2023 ENERGY SERVICES MARKET INTELLIGENCE REPORT

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GreenCape

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GREENCAPE

GreenCape is a non-profit organisation that works at the interface of business, government, and academia to identify and remove barriers to economically viable green economy infrastructure solutions. Working in developing countries, GreenCape catalyses the replication and large-scale uptake of these solutions to enable each country and its citizens to prosper.

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LIST OF ABBREVIATIONS AND ACRONYMS

AMI	Advanced Metering Infrastructure
AMR	Automated meter reading
ASDU	Alternate Service Delivery Unit
BTM	Behind-the-meter
CAGR	Compound annual growth rate
C&I	Commercial and industrial
CoC	Certificate of Compliance
CoCT	City of Cape Town
COP26	The 2021 United Nations Climate Change Conference
CPI	Consumer Price Index
DBSA	Development Bank of Southern Africa
DC	Direct current
DMRE	Department of Mineral and Energy Resources
DPE	Department of Public Enterprises
EAF	Energy availability factor
EE	Energy efficiency
EIB	European Investment Bank
EPC	Engineering, procurement and construction
ERA	Energy Regulation Act
ES	Energy services
ESCo	Energy Services Company
GW	Gigawatts
GWh	Gigawatt-hours
IEA	International Energy Agency
IRP	Integrated Resource Plan
IPP	Independent Power Producer

JET-IP	Just Energy Transition Investment Plan
LCOS	Levelised cost of storage
Li-ion	Lithium ion
M&V	Measurement and verification
MW	Megawatt
MWh	Megawatt-hours
MWp	Megawatt peak
NBI	National Business Initiative
NDC	Nationally Determined Contribution
NERSA	National Energy Regulator of South Africa
PCC	Presidential Climate Commission
PPA	Power purchase agreement
PSEE	Private Sector Energy Efficiency Programme
PV	Photovoltaic
SAESA	South African Energy Storage Association
SALGA	South African Local Government Association
SANEDI	South African National Energy Development Institute
SANS	South African National Standard
SAPVIA	South African Photovoltaic Industry Association
SM	Smart meters
SPV	Special purpose vehicle
SSEG	Small-scale embedded generation
TVET	Tertiary Vocational Education and Training
TWh	Terrawatt-hours
UPS	Uninterruptible power supply
VRFB	Vanadium redox flow battery
Wh	Watt-hours, units of energy consumed
Wp	Watt-peak, energy capacity
WPS	World Port Source

Exchange rates used: 1 USD = R17.23 (November 2022)

EXECUTIVE SUMMARY

CLICK HERE TO WATCH A SUMMARY OF THE MIR OPPORTUNITIES

This market intelligence report is compiled for foreign and local investors looking to invest in the South African green economy through project development, asset management, equity, debt, equipment manufacturing, or support services. It highlights investment opportunities in embedded generation, energy storage and energy efficiency created by South Africa's diversifying energy services market.

There are five main factors driving growth in the energy services (ES) market: Above-inflation electricity price rises; national energy insecurity; decreasing technology costs; supportive policies, regulations, and tariffs; and increasingly relevant finance options have all played an important role in driving the growth of the ES market.

Amidst on-going load shedding, there is an increased interest from businesses in improved cost efficiencies and secure energy supply.

Rooftop solar PV has been identified as an important part of the country's immediate efforts towards energy security.

Positive regulatory movement, investor sentiment, and steady recovery in the key commercial, industrial, and agricultural sectors have led to continued market growth in 2022. The annual added capacity in 2022 is estimated to be 600-900 MWp nationally at a market value of R7.5 billion. The market is still expected to reach a total capacity of 10 GWp by 2035 at a market value of ~R100 billion. This steady growth, which translates to the potential creation of ~1 250 jobs, is significant in the South African context, considering the ongoing need to reduce the current 44.1% unemployment rate[1].

Uptake of **energy storage**, in particular lithium-ion (Li-ion) batteries, continued to grow in the commercial and agricultural sectors in 2022.

The increasing relevance of load shedding related risks is expected to lead to an increasingly prevalent role for the storage segment for back-up purposes in energy service provision. Flexibility of application use cases will also be attractive once Li-ion prices drop past a tipping point against time-of-use tariffs allowing numerous value stacking options such as peak shaving and arbitrage to become economically viable. The upfront capital cost remains the largest market barrier for Li-ion batteries, but the rising price of diesel is resulting in closer cost competitiveness on a levelised cost of storage (LCOS) basis. The current national market size is R4 billion with 500 MWh installed battery capacity. It is expected to rise to ~R32.5 billion with 6.5 GWh installed battery capacity by 2035.

[1] Based on the expanded definition, which includes people who are available for work but not looking for a job.

The **energy efficiency (EE)** sector remains sluggish relative to the large identified annual saving potential across South Africa of 120 TWh. This is due to market barriers in end-user awareness, behaviour change, small project sizes and limited access to appropriate finance instruments, but segments that are seeing growth are the implementation of smart meters and third-party aggregation. These tie into trends in both the public and private sector, including load curtailment programmes, energy performance certificates and load aggregation for multiple energy users in building complexes. The national market value for smart meters is expected to reach ~R40 billion by 2035, based on an upgrade rate of 100 000 to 300 000 upgrades per annum.

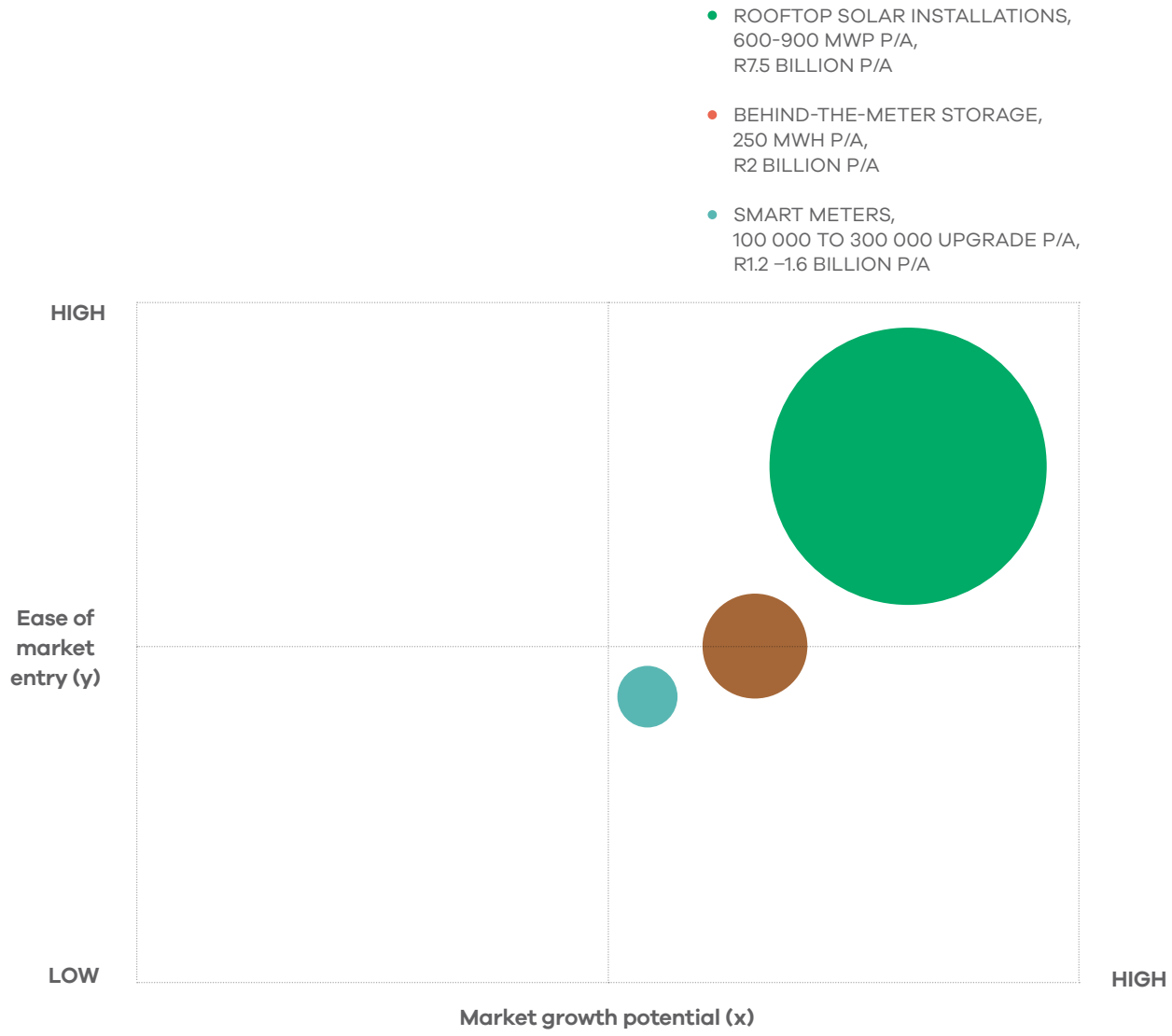

Figure 1: Investment prioritisation matrix of energy services opportunities[2]

[2] Size of bubble proportional to relative market opportunity size

Table 1: Energy services opportunities

Opportunity			
Rooftop solar PV installations			
Drivers	**Barriers**	**Expected timeframe**	**Macro-environment**
• Strong business case. • Larger developers shifting a portion of focus to >1MWp projects and wheeling, thus opening the <1MWp market for smaller developers. • Power purchase agreements (PPAs) allow access to energy users who cannot raise upfront capital.	• Availability of high-quality skills in the sector, particularly technicians and installers. • Limited effectiveness in the enforcement of regulations and standards to prevent poor quality installations. • Municipal embedded generation policy and processes are not streamlined, resulting in procurement delays. • Municipal wheeling is still in the pilot phase, which limits applications mostly for generation for on-site use.	Immediate	• Eskom and municipal electricity tariffs on the rise. • National energy insecurity leading to frequent rolling blackouts referred to as "load shedding."
Opportunity			
Behind- the-meter battery storage			
Drivers	**Barriers**	**Expected timeframe**	**Macro-environment**
• Backup and uninterruptible power supply (UPS) application to limit costs and losses associated with load shedding induced interruptions to manufacturing and crop production. • Li-ion battery prices have decreased.	• Upfront costs for batteries are still high for the need. • Lack of battery specific power purchase agreement (PPA) / financing / lease options. • Additional expertise required to deliver complex hybrid designs.	Short term 3 years	• Load shedding and security of supply are major concerns. • Rising cost of diesel.
Opportunity			
Smart meters			
Drivers	**Barriers**	**Expected timeframe**	**Macro-environment**
• Enables energy as a service model. • Decreasing cost of meters. • South Africa has a strong local meter manufacturing industry. • Ten million traditional prepaid meters will need to be replaced/upgraded. • Load curtailment programmes and the need for demand response levers at a municipal system level.	• Public sector market will concentrate towards technologies currently in or specified in tenders/pilots. • Private sector market can be limited by understanding and negative perceptions of effectiveness. • High measurement and verification (M&V) costs to prove savings and qualify for the 12L tax rebate.	Short term 3 years	• Energy performance certificates are now mandatory for large buildings. • The National Building Regulations and specifically SANS10400XA, which applies to energy usage in buildings, sets particular energy efficiency requirements.


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WHAT'S NEW?

This Market Intelligence Report (MIR) updates the opportunities, barriers, and regulations discussed in the 2022 Energy Services MIR. It also outlines investment opportunities and barriers in rooftop solar photovoltaic (PV), energy storage, and energy efficiency.

January to December: Russia invades Ukraine in a major escalation of the Russia-Ukrainian War, which began in 2014. This sets off a global escalation of fuel prices, including a 49% increase in the price of diesel in South Africa in the course of 2022. This has resulted in increased demand for cost-effective energy security technology alternatives.

February: National Treasury announces an increase in the carbon tax rate to R144 effective from 1 January 2022. To uphold South Africa's commitments at the 2021 United Nations Climate Change Conference (COP26), the rate will increase each year by at least R15 until it reaches R300. From 2026, government intends to escalate the carbon price more rapidly every year to reach at least R450 by 2030.

July: The City of Cape Town (CoCT) allows its commercial and industrial (C&I) customers with embedded generation (or their own power solutions) to be net consumers. Previously these customers have been prevented from feeding back more kWh units of power than they consume from CoCT in a given annual billing period.

CoCT is now crediting the electricity bills of net consumers on a rand basis and is willing to pay the excess in the event of the customer being in credit.

