coalbed Methane Gas-Fired Power Generation Plant
	100 MW Zhenfa Solar Photovoltaic Project
	600 MW Makomo Power Plant, Hwange
	1200 MW Thermal Power Plant, Western coal mining belt
	150 MW Marondera Solar Park
	120 MW Chaka Hills Farm Solar power plant, Marondera
	600 MW PER Lusulu Power Coal Power Plant
	175 MW Chapfucheche Farm Solar Photovoltaic Power Plant
	50 MW Marondera Solar Park - Phase I
	200 MW Kondo Dam, Save River
	2000 MW Lusulu Thermal Station, Binga
	2400 MW Batoka Gorge Hydroelectric Power Project
	2400 MW Gokwe North Sengwa Power Project

Source: PIDA (2017)

3. ESKOM power generation, transmission and distribution network



Source: Eskom (2016)

The electricity supply industry value chain in South Africa consists broadly of three distinct groups of services: generation, transmission and distribution. Eskom is vertically integrated across all three areas of the value chain and is responsible for almost all power generation and transmission in South Africa, but shares the role of distributing power to end-users with municipalities.

Eskom generates about 95% of total electricity consumed in South Africa while municipal-owned power plants and IPPs generate the remaining 5%. All transmission networks in South Africa are owned by Eskom which consequently provides 100% of transmission services. In 2014/15 Eskom distributed roughly 58% of its sales directly to end-users of power – which included a mix of large industrial (23% of total sales) mining (14%), international, residential, commercial, agricultural and rail consumers. The remaining 42% of Eskom's total sales were to municipalities, which are in turn responsible for distributing power to a mix of consumers – mostly residential, industrial and commercial (Deloitte, 2017).

4. South Africa and Zambia's top 10 import and export markets of electrical machinery

Table 12: South Africa and Zambia electrical machinery trade markets (US$ thousand)

	SA Top 10 Import Markets	2010	2017	Share 2017
	World	**8 712 786**	**8 495 646**	
1	China	2 589 542	4 048 192	**47,7%**
2	Viet Nam	187 236	605 228	**7,1%**
3	Germany	703 190	487 201	**5,7%**
4	USA	488 207	373 094	**4,4%**
5	Spain	68 464	192 280	**2,3%**
6	France	177 112	170 175	**2,0%**
7	Taipei, Chinese	227 267	155 323	**1,8%**
8	Japan	351 170	155 257	**1,8%**
9	Italy	157 749	147 674	**1,7%**
10	United Kingdom	226 687	147 224	**1,7%**

	Zambia Top 10 Import Markets	2010	2017	Share 2017
	World	**247 654**	**443 673**	
1	China	33 291	151 309	**34,1%**
2	South Africa	104 305	148 241	**33,4%**
3	Hong Kong	8 886	25 224	**5,7%**
4	Sweden	7 097	19 265	**4,3%**
5	India	7 334	7 923	**1,8%**
6	United Kingdom	5 286	7 900	**1,8%**
7	Finland	3 972	7 706	**1,7%**
8	Netherlands	1 046	7 098	**1,6%**
9	United Arab Emirates	20 485	6 983	**1,6%**
10	Viet Nam	203	6 691	**1,5%**

	SA Top 10 Export Markets	2010	2017	Share 2017
	World	**2 008 427**	**1 802 545**	
1	Namibia	231 981	222 707	**12,4%**
2	Botswana	201 783	207 479	**11,5%**
3	Zambia	117 257	131 516	**7,3%**
4	Mozambique	111 329	93 718	**5,2%**
5	Netherlands	25 464	83 632	**4,6%**
6	DRC	68 916	81 450	**4,5%**
7	USA	67 603	77 197	**4,3%**
8	Lesotho	93 230	73 878	**4,1%**
9	Zimbabwe	106 234	71 032	**3,9%**
10	Swaziland	91 545	61 917	**3,4%**

	Zambia Top 10 Export Markets	2010	2017	Share 2017
	World	**45 672**	**58 735**	
1	United Arab Emirates	46	26 482	**45,1%**
2	South Africa	37 402	12 509	**21,3%**
3	DRC	4 251	6 304	**10,7%**
4	Kenya	796	3 499	**6,0%**
5	Tanzania	795	3 144	**5,4%**
6	Uganda	-	1 847	**3,1%**
7	Zimbabwe	129	1 247	**2,1%**
8	Ghana	2	576	**1,0%**
9	Netherlands	116	542	**0,9%**
10	Singapore	-	525	**0,9%**

Source: Trade Map (2018)

5. Firms in South Africa's SAEEC members operating in the power and energy sector

Table 13: 55 firms in South Africa's electrotechnical industry in the power and energy sector

Firms		
ABB South Africa	ISF Group	Rethuseng Live Line & Services
ACTOM	Itron	Rittal
ADC Projects	Kama Industries	Rousant International
Adroit Technologies	KBK Power Solutions	Schweitzer Engineering Laboratories
Allbro Industries	Landis + Gyr	Secelec Consulting Engineers
Apple Plastics SA	Lapp Group	Siemens SA
ARB Electrical Wholesalers	Likusasa Engineering & Contracting	Southern Mapping Co.
CBI Electric - Low Voltage	Lucy Electric SA	Specialist System Engineering
Chopper Worx	Manoa Intelligent Energy	Speedcraft Manufacturing
Conlog	Master Power Technologies	Surge Technology
Consolidated African Technologies	McWade Productions	TEQDAS cc
DesSoft	Metpress	The Fibreglass Shop
Directech	Nexans Trade	Trans-Africa Projects
Doble Engineering Africa	Pfisterer	Transoil Services
Electro Inductive Industries	Polybox	Treated Timber Products
Emerson Network Power SA	Power Technologies	Zest Electrical Motors
Enzani Technologies	Pragma Africa	
First National Battery Industrial	Pratley Exporting	
General Cable (SSA)	Preformed Line Products	

Source: **SAEEC (2017)**

6. Expenditure and demand forecast for transformers in South Africa

Table 14: Indicative figures of Eskom's demand (2010-2014)

Class	Total number of transformers	Average per annum	Average Expenditure	Average Expenditure per Unit Cost
0	180 000	36 000	R3 000 000 000	R16 667
1	705	117	R750 000 000	R1 063 830
2	47	8	R280 000 000	R5 957 447
3	111	18	R500 000 000	R4 504 505
4	18	3	R200 000 000	R11 111 111

Source: the dti (2015)

Table 15: Eskom's 5-year forecast for transformers per class (2015-2020)

Class	High scenario	Low scenario	Projection	Projected average spend	Average Expenditure per Unit Cost
0	180 000	120 000	150 000	R3 357 000 000	R22 380
1	800	400	500	R714 000 000	R1 428 000
2	50	20	30	R240 000 000	R8 000 000
3	110	70	90	R544 000 000	R6 044 444
4	20	5	10	R149 000 000	R14 900 000

Source: the dti (2015)

Table 16: Classes of transformers

Transformer Class	Power Rating, MVA (Range)	Voltage Rating, kV (Range)
Class 0	0.001 to 1	220V to 22
Class 1	1.25 to 160	11 to 132
Class 2	40 to 315	220 to 275
Class 3A	360 to 500	220 to 275
Class 3B	40 to 1000	320 to 400
Class 4	40 to 2000	>420 to 800

Source: the dti (2015)