October: CoCT issues a 60 MW demand response tender to appoint third-party aggregators with a view to facilitating voluntary residential and small-scale commercial customers in reducing their power use at a given time so that city-supplied customers can be protected from the impacts of load shedding. The aggregators determine the incentives for the customers, and the city rewards the aggregators based on the tender terms and conditions.

November: The National Energy Regulator of South Africa (NERSA) continues to approve energy trading licences. This allows developers to sign a power purchase agreement (PPA) with the energy trader. The trader then provides a diversified customer pool, alongside energy contracts that are flexible and affordable for the South African market, whilst reducing the overall off-take risk for the developers.

December: The Minister of Mineral Resources and Energy publishes proposed amendments to Schedule 2 of the Electricity Regulation Act, 2006 (ERA) for public comment. Main changes include the removal of the 100 MW threshold, as well as clarification on which activities remain exempt from the generation licence requirement, but not from registration with NERSA.

INTRODUCTION AND PURPOSE

Over the past 10 years, the concept of energy services and energy service companies have evolved and matured in several markets worldwide, including South Africa.


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The term 'Energy Services' is used to describe three interlinked energy market segments in the South African energy space, namely rooftop solar PV systems, energy storage, and EE. Figure 2 below breaks down the three interlinked energy market segments.

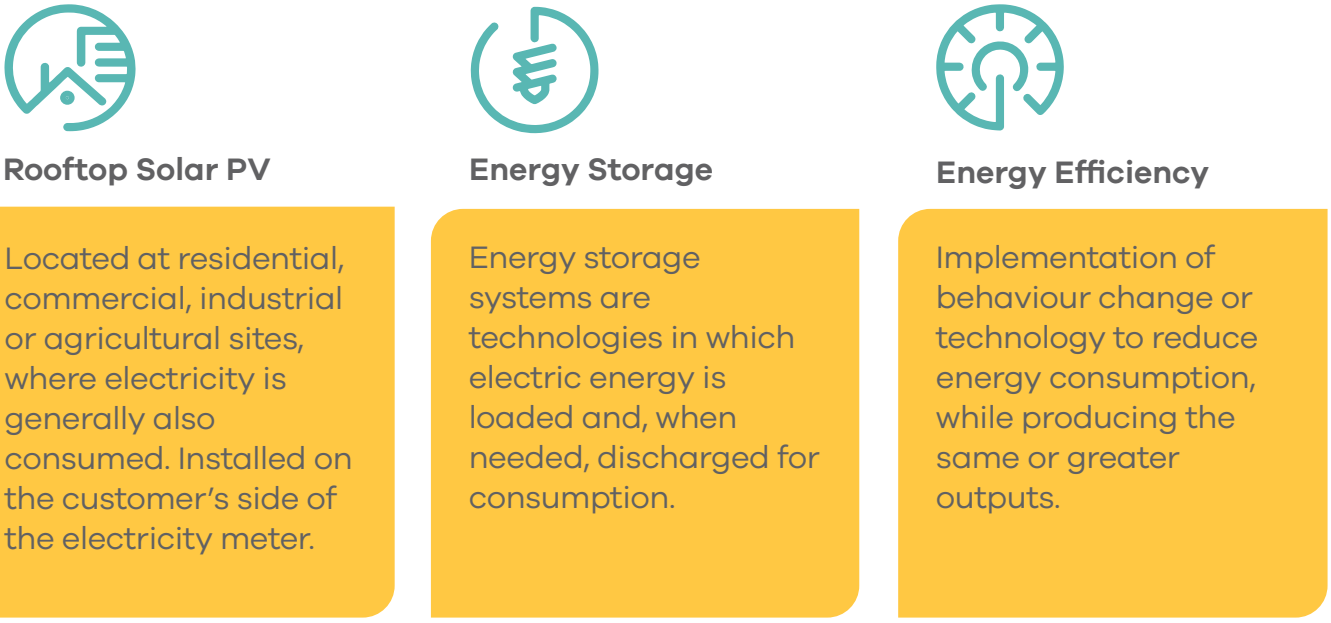

Figure 2: Energy services interlinked market segments

This market intelligence report provides greater understanding of South Africa's market opportunities in these segments, considering the size of the opportunities, the market drivers, and current barriers.

The report is compiled for foreign and local investors (persons or organisations) looking to invest in the South African green economy through project development, asset management, equity, debt, equipment manufacture, or support services.

In what follows:

- **The sector overview** (Section 2) provides a national economic overview of the energy services market, including:
- cross-cutting market drivers and barriers in the South African energy services market;
- market sizing (small-scale embedded generation, energy storage, and energy efficiency); and
- key players in the South African energy services market.
- This is followed by an overview and update of **policies, legislation, and governance** (Section 3) that guide and affect the energy services market.
- In Section 4, **opportunities** and their related drivers and barriers are highlighted, followed by sections that outline various **finance and investment incentives** (Section 5) and explain **GreenCape's work within the green economy** (Section 6).

FOR QUESTIONS, QUERIES, OR TO ACCESS GREENCAPE'S SERVICES, CONTACT THE ENERGY SERVICES TEAM AT energysectordesk@greencape.co.za

SECTOR OVERVIEW

Rising electricity prices, energy insecurity, decreasing technology costs, supportive energy policies, and incentives prompt consumers to explore alternative energy options, thereby driving the growth of the energy services market in South Africa and creating a thriving value chain for equipment suppliers, project developers, technical advisors, and financial investors.


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2.1. National electricity landscape

Eskom, the state-owned power company, provides ~95% of South Africa's total electricity supply, i.e., 53.7 GW. The remaining 5% of demand is met through municipalities, imports, and renewable independent power producers (IPPs) (CSIR, 2022).

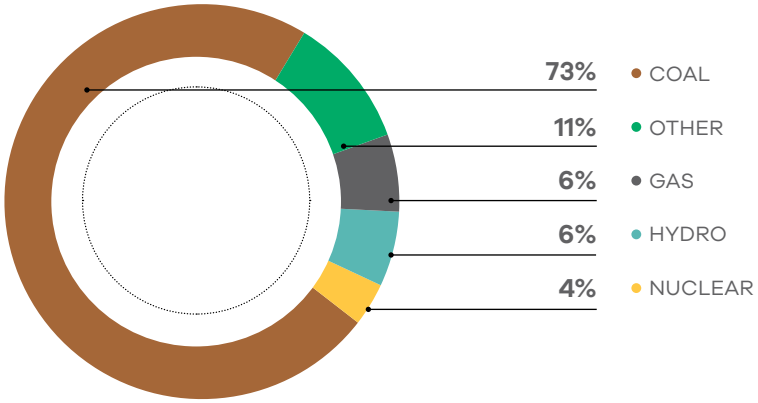

Figure 3: National generation mix

Source: CSIR (2022)

As depicted in Figure 3, South Africa's electricity supply is currently dominated by coal-fired power generation with an installed capacity of 39.3 GW. The generation mix includes a nuclear power plant, as well as two conventional hydroelectric power stations and four non-dispatchable mini hydro stations. There are also three hydro-pumped storage schemes which are used for peak and sudden demand response.

Lastly, there are four quick reaction gas turbine power stations run on diesel, which are reserved for use during extreme demand response emergencies due to their very high operating costs.

Degradation of the existing Eskom coal fleet has led to the annual average energy availability factor (EAF) declining from ~94% in 2002 to ~53% in 2022 (Eskom, 2022a).

The utility's most optimistic scenario suggests this can be improved to 69% by 2030, but it is more likely that it will remain at ~60% for the remainder of the decade. The knock-on effect of this historic underperformance and delayed commissioning of new generation has led to a supply and demand imbalance, and country-wide load shedding (CSIR, 2022).

Load shedding: The practice of reducing load by switching off electricity supply to customers, often in the form of planned outages, such that the overall system can handle periods where demand exceeds available capacity.

2.2. South African electricity security and load shedding

2.2.1. Load shedding and the hours of planned outages

Since 2008, load shedding has been an almost constant part of the South African electricity landscape. In 2022 the supply shortfall has been between 4 GW and 6 GW, and the resulting load shedding as depicted in Figure 4 and Figure 5 has already reached an all-time high. **It is expected that load shedding is likely to persist for the next three to seven years.**

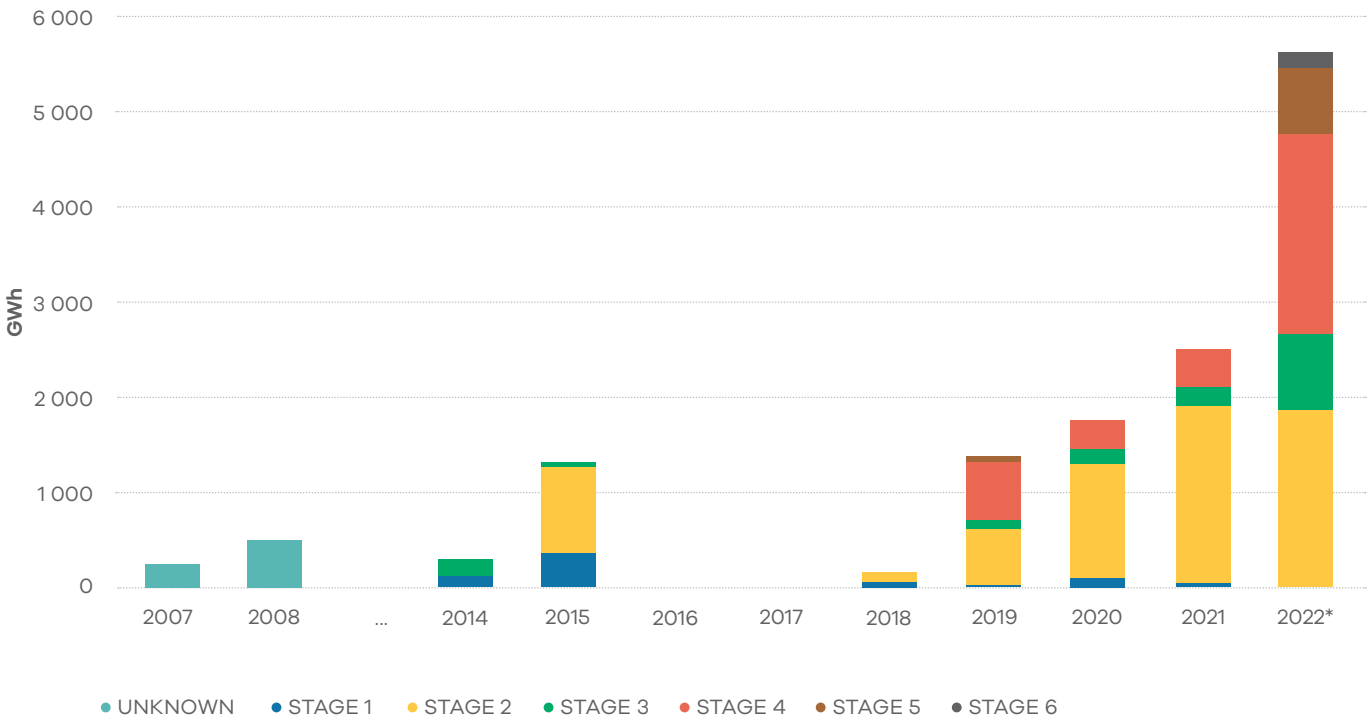

Figure 4: Load shedding statistics – energy basis

Source: CSIR (2022)

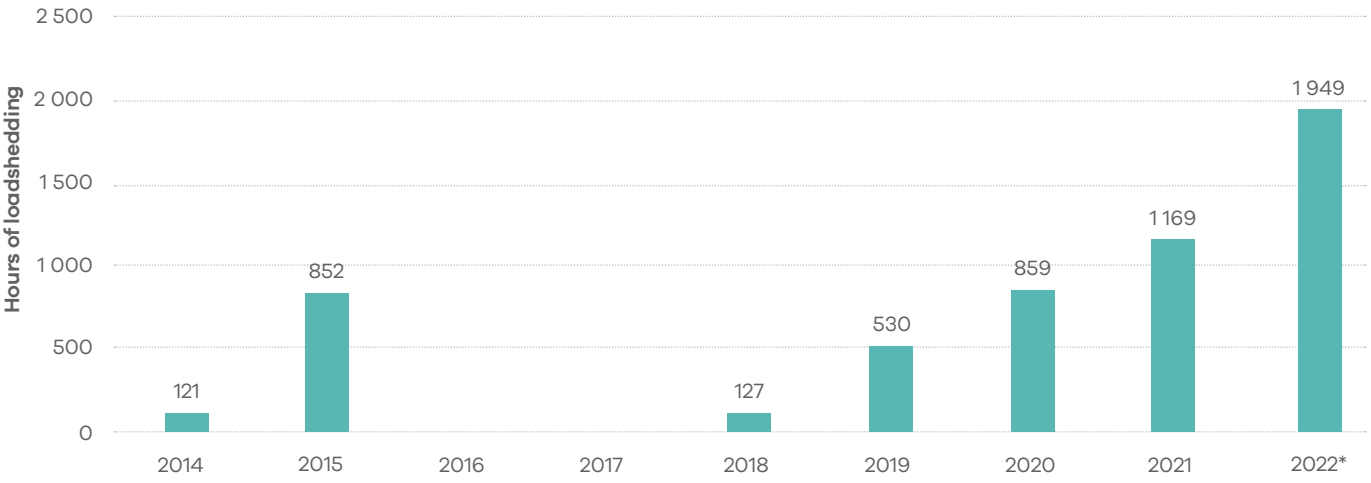

Figure 5: Load shedding statistics – hour basis

Source: CSIR (2022)

**Accurate to September 2022*

The greater the supply shortfall, the more reliant Eskom becomes on its diesel-based gas turbines to mitigate against higher stages of load shedding. This drives up the overall cost of electricity over time, which has a significant knock-on effect on the South African economy, in addition to the more immediate financial and ultimately economy impact of losses experienced by businesses due to extended periods without power.

2.3. Energy services drivers

There are three general drivers of energy service opportunities:

2.3.1. Rising electricity costs

Rapidly rising Eskom electricity prices have created a sizeable demand for viable alternative energy sources in South Africa.

Comparing Eskom's price increases to South Africa's inflation rate (as reflected by the Consumer Price Index), average standard Eskom tariffs have increased by 753% between 2007 and 2021.

Historical data from the Bureau of Economic Research (2022) and StatsSA (2022), shown in Figure 6, reveal that inflation over this period was 134%. Thus, electricity tariffs increased four-fold (or quadrupled) in real money terms in 14 years.

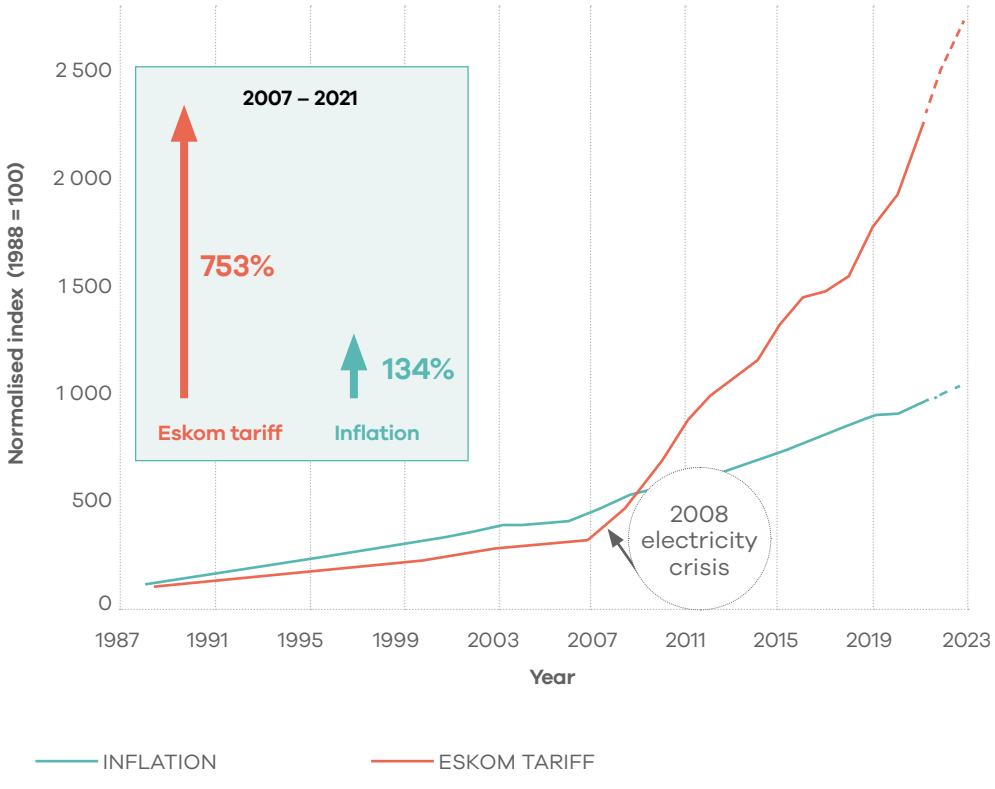

Figure 6: Average Eskom tariff versus inflation (CPI) projected to 2023

Sources: Statistics South Africa (StatsSA) (2022) and Bureau of Economic Research (2022)

The NERSA approved an above consumer price index (CPI) increase for Eskom for the past ten years, with increases in the last five years shown in Table 2.

Table 2: Eskom price increases 2018-2022

Sources: Statistics South Africa (StatsSA) and Bureau of Economic Research (2022)

Year	Average price increase	Inflation	Inflation adjusted price (c/kWh)
2018	5.20%	2.48%	99.82
2019	13.90%	4.13%	109.57
2020	3.90%	2.43%	111.18
2021	15.63%	5.22%	122.75
2022	9.61%	7.70%	125.09

Eskom has indicated that more cost-reflective double-digit hikes will be required in coming years. The utility applied to NERSA for a 32% tariff increase in April 2023.

2.3.2. Falling costs of renewable energy technologies

Renewable energy technology prices have been dropping steadily since 2010. The global average price was R5.33 per kWh in 2010 (IRENA, 2017). In 2022, the average power purchase agreement (PPA) rate for commercial PV has come down to 86c per kWh.

Figure 7 depicts the trend of falling technology prices in the South African rooftop PV market. The South African embedded generation market is currently dominated by rooftop solar PV, given the competitive price, technical maturity, and ease of implementation of this technology.

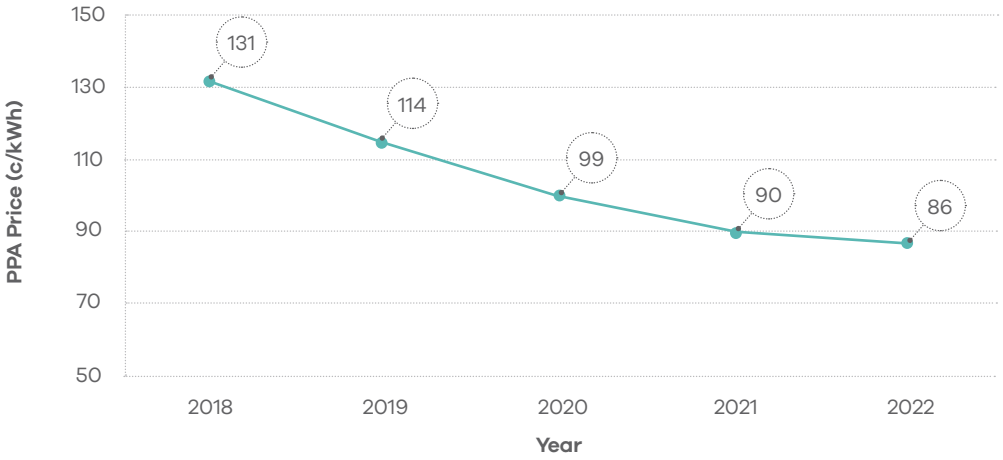

Figure 7: Declining price of rooftop solar PV electricity in South Africa from 2018 to 2022

Source: GreenCape Analysis

2.3.3. Access to finance

Financing for small-scale embedded generation (SSEG), specifically rooftop solar PV, requires a multitude of small contracts with consumers. Traditionally, commercial banks have favoured big solar/wind farms because they are based on contracts with investment-grade utilities and international companies. Only in the past three years have most of the commercial banks started to provide tailored mechanisms for rooftop solar PV investments.

Commercial and residential debt largely remains closely tied to strong individual credit scores and existing bank-customer relations. However, **in 2017, the big five banks in South Africa started to focus on rooftop PV's unique financing needs**, providing more targeted, patient, and affordable finance packages for commercial and residential solar PV.

The inclusion of the commercial banking sector unlocks SSEG opportunities for end-users and installers, engineering, procurement, and construction contractors (EPCs), and energy services companies (ESCos), by providing accessible and affordable financing [3]. Banks' offerings include mechanisms covering 70% to 100% of capital costs, with a five- to ten-year loan repayment option. However, by using pre-selected EPCs and meticulous energy audits, banks ensure that financed projects are designed so that the customer's savings generated from the solar installation are greater than the loan repayments. This results in a positive cash flow.

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Since 2020 there has been an improvement in PV asset class risk profiles, resulting in reduced finance costs. Commercial banks have seen significant growth of successful projects on their loan books, with portfolios tripling between 2018 and 2020. As a result, perceived risks have started stabilising, and finance offerings have become more competitive. Commercial banks have also started exploring new approaches to loan collateral. Whereas in the past security has been tied to the asset or balance sheet of the client, financiers increasingly prefer agreements that tie security to the property on which the asset is installed. Amortising debt is still the most cost-competitive form of finance for invest-to-own scenarios. However, financiers have noted that power purchase agreements (PPAs), whilst more expensive, are growing for the following main reason – cash flow stability.

[3] Most commercial banks do not offer standalone services; e.g., for solar PV finance, customers would need to make use of other bank products as well (e.g., a business account).

A PPA provides a clear indication of electricity costs, and the client does not always want to own the system or take on the performance risk. This is especially true for large corporate clients.

Since 2021, a greater diversity of investors moved into the SSEG sector, driven by positive regulatory sentiment around wheeling and the raising of the cap on the requirement of a generation licence. A greater pool of debt and equity partners in the market is expected to facilitate the increased delivery of PPA projects. This dovetails with unlocking segments of the commercial, industrial, and agriculture sectors that are still cash-constrained in the post-COVID-19 recovery period.

2.4. Energy services barriers

There are two general barriers of energy service opportunities:

2.4.1. Port efficiency

According to Quantec import data, 400-500 MWp of solar panels per annum have been imported into South Africa in the past two years. Contributing factors to rates of imports in 2022 have been the ramping up of commercial and industrial (C&I) embedded generation projects, particularly > 1MW in size, post COVID-19 hard lockdown recovery, global PV prices and ease of flow through logistical ports from Asia. It is, however, quite clear that this leaves a ~250 MWp per annum gap for either locally manufactured panels or increased volumes of imports from international panel providers.

South Africa has the following container ports (World Port Source, 2022):

- Durban
- East London
- Ngqura
- Gqeberha
- Cape Town

In recent times, many of these ports have reported poor performance compared to global standards. Poorly performing ports are characterised by limitations in spatial and operating efficiency, limitations in maritime and landside access, inadequate oversight, and poor coordination between the public agencies involved, resulting in a lack of predictability and reliability (World Bank, 2022).

This has had a significant impact on the energy services value chain as it causes long lead times in procuring imported equipment, sometimes up to six to nine months.

The Transnet National Port Authority is in the process of finalising port master plans, which will outline the pathway forward towards improvements in capacity, efficiency, and the potential for privatisation. In the interim there is also potential for equipment aggregators to take on the role of fulfilling massive bulk orders for storage and distribution. This could alleviate the market, time and expense stress placed on individual companies to secure equipment for their project pipelines.

2.4.2. Availability of skills

The rate at which the rapidly growing demand for rooftop PV can be served is expected to be limited by the availability of skills. Table 3 below provides an overview of skills in high demand and at risk of shortages for rooftop PV.

Table 3: List of occupations in high demand for rooftop solar PV

Source: Department of Science and Innovation (2022)

Value chain stage	White collar	Highly skilled	Blue collar skilled	Blue collar semi-skilled	Blue collar unskilled
Solar PV rooftop	• Project development manager • Business development manager	• Electrical engineer • Solar PV designer	• Solar PV installer (electrician) • Grid connection engineer	Solar PV mounter	Solar PV site worker
Energy storage	–	Electrical / mechanical / mechatronics engineer	–	Battery technician	–

In addition to limiting the rate of deployment of rooftop solar PV, there is also a risk that the gap will be filled by those with poor or inadequate skills, which may ultimately undermine the credibility of the technology.

Although there have been several initiatives to enable greater numbers of quality assured installers and mounters to be qualified (e.g., new training facilities at Tertiary Vocational Education and Training (TVET) colleges, and introduction of the South African Photovoltaic Industry Association (SAPVIA) GreenCard certification, it is likely that current and new entrants to the market will need to invest in training and/or provide opportunities for practical experience (e.g., trainee and apprenticeships) to fulfil their skills demands. The need for energy security and efficiency has never been greater for the South African economy. This sets the scene for rapid growth and innovation in the energy services sector particularly related to the opportunities highlighted in this report. The sections that follow detail the rooftop solar PV, energy storage, and energy efficient market sizes in South Africa.

2.5. Rooftop solar PV market size

Rooftop solar PV has continued to grow rapidly as a business-level energy and price resilience measure. As depicted in Table 4, the rate of growth, particularly in the commercial and industrial (C&I) and agricultural sectors, has remained high.

This is largely due to a strong commercial business case, established technologies and service providers, electricity use profiles that align well with solar PV generation times, and an enabling regulatory environment.

The Schedule 2 Amendment of the Energy Regulation Act (ERA), which removed the requirement of a generation licence for PV systems greater than 1 MW, has also resulted in larger systems being installed or existing systems expanded to as large as 5 MWp, where the only limitation is the available roof space.

As a result, the average system size has increased from 350 kWp in 2020 to 400 kWp in 2021/22. In 2022 the total rooftop solar PV market in South Africa grew from 1.5 GWp to 2.3 GWp. Table 4 below gives an estimate breakdown of the rooftop PV market by sector.

Table 4: Rooftop solar PV market size

Source: SAPVIA (2022), GreenCape Analysis

Rooftop segment	Residential	Commercial and industrial	Agricultural
Compound annual growth rate (2020-2022)	30%	60%	45%
Installed capacity 2022 (MWp)	90-120	450-600	120-160
Total installed capacity (MWp)	250	1 650	400
% of total market	11%	72%	17%

Compound annual growth rate (CAGR): the average annual growth rate over a period of time.

As depicted in Figure 8, the Western Cape and Gauteng provinces have historically had the highest share of new installations, with many PV companies choosing these provinces as operation bases. This has been driven by customer demand, conducive local municipal policies, and the co-location of value chain stakeholders such as contractors, distributors, and financial service providers. These areas have thus become increasingly competitive. On the other hand, the Free State, Mpumalanga, KwaZulu-Natal, and Eastern Cape are expected to grow as developers actively explore opportunities in new markets.

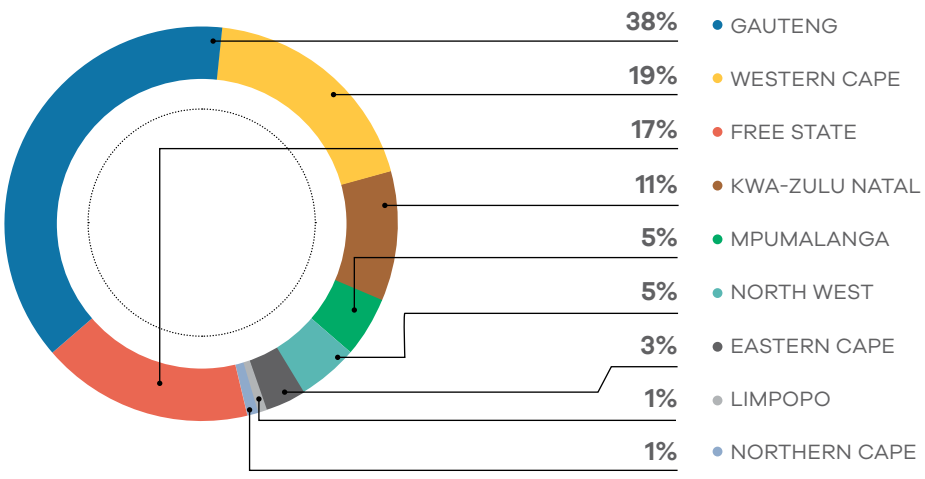

Figure 8: Rooftop solar PV market by province

Source: SAPVIA, GreenCape Analysis

The total annual available market should continue to grow at a rate of 600-900 MWp installed per year, reaching a total of ~10 GW of installed capacity by 2035.

Assuming the cost of R10/W_p for a full solar PV system including all equipment components, engineering, and construction, this installed capacity growth conservatively represents a total available market of R7.5 billion a year, and a total available market of R100 billion by 2035.

The installation of an additional 500 MW_p in one year translates to the potential creation of ~1 250 jobs.

2.6. Energy storage market size

Development and growth in battery storage technology will have an impact on the energy services market in South Africa in the next 5 to10 years. The most promising short duration application (<4hrs) is Li-ion batteries in the commercial, industrial, and agricultural sectors. Vanadium redox flow batteries (VRFBs) are also expected to become a strong medium-long duration application (>4hrs). However, the development of this segment is still in an early stage in South Africa. Overall, growth in this space is driven primarily by load shedding – though battery prices are still prohibitively high.

South Africa has taken the lead in battery manufacturing in Africa. Incumbents such as AutoX, Donaventa Holdings, Duracell South Africa, Energizer South Africa, Eveready, Metindustrial, Potensa, Probe Corporation, and Solguard have specialised in lead-acid batteries.

China currently dominates Li-ion production, although there are also some production facilities in the US and Europe. Accordingly, cell production has already been captured by a few key players, including Panasonic, CATL, and LG Chem.

There are, however, a few companies already participating in or considering local Li-ion battery assembly. This typically entails importing the Li-ion cells and locally manufacturing the balance of equipment. South Africa has at its disposal the primary resources needed in the manufacturing of batteries, both in South Africa and its neighbouring countries, with ample opportunities to manufacture locally due to the synergistic development of the electric vehicle market.

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Local battery production

Battery ecosystem developments include the following:

I-G3N successfully raised R20m (US$1.3m) from Edge Growth and the ASISA Enterprise and Supplier Development Fund as part of the Green Outcomes Fund (GOF) in 2021. I-G3N (Pty) Ltd is a female-owned manufacturing start-up that assembles LiFePO4 batteries in South Africa, working towards its mission of providing accessible and affordable clean energy. This investment will help I-G3N meet the increasing demand for high quality, locally made, and trusted battery storage solutions. I-G3N is part of a few local lithium-ion battery manufacturers that serve installers of solar and backup power systems in Southern Africa, with LiFePO4 battery products reported to have the lowest failure rates in the market.

Megamillion plans to be Africa's first large-scale manufacturer of Li-ion cells and battery packs in the hope of bringing down prices, thereby catalysing mass adoption of energy storage systems. The company is banking on economies of scale to reduce the price of the cells, with the goal of producing 38 GWh/yr by 2028.

Metair partnered with the South African Institute for Advanced Materials Chemistry located at the University of the Western Cape, which houses the only pilot scale Li-ion battery cell assembly facility in Africa. The partnerships would entail an investment of R3 million over three years, i.e., from 2021 to 2024, to pilot a prototype lithium production project to produce mining cap lamp cells, 12V Li-ion automotive batteries, 48V Li-ion batteries for energy storage applications, and solar panel recharge technology.

Polarium opened an assembly facility in Cape Town in 2022. The facility will have a maximum capacity that can reach 300 000 batteries per year or 4GWh. Production is geared towards the telecommunications market with 90% of output to be exported to the rest of Africa.

SolarMD expects to be the first Li-ion gigafactory in Africa. The current manufacturing capacity in their Cape Town factory is 180 MWh/y, and the company has set out to double that in the course of 2022.

Revov imported its first container of second life (2nd LiFe) batteries in 2018 from China, where the cells are removed from battery packs of buses and other electric vehicles and then assembled into stationary storage packs. Its batteries are also now being exported to Namibia, Botswana, Zimbabwe, Mozambique, Eswatini (formerly Swaziland), and Lesotho. The company has plans to scale up its operations and move to a new facility.

Manganese Metal Company in Nelspruit is the only company in the world, outside of China, that refines manganese to battery grade. The company produces about 28 000 t/y of electrolytic manganese metal for use in high-purity manganese sulphate, and in cathodes.

Geological exploration restarted at the **Zebediela nickel project** on the northern limb of the Bushveld Complex in Limpopo, South Africa. The Bushveld Complex hosts an estimated 11.9 million tons of nickel and ranks third in terms of nickel sulphide content globally. (Class 1 nickel is sought after for EV lithium-ion batteries, whilst Class 2 nickel is mainly used in nickel pig iron and the steel industry).

Assuming that 5% of the current installed 2.3 GWp rooftop solar PV market has installed behind-the-meter energy storage to combat load shedding (approximately four hours of backup storage required) and a cost of R8/Wh based on market competitive prices of Li-ion storage, **the current market is R4 billion with 500 MWh installed battery capacity**. The potential market will depend on the growth of the solar PV market. Assuming that **by 2035**, 30% of the annually installed solar PV systems will have installed behind-the-meter energy storage; **the South African market would be approximately R32.5 billion with 6.5 GWh installed battery energy capacity**.

2.7. Energy efficiency market size

ESCos are those companies that offer innovative financial models for energy efficiency projects[4] based on achievable energy savings. In South Africa, the commercial and industrial (C&I) sectors are most attractive to ESCos, as shown in Figure 9.

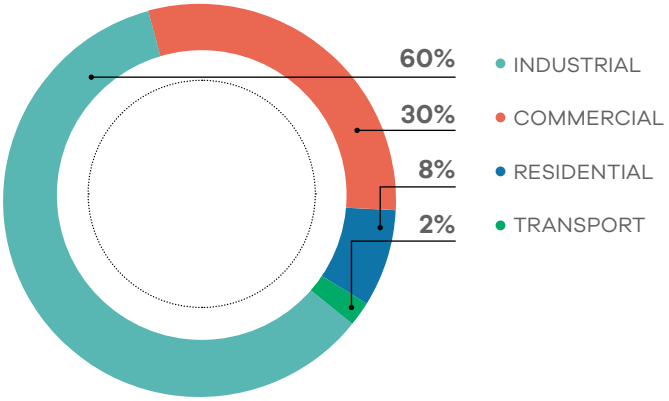

Figure 9: ESCos market for energy efficiency in South Africa

Source: SANEDI (2021)

On average, energy efficiency projects in South Africa are relatively small. The average capital cost of a South African ESCo project is under R3 million (SANEDI, 2021). A number of new commercial finance instruments have been suggested through sector-wide industry workshops as suitable to service projects as small as these, though to date not many are available or easy to access.

The main ones are revolving funds, concessional loans, loan guarantees, performance guarantees, and prescriptive or standardised offers.

The line of sight to assess the market opportunity in energy efficiency (EE) has been limited.

Table 5 represents the most recent estimations, though lack of reliable energy performance data has been highlighted as a market barrier. This is particularly the case in the commercial sector, which regulators are aiming to alleviate through the implementation of energy performance certificates.

[4] ESCOs may also participate in RE projects

Table 5: EE market estimates 2021/22

Source: SANEDI (2021)

Sector	Identified potential energy savings (TWh/a)	Capital required (R billion)
Agriculture	19.4	66.8
Industry (mining and manufacturing)	94.4	226.4
Public sector	6.1	33.1
Total	**120**	**326.2**

The estimates above indicate that there is still a likely opportunity for further energy efficiency interventions by ESCos, all of which have been estimated to typically have a payback period of under three years, as seen in Figure 10[5].

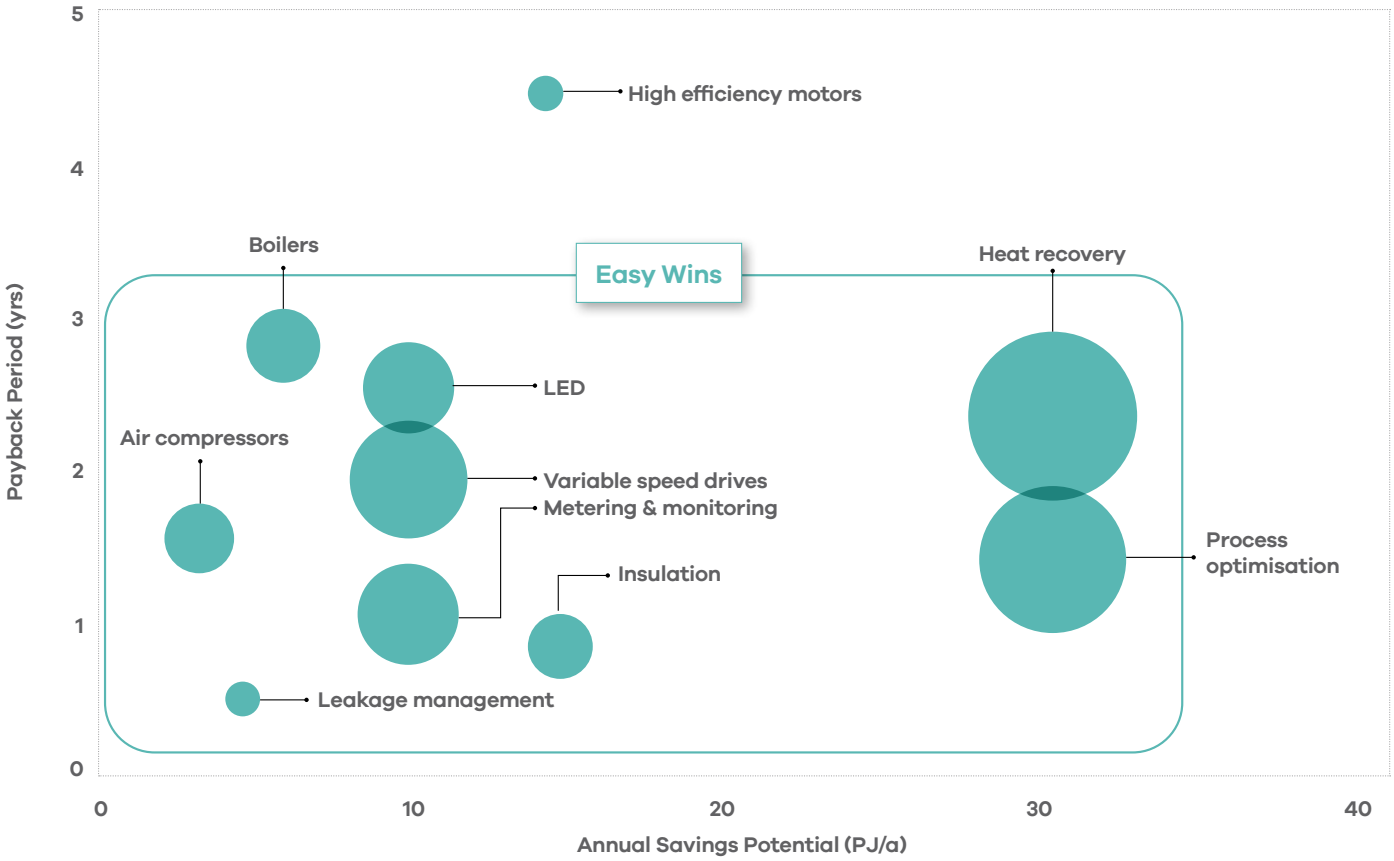

Figure 10: Feasibility of energy efficiency technologies for the commercial and industrial sectors

Source: SANEDI (2021)

[5] Size of bubble proportional to relative market opportunity size.

2.8. Key players

Figure 11 shows the energy services value chain and key players in the chain, with the roles of specific actors outlined in Table 6.

The value chain is based on the stages of a generic energy intervention, showing the types of services or products provided by key players. This represents a simplified view of a vertically integrated value chain. In practice, the roles of these actors often shift with relative fluidity. For example, the boundary between a project developer, an EPC company, and installer is often blurred, with players taking on different roles depending on the size, cost, ease of implementation, or other project-specific factors.

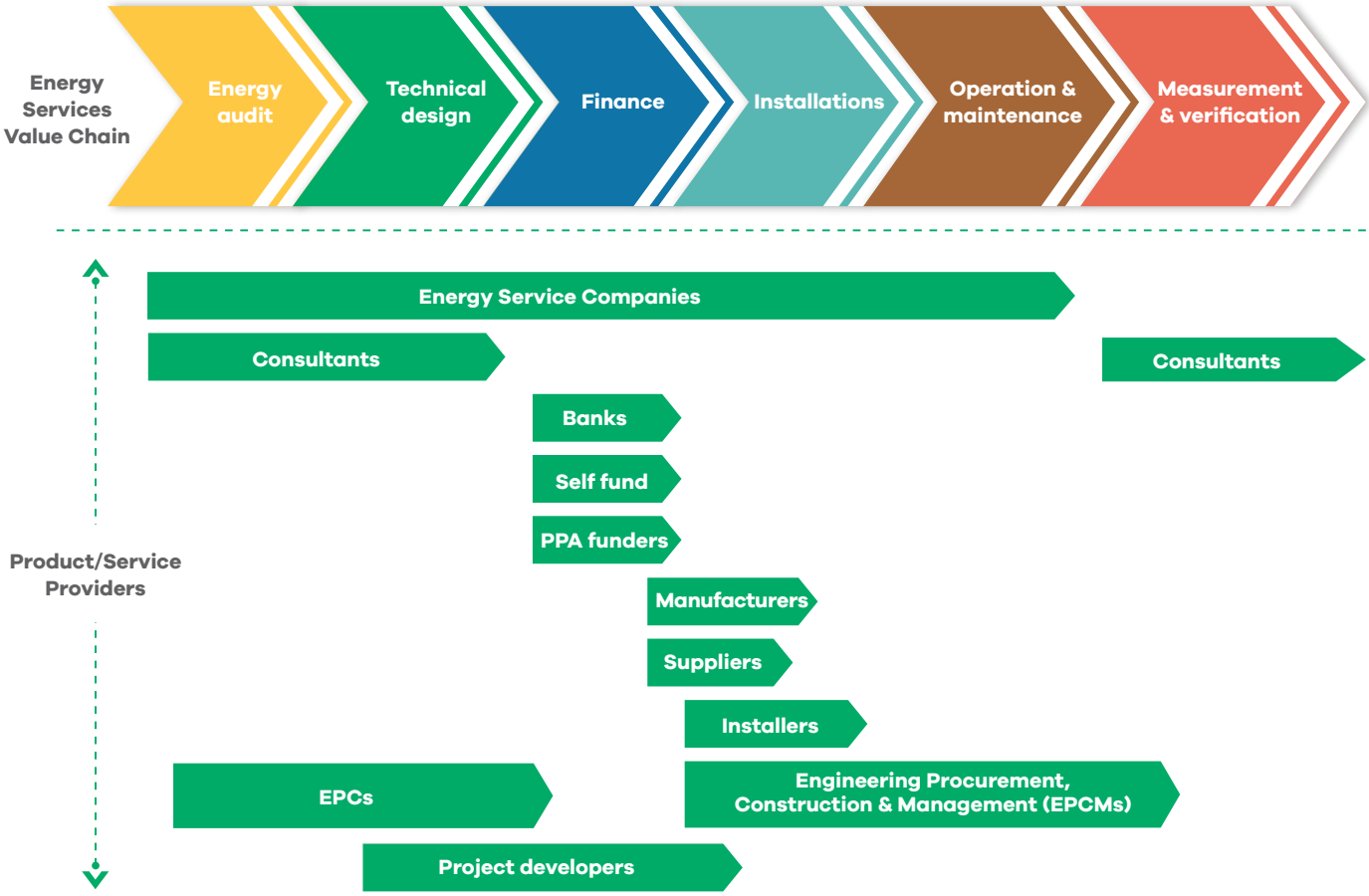

Figure 11: Energy services market value chain

Table 6: Roles of key players in the ES value chain

Key player	Role
ESCos	ESCos are active across the whole value chain, including measurement and verification, although to enable objective analyses, this stage might be better done by independent consultants. There are two generic ESCo-type energy contract models: • **Energy supply contracting** (ESC), which delivers units of energy. • **Energy performance contracting**, which provides energy savings determined by comparison to an established and agreed-upon baseline.
Consultants	Consultants include energy auditors, planning engineers, certified measurement and verification professionals (CMVP), accountants, and lawyers.
Financiers	Financiers provide funding and financing mechanisms to realise projects. • **Project finance** – commercial banks (commercial and asset finance), self-funded individuals (with cash reserves) and power purchase agreement (PPA) financiers (such as private equity funds, debt facilities). • **Funding for ESCos** (not detailed in the diagram) – commercial banks, private equity funds, corporate foundations, private and family foundations, and venture capitalists.
Manufacturers and suppliers	Manufacturers and suppliers include technology suppliers or original equipment manufacturers (OEMs). They manufacture and supply equipment and form part of typical energy efficiency or supply interventions.
Installers	Most energy service companies, EPCs and project developers use specialised installers for both energy efficiency and SSEG (technology-specific).
EPC company	EPCs design interventions, and procure and install tailored turnkey energy efficiency and/or renewable energy solutions.
Project developers	Project developers handle tasks that focus on moving the project along toward successful completion. In the energy services value chain, they play more of a business development role as they focus on, for example, project design and procurement but make use of specialised installers.

As with much of South Africa's green economy, small- and medium-sized enterprises (SMEs) dominate the ES value chain. As the market continues to develop, disruption is expected to be a feature of this nascent economic sector. Adapting to this rapid growth is easier for SMEs as pre-existing corporate structures, and sunk investments do not hamper them. That said, their growth could be stifled by their inability to scale up fast enough to take advantage of opportunities.

POLICY AND LEGISLATION

Several acts, regulations and policies guide the development of the electricity sector, with the main guiding document being the Integrated Resource Plan 2019.

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3.1. National governance and industry structures

Several government departments and institutions guide the development of the energy services sector.

3.1.1. Regulators

The Department of Mineral Resources and Energy (DMRE) is the custodian of all energy policies and energy security in South Africa.

The Department of Public Enterprises (DPE) is responsible for the country's energy infrastructure, primarily for state-owned entities such as Eskom.

Eskom is a state-owned energy utility. It owns most of the electricity generation and transmission infrastructure. It is an essential player in the electricity sector, especially as a delivery vehicle for numerous government programmes. Eskom is in the process of being unbundled.

A legally binding agreement to transfer Eskom's transmission division to its wholly owned subsidiary, National Transmission Company South Africa SOC Limited (NTCSA), was executed in December 2021. Legal separation of the generation and distribution divisions was expected to be completed by December 2022 (Eskom, 2022b).

The National Energy Regulator of South Africa (NERSA) regulates the electricity sector, with the Department of Mineral Resources and Energy as the custodian department. NERSA's main energy services related responsibilities are licensing and registrations, pricing and tariffs, promoting competition, compliance monitoring, and dispute resolution.

South African National Energy Development Institute (SANEDI) is responsible for achieving the National Energy Efficiency Strategy (NEES) objectives, the main strategy guiding the uptake of energy efficiency projects in South Africa.

SANEDI's primary function is to direct, monitor and conduct applied-energy research, development, demonstration, and deployment. It also has to undertake specific measures to promote green energy and energy efficiency in South Africa.

3.1.2. Industry bodies

South African Energy Storage Association (SAESA) is a non-profit organisation that aims to guide policy to allow for the accessibility of storage projects, and advocate and advance the energy storage industry in South Africa.

SAPVIA is a not-for-profit organisation that represents the solar PV industry in South Africa. It aims to ensure that solar PV is the generation technology of choice in South Africa and the rest of sub-Saharan Africa, supporting the country's socio-economic development targets.

3.2. National acts, legislation, policies and plans

3.2.1. National acts

The Carbon Tax Act, No 15 of 2019 was gazetted in May 2019 and came into effect on 01 June 2019. The carbon tax will be applied in two phases: Phase 1 is from 01 June 2019 to 31 December 2022, and phase 2 will be from 2023 to 2030. Phase 1 will not have an impact on electricity prices. The carbon tax rate will be imposed at an amount of R120 per tonne of carbon dioxide equivalent (tCO_2e) emitted. However, taking the tax-free thresholds into account, this rate will range closer to R6 and R48 per tCO_2e. This rate has increaseb by the consumer price index (CPI) +2% per year until 31 December 2022. The Act has assumed a 'polluter pays' principle to the tax. This relatively low tax rate and range of tax-free allowances in Phase 1 are designed to incentivise large emitters to transit to a low carbon profile before Phase 2. Once the tax results have been reviewed at the end of Phase 1, changes to rates and tax-free thresholds will be applied before the next phase begins. This would especially affect businesses with high fuel and electricity consumption. The impact of the carbon tax on the uptake of solar and other renewable forms of energy (which present a great case for carbon offsetting) is still to be determined and will be monitored, although for now these projects do not meet the requirement of additionality.

On 22 February 2022, National Treasury announced an increase in the carbon tax rate to R144 effective from 1 January 2022. To uphold South Africa's COP26 commitments, the rate will increase each year by at least R15 until it reaches R300. From 2026, government intends to escalate the carbon price more rapidly every year to reach at least R450 by 2030, and R1 800 beyond 2050. The carbon tax is being implemented in three phases, with Phase 2 originally scheduled to start in January 2023. But the finance minister extended Phase 1 by three years until 31 December 2025. As a result of delaying Phase 2, some sectors will remain beyond the reach of the carbon tax for now. These include the agriculture, forestry, and waste sectors.

Electricity Regulation Act 4 of 2006 as amended by the Electricity Regulation Amendment Act 28 of 2007 (ERA). These regulations guide the issuance of licences for generators and transmitters, wheelers, and distributors of electricity. In 2021, Schedule 2 of the ERA was amended to increase the threshold for embedded generation from the current 1 MWp to 100 MWp without needing a generation licence from NERSA. As of December 2022, the threshold has been **removed** entirely. The requirement remains of registering embedded generation systems and applying for grid connections with the relevant distributor (municipality or Eskom).

3.2.2. National plans and commitments

Integrated Resource Plan (IRP) 2019: First promulgated in 2011, the IRP guides electricity provision in South Africa. Its custodian is the DMRE. The IRP, a living document that the DMRE is to update every two years, is developed in the context of the Integrated Energy Plan. The IRP provides:

1) an overall plan indicating the quantities of various electricity sources to meet the country's electricity demand in the next 20 years (the typical planning horizon); and

2) guidance for future energy infrastructure investments.

Thus, it largely determines the country's generation mix. After several iterations and a long wait, the IRP 2019 was gazetted in October 2019. It is expected that, given the significant regulatory movement since then and the national energy security context, the IRP will be updated in 2023.

Nationally Determined Contributions under the Paris Agreement: South Africa submitted its first Nationally Determined Contribution (NDC) on 1 November 2016, outlining its pledge to transition to a lower-carbon economy. The NDC covers adaptation, mitigation as well as finance and investment requirements, and is based on equity.

In March 2021, South Africa launched its updated draft of the NDC for public consultation. The finalised targets, which were approved by Cabinet in September 2021, indicated South Africa's intention to limit GHG emissions to 398-510 MtCO2e by 2025, and to 350-420 MtCO2e by 2030. This is significantly lower than the mitigation targets communicated in 2016. These new targets will also see South Africa's emissions decline in absolute terms from 2025, a decade earlier than planned. This will be a driver for decarbonisation of industry in South Africa.

Transmission Development Plan (TDP): This updated Eskom plan, published in 2022, indicates that 53 GWp of new additional generation will be required for the period up to 2032 to ensure energy security in the country. Transmission infrastructure required would include 2 890 km of additional high voltage lines and 60 transformers, requiring a capital investment of R72.2 billion by FY2027.

3.2.3. National regulations and standards

NRS 049:2016: The NRS 049 was **published** to set a specific standard for the implementation of **Advanced Metering Infrastructure** (AMI) systems in the country. The standard specifies that the meter must store the energy consumption data as a total registered value, as well as the data in half-hourly intervals. The data retrieval station or system should support the retrieval of billing, using both the total cost and the half-hourly data. The municipalities would have a choice to bill their customers utilising the total registered value or the half-hourly data.

Asbestos Abatement Regulations 2020: This applies to all building owners, including schools and educational facilities, older sectional title complexes and homes, industrial buildings, factories, warehouses, offices, and any building that may have used asbestos during its construction. It provides detailed guidelines for the identification of asbestos and plans for its removal, including the use of only registered asbestos contractors. In 2022, the Department of Labour (DoL) clarified that there would be strict inspection of the condition and maintenance of existing solar panels or over-roofing sheets installed on asbestos roofs. New installations of these kinds will no longer be allowed by inspectors.

South African National Building Regulations, SANS 10400-XA: 2011 Energy usage in buildings: It is still being revised, introducing tighter requirements of the energy performance components of building standards for the public, commercial, and residential building sectors. It is expected that the required performance level in SANS 10400-XA will be increased to the voluntary SANS 204 standards for buildings.

DC wiring code, SANS 10142-1-2: It allows electricians to issue a Certificate of Compliance (CoC) for the direct current (DC) side of a SSEG installation. In the past, professionally registered engineers needed to sign off installation to ensure compliance. This standard is still in development and is a key focus area for distribution licence holders to drive safety and compliance.

Energy Performance Certificates, SANS 1544: As published in the Government Gazette on 8 December 2020, energy performance certificates are now mandatory for the private sector, non-residential buildings with a total net floor area of more than 2 000 sqm, and government buildings of more than 1 000 sqm. The certificates must be displayed at the building's main entrance and submitted to the **SANEDI**. With the law now in effect, building owners are required to obtain an energy performance certificate within two years. As of November 2022, only 12 South African National Accreditation Systems (SANAS) were accredited **inspection bodies**, who with ESCos will need to service the ~200k buildings requiring evaluation in this time period. Despite the deadline set for December 2022, only 450 certificates had been issued by October 2022. It is implied that applicable buildings that do not comply by this deadline will be liable for a fine of up to R5 million. However, there has been little indication of enforcing this and the DMRE is considering extending the deadline.

Wheeling and energy trading licences: The development of wheeling frameworks and the issuing of energy trading licences are opening up space for an increasingly distributed electricity market.

NERSA-issued energy trading licences authorise the trading of power anywhere in South Africa, enabling the procurement of electricity generated from renewable resources and sale directly to customers.

The licence provides for the use of the national transmission and distribution network managed by Eskom but requires additional permission to use any municipal network.

3.3. Municipal policy and legislation

Municipalities play a significant role in the distribution of electricity in South Africa. Acting mostly as intermediaries, municipalities buy electricity from Eskom and then resell it to businesses, homes, and other institutions. This makes them a key regulatory body in the energy services market.

The DMRE has approved municipalities' capacity to buy electricity from independent power producers (IPPs).

In an amendment to the Electricity Regulations on New Generation Capacity in terms of Section 35(4) of the ERA of 2006, gazetted by the DMRE in October 2020, municipalities in good financial standing will now be allowed to formulate an energy plan that does not rely solely on the government-owned utility Eskom. Metropolitan municipalities around the country, specifically the CoCT, George, Tshwane, City Power (Johannesburg), eThekwini and Nelson Mandela Bay municipalities, have undertaken initiatives to purchase electricity directly from IPPs and on-sell this electricity to their customers.

The country-wide rollout of national embedded generation rules, regulations, and tariffs to promote the safe and legal uptake of embedded generation for own use [6] has been a major local driver. **Figure 12** and **Figure 13** present data obtained by the South African Local Government Association (SALGA, 2021) on the positive uptake of embedded generation processes in municipalities by October 2021, and data on developments in 2022.

[6] The generation of electricity on the load site where it will also be consumed.

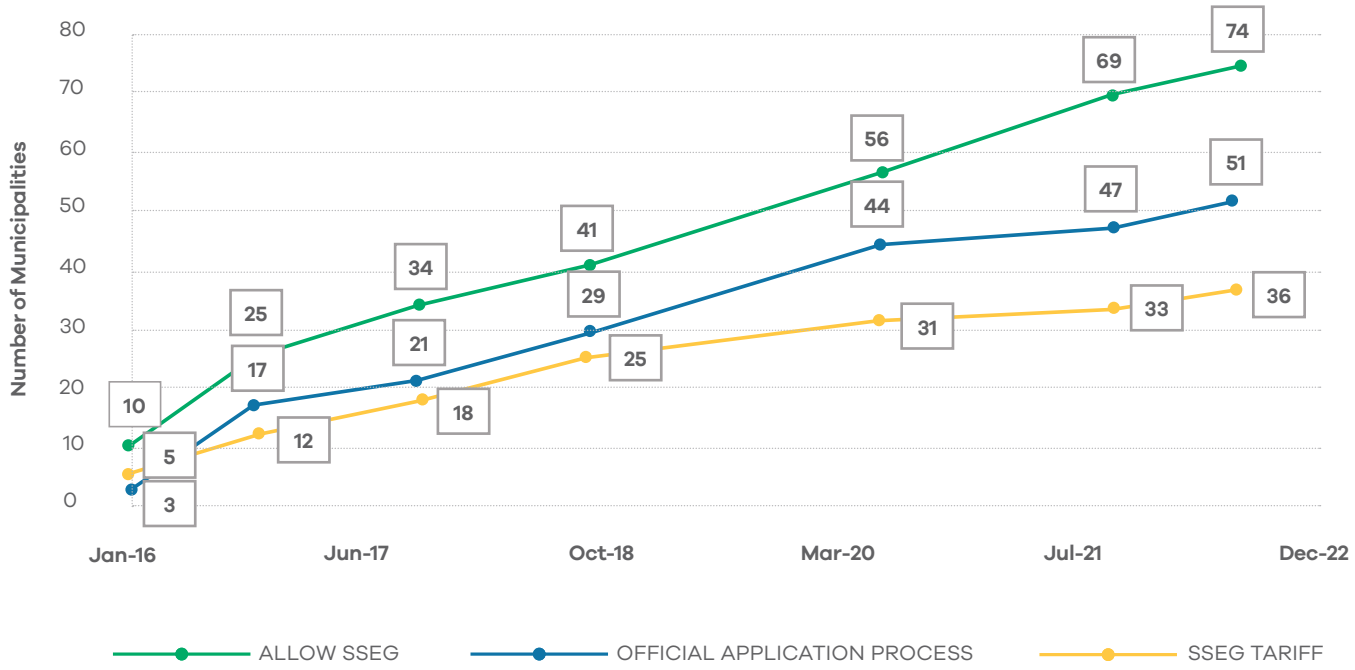

Figure 12: Uptake of SSEG processes in municipalities

Source: SALGA (2021) and GreenCape Analysis 2022

There is a large range of feed-in tariffs across the municipalities, as depicted in **Figure 13**.

Feed-in tariffs allow embedded generators to get remunerated per kWh they export back onto the municipal grid.

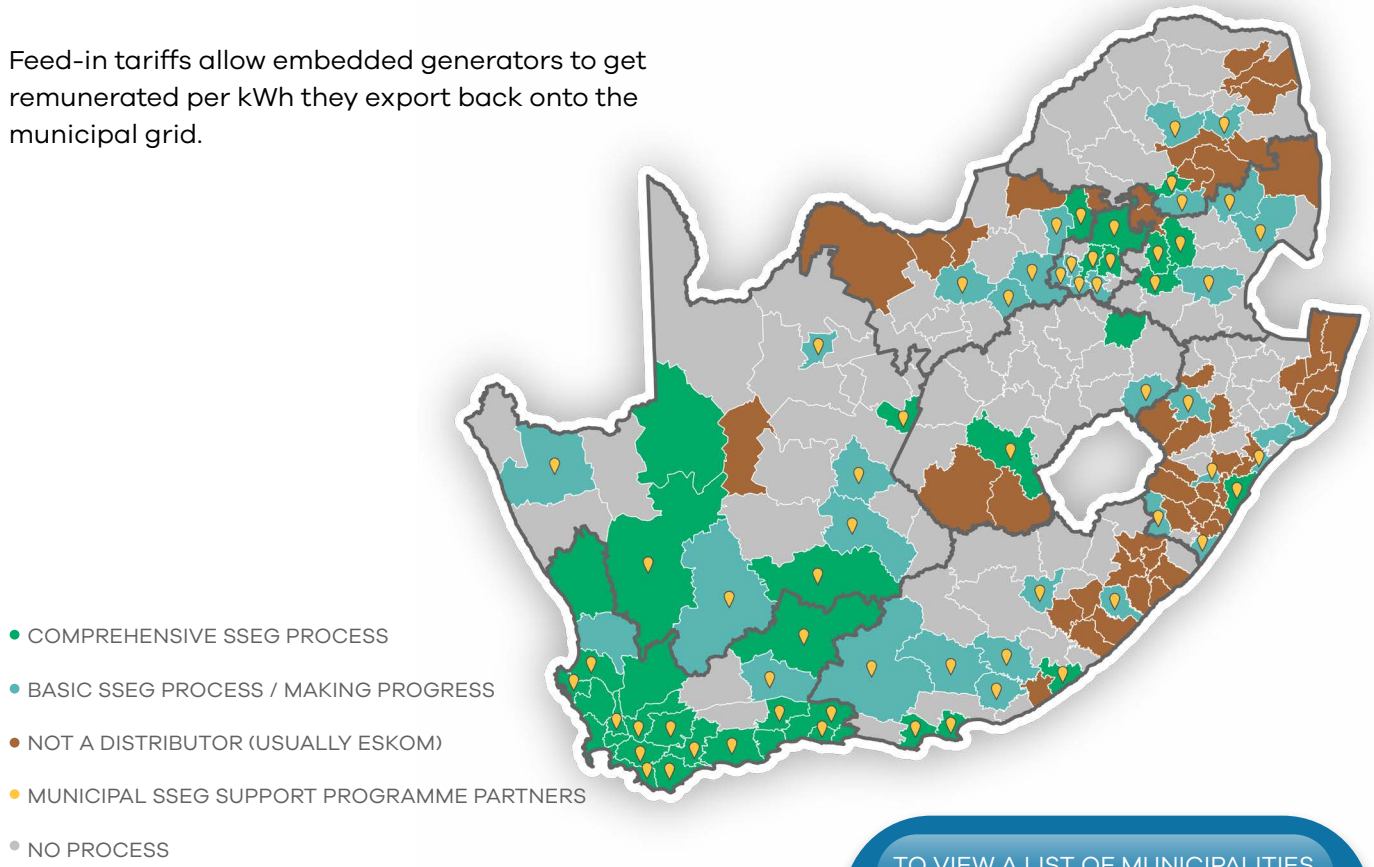

Figure 13: Municipal embedded generation processes map

Source: SEA (2022)

TO VIEW A LIST OF MUNICIPALITIES ALLOWING SSEG TO THE GRID, **SEE TABLE 5 OF THE 2022 ENERGY SERVICES MIR**

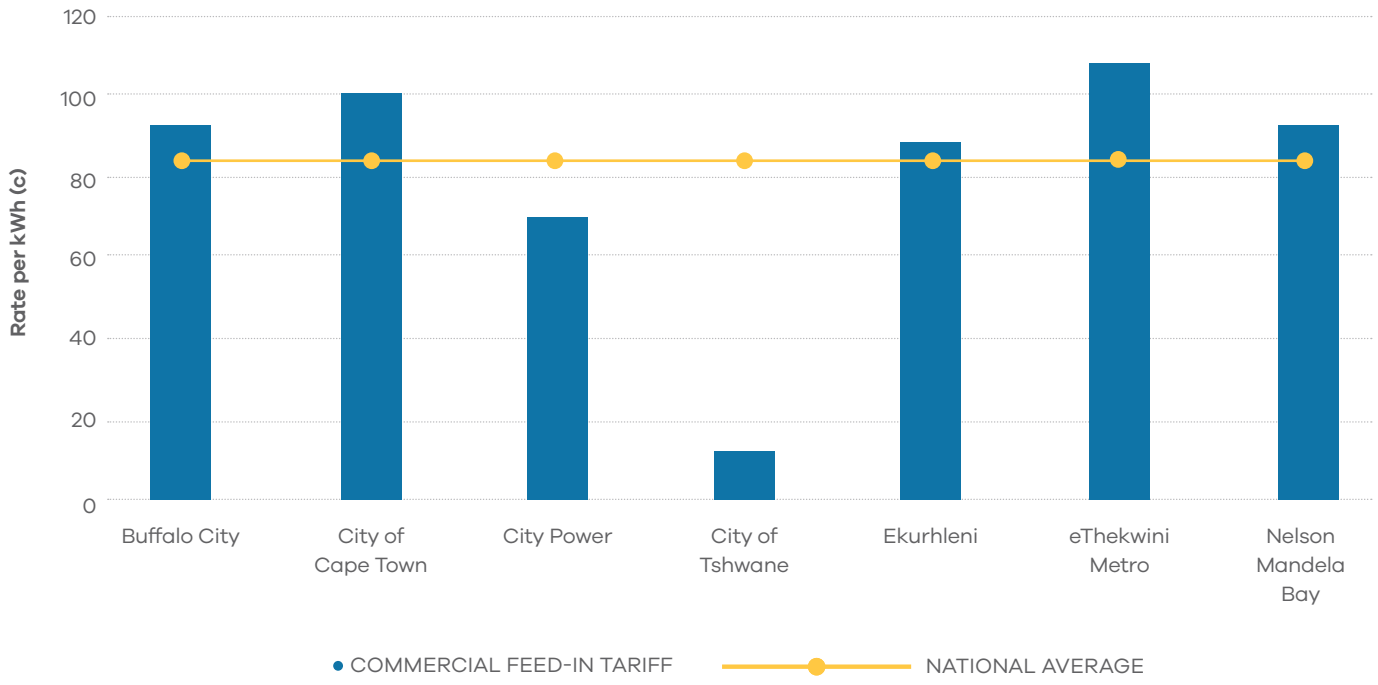

Figure 14: Commercial feed-in tariffs summary

Source: NERSA (2022)

Whilst the national average of available feed-in tariffs remains relatively low at 83c (**Figure 14**), it is still a potential added benefit, built on an already strong business case for own generation. There is currently no guarantee on the structure and cost of municipal consumption and feed-in tariffs from year to year. Municipalities are moving tariffs to be more cost-reflective, with the bulk of their costs derived from energy time-of-use purchases from Eskom.

These changes at the municipal level complement legislative updates on a national level. Together these changes herald a freer, more 'liberalised' electricity market, in which stakeholders can be more empowered in their energy choices.

Municipal Energy Efficiency and Demand Side Management programme: The DMRE provides selected municipalities with grants for the planning and implementation of energy efficiency projects across their public infrastructure.

Typical technology categories include street lighting and water service infrastructure (pumps). In 2022, the total annual project value on this programme was R220 million, and R231 million has been budgeted for 2023.

OPPORTUNITIES, DRIVERS AND BARRIERS

The evolving South African energy landscape creates opportunities for investors, financiers, project developers, component manufacturers and suppliers in the energy services sector.


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The following market opportunities have been identified through engagement with an array of energy services and green economy stakeholders. Each opportunity is outlined in greater detail in the sub-sections that follow. A brief overview is provided in **Table 7**:

Table 7: Energy services opportunities

Energy services sector	Opportunities	Market Size pa
Rooftop solar PV	A strong business case continues to drive the growth and footprint of solar PV in the commercial, industrial and agricultural sectors. Zero-capital procurement options such as power purchase agreements (PPAs) are becoming a common choice in the market. There is also a high demand for third party finance instruments to support project development.	600 – 900 MWp R7.5 billion
Behind-the-meter storage	The need for energy independence and resilience in light of ongoing load shedding is driving demand in backup power and uninterruptible power supply (UPS) applications, particularly in commercial, industrial and agricultural applications where the opportunity costs of energy insecurity are high. A 50% rise in the cost of diesel has resulted in battery storage becoming much more cost competitive.	250 MWh R2 billion
Smart meters	Regulations and standards are driving upgrades to smart meters in the public sector, whereas private sector demand is based on potential benefits and returns from aggregated energy efficiency (EE) interventions. It is estimated that there is capacity for 100 000 to 300 000 upgraded meters to be implemented per year.	100 000 – 300 000 R1.2 – R1.6 billion

4.1. Rooftop solar PV installations

As stated in **Table 7** above, a strong business case is driving the growth and footprint of solar PV in the commercial, industrial, and agricultural sectors. Increasing maturity over the past few years has led to a concentration of projects in the 500 kWp – 1 MWp range amongst a handful of market players with strong reputations.

Many of these developers, and EPC contractors, have now diverted part of their attention and capacity to the 1 MWp to 10 MWp segment, which has opened up following the lifting of the generation licence threshold. This is leading to higher utilisation of roof space and expansion of existing systems.

Consequently, there is a larger potential market for service providers and investors in which to participate and achieve reliable pipelines for adequate returns. **Table 8** provides an overview of the PV procurement options available in the market, and of the available competitive rates:

Table 8: South African rooftop solar PV prices 2022

Source: GreenCape Analysis

Procurement options / system size	<100 kWp	<500 kWp	>500 kWp	>1 MWp
Balance sheet (per kWp)	R11 000 – R15 000	R10 500 – R13 000	R10 000 – R12 000	R8 000 – R9 500
Debt finance (5- to 10-year period)	Above amortised plus 5-8% interest pa			
Lease-to-own (per month excl. escalation pa)	Highly dependent on agreed upon term length and whether a buy-out clause is desired			
Power purchase agreement (PPA) (per kWh)	90c – R1.20	80c – R1.00	70c – 90c	65c – 75c

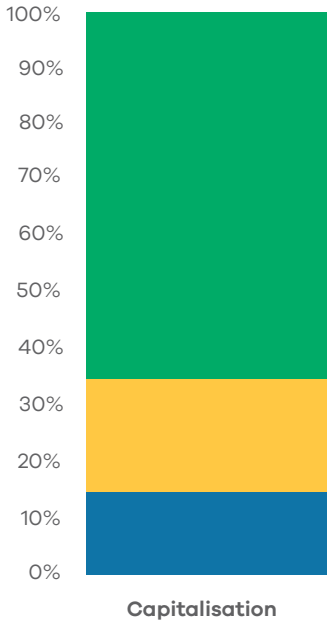
Historically, most projects have been funded through outright purchases, either on balance sheet or through commercial tenor debt. However, power purchase agreements (PPAs) have become more common, accounting for 30% of new commercial and industrial (C&I) rooftop projects.

This has been driven by:

- increased availability of third-party finance to solar developers;
- increased awareness of the PV opportunity in businesses who are taking a conservative approach with their balance sheets;
- a guaranteed, immediate 40-60% saving on the PV portion of the electricity bill when compared to distribution utility tariff rates; and
- a desire by large corporates to pass on the performance and maintenance risks across multiple sites to the developer.

To provide competitive PV procurement offerings, many developers are seeking third-party commercial finance to increase access to further capital markets, reduce the cost of debt through various partial risk guarantees on project aspects such as construction, performance, and insurance, and to establish a revolving fund for rolling out projects.

A PPA is a contract between a generator of electricity and buyer to purchase electricity (whether physically or notionally) at a pre-agreed price for a pre-agreed period. In this arrangement, the generator maintains ownership of the asset and ensures optimum performance and maintenance, recovering the cost at a premium included in the tariff.



● DEBT	60-80%	COMMERCIAL LOANS & BONDS
● MEZZANINE	0-20%	RISK GUARANTEES
● EQUITY	10-30%	COMPANY OR SPECIAL PURPOSE VEHICLE / PROJECT BASED, REVOLVING FUNDS

Figure 15: Rooftop solar PV finance structuring breakdown

Source: GreenCape Analysis

Figure 15 provides an illustration of how a PV project would be funded with the majority share coming from a commercial bank in the form of debt, an equity stake by the implementing developer, and a portion of mezzanine finance provided by a third-party equity partner in the form of guarantees.

The drivers and barriers for the rooftop solar PV opportunity are presented in Table 9 below:

Table 9: Drivers and barriers of the rooftop solar PV opportunity

Drivers	Barriers
An increasingly strong business case makes investment decisions attractive for energy users who prioritise long-term resilience to rising electricity tariffs.	**Installations of poorly designed, sub-par systems,** partially mitigated by the PV Green Card, but poor quality still a risk, particularly on smaller projects.
The removal of the embedded generation licence threshold has decreased the level of competition for 150-500 kWp projects, as many established market players are shifting capacity to larger projects.	**Regulatory certainty,** as the sector is still adapting to the most recent developments in municipal processes, system registration and wheeling.
Access to finance has been unlocked with commercial banks dedicating specific portfolios to supporting embedded generation projects.	**Tariff uncertainty** as municipalities can change or remove feed-in-tariffs on an annual basis, which makes long-term projections difficult.
Zero capital options such as PPAs make PV accessible to energy users that may be particularly cash-constrained in the post-COVID-19 recovery period.	–

4.2. Behind-the-meter storage

There are several technologies making inroads in the South African backup energy storage sector. Li-ion and lead-acid battery technologies (see **Table 10**, **Figure 16** and **Table 11**) are the most tried and tested.

They remain the leaders in this market, with the former being a dominant choice due to its short duration performance, faster charging times, and proven operational stability. There has been a 90% decrease in the cost of Li-ion batteries since 2010 (Statista, 2022), and there are further indications for lower price potential due to developments in technology and manufacturing.

However, it is expected that increasing resource scarcity relative to demand and global supply chain dynamics will play a role in slowing these reductions from as soon as 2025 onwards (IEA, 2022).

Table 10: Battery technology comparison

Source: Thango and Bokoro (2022), USTDA (2017)

Technology	Charge / discharge efficiency	Max depth of discharge	Cycles	Lifetime (yr)	Energy density ($kWhm^3$)	Discharge Time
Lead-acid	70 – 90%	50%	500 – 1 800	3 – 15	50 – 80	sec-hours
Advanced lead-acid	75 – 90%	100%	2 200 – 4 500	5 – 15	50 – 80	min-hours
Li-ion	92 – 97%	80%	300 – 20 000	10 – 20	250 – 620	sec-hours
Redox flow	60 – 85%	100%	> 20 000	10 – 20	16 – 35	sec-10 hours

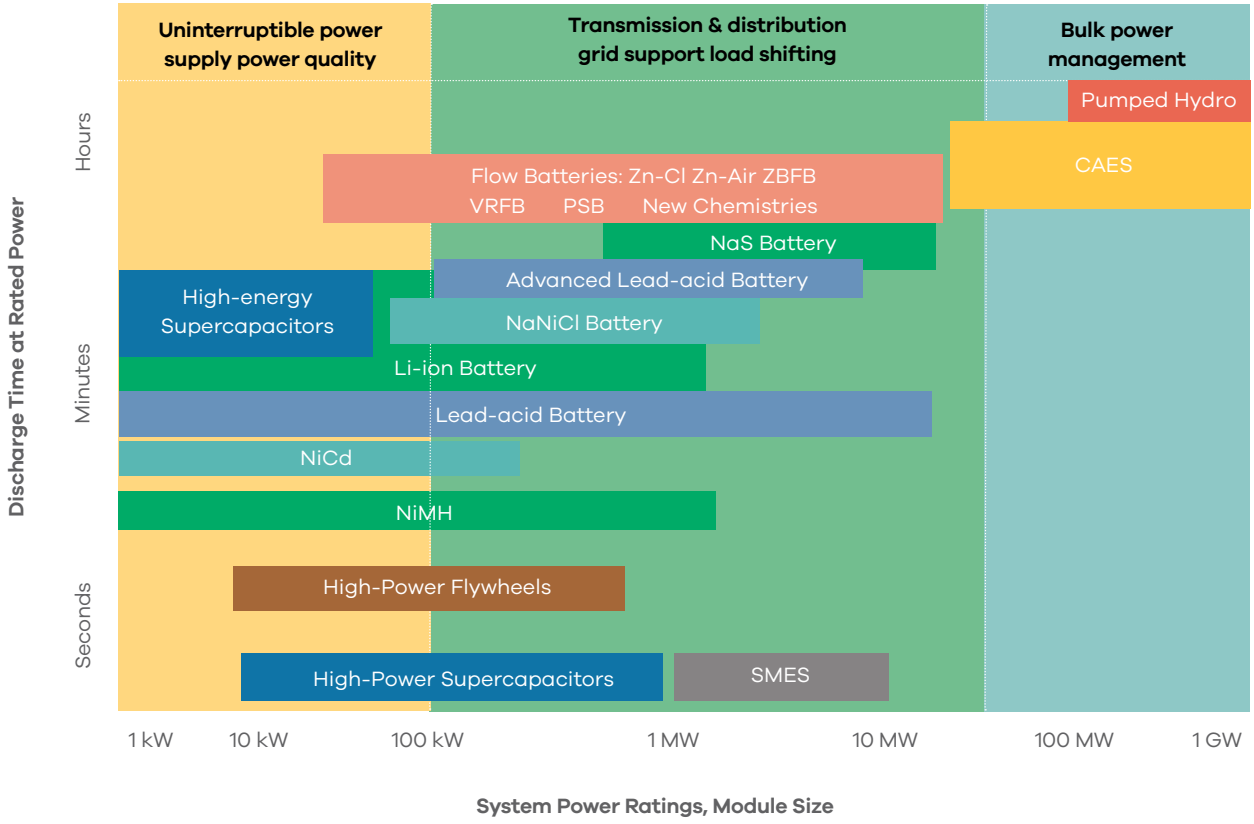


Figure 16: Comparison of storage technologies per power rating and discharge times

Source: IRENA (2017)

Table 11: Life-time cost comparison of batteries vs diesel generators in 2022[7]

Source: GreenCape Analysis

Technology	Pros	Cons	Investment cost R/kWh capacity	LCOS R/kWh units
Lead acid	Very mature technology Low cost	Low cycle life and depth of discharge Deteriorates with micro cycles Impact of disposal	200 – 1 000	4.00 – 5.50
Advanced lead acid	Superior cycle life and DoD compared to conventional lead acid Functions well at partial state of charge Low cost compared to Li-ion	Impact of disposal	1 500 – 2 000	4.50 – 6.00
Li-ion	High efficiency High energy density Improving technology in terms of performance and cost	Recharge time Global lithium supply chain is constrained Safety – thermal runaway	4 000 – 10 000	5.50 – 6.50
Diesel Generator	Higher energy density - 27x Li-ion Dispatchable	Rising diesel prices Chance of breakdown May have carbon tax implications	2 000 – 3 500[8]	4.50 – 7.00[9]

Levelised cost of storage (LCOS): The cost of kWh electricity discharged from a storage device when accounting for all costs incurred, and energy produced throughout the lifetime of the device. For batteries, this would most notably include the cost of replacements.

[7] Operating, maintenance and replacement costs are highly dependent on the nature of usage.

[8] Per rated kVA capacity.

[9] Taking into account possible implications of carbon tax.

In 2022, the comparative dynamic between technologies shifted significantly. As seen in **Figure 17**, the rise in global diesel prices, largely due to the Russian invasion of Ukraine, saw the local market price increase by 49%.

The levelised cost of a diesel generator is highly sensitive to fuel cost. As a result, there was a rise from R3.50 to R6.00 in 2021, and from R4.50 to R7.00 in 2022.

Battery technologies are hence much closer aligned to cost competitiveness when considering lifetime operating, maintenance and replacement costs. However, it should be noted that this remains dependent on fluctuations in the fuel price.

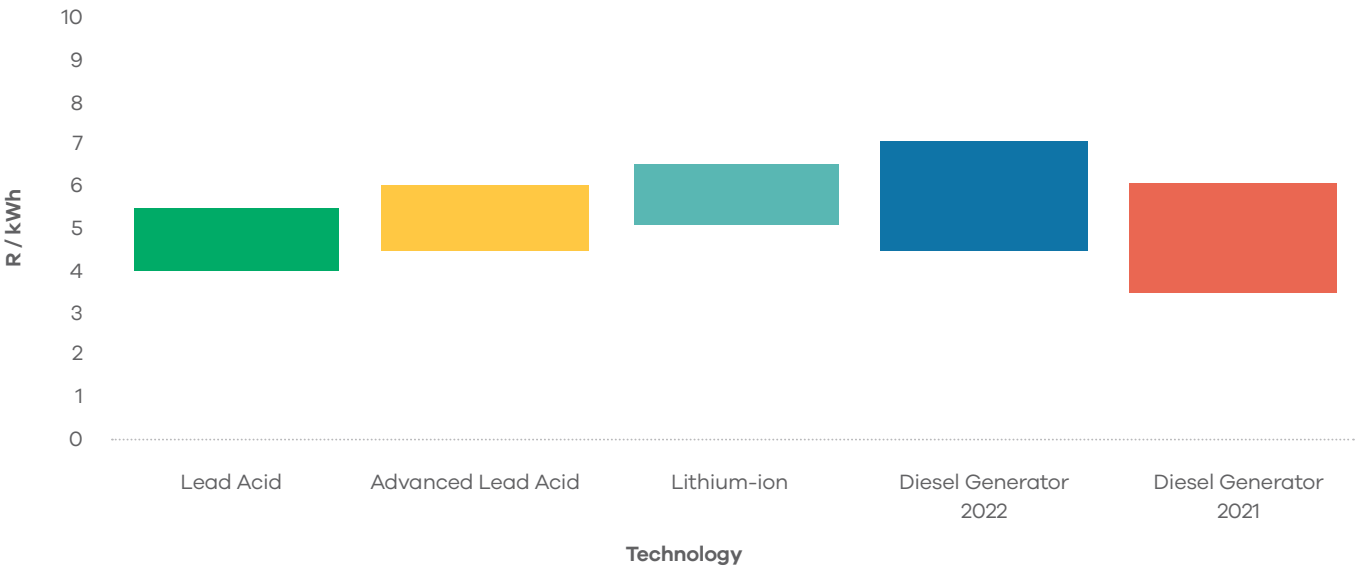


Figure 17: LCOS comparison of backup technologies

Source: GreenCape Analysis

Applications in rooftop solar PV systems are mainly driven by load shedding-related costs associated with the spoilage of products/crops, or long downtimes for manufacturing production lines in the commercial, industrial, and agricultural sectors. Installers are increasingly likely to opt for PV-battery or PV-diesel-battery hybrid designs to provide greater flexibility and optimise on costs per kWh.

Notably, as uptake increases and EPCs move to capitalise on a potential new market segment, growing pains have been experienced in bridging the gap in additional technical expertise to deal with the complexity of designs, compared to a conventional grid-tied PV system or hybrid backup systems. Communication of proper system use and monitoring is also a key success factor in ensuring maximum performance and return on investment.

It is predicted that **penetration will accelerate in the medium to long term (5 to 10 years) when Li-ion prices drop past a tipping point against time-of-use tariffs, allowing numerous value stacking options** such as peak shaving and arbitrage to **become economically viable**. Value stacking is the ability to leverage the same equipment, system, or process to deliver multiple benefits that maximise the financial impact. In order of prevalence, these applications include:

Power reliability: The battery storage unit provides a source of backup in the event of loss of power from the grid, such as load shedding.

Peak shaving: The battery storage unit is charged during periods of low power consumption and discharged at times of high power consumption. The aim is to reduce the maximum peak power consumption – the resulting power price is reduced, and electricity costs are reduced.

Peak arbitrage: The battery storage unit is charged during off-peak periods and discharged during peaks to take advantage of the tariff difference.

Power quality: The battery storage unit provides a target quality in the event of unstable or poor quality grid power, such as short-term voltage spikes or dips, frequency variations, or low power factor.

Capital deferment: The battery storage unit reduces grid demand by optimising on-site generated energy usage.

As a result, energy storage can alleviate bottlenecks that require capital expenditure to upgrade electrical infrastructure.

The drivers and barriers of the behind-the-meter (BTM) storage opportunity are presented in **Table 12**.

Table 12: Drivers and barriers of the behind-the-meter storage opportunity

Drivers	Barriers
Load shedding has created the need for providing backup power in the commercial, industrial, and agricultural sectors to ensure the security and resilience of the power supply against the cost of disruption.	**High upfront costs** still limit market growth; this can be countered by focused financing mechanisms, e.g., tariff structures, incentives, or battery-specific lease agreements (PPAs).
Diesel generators are becoming less competitive due to rising fuel cost.	**Value stacking options** are not yet economically viable, given the relative cost of storage to time-of-use (ToU) tariffs.
BTM battery prices have declined considerably.	**Rules and regulations** for behind-the-meter energy storage are still in a nascent stage.
The carbon tax will be an increasingly relevant cost implication for agricultural and industrial diesel generator use over the next decade.	–

4.3. Smart meters

There is currently a major gap in the implementation and roll-out of advanced metering infrastructure (AMI) systems in line with the national smart metering standards in South Africa. It is estimated that there are currently 4 to 6 million meters that will need to be upgraded at a cost of R9 000 to R12 000 per smart meter.

This presents an apparent market opportunity of R40 – R60 billion rand. Based on the current rate of implementation of 100 000 to 150 000 meters upgraded per year, this represents an annual market size of R1.2 – 1.6 billion.

It should be noted that some municipalities, such as the City of Ekurhuleni, allow for automatic meter reading (AMR) devices as an interim requirement for embedded generation installations. A MR meters cost R6 000 to R7 000. Overall, ease of entry into the meter supply market remains low as competition and differentiation can be a challenge.

There are several meter providers already operating in South Africa. Gaining market share will be heavily subject to meeting the criteria and winning public procurement tenders. **The Smart Grid Vision 2030** pioneered by SANEDI as part of the South African Smart Grid Initiative (SASGI) also aims to facilitate the demand for smart electricity meters in South African cities. SANEDI has since implemented a Smart Grid Readiness Assessment tool that can assist municipalities in assessing when they can and should invest in a smart grid network. To date some cities, including the CoCT, Nelson Mandela Bay, City of Johannesburg, eThekwini and City of Tshwane have embarked on smart meter and meter upgrade projects with targets set for 2024.

Third-party load aggregation and load management is the main trend that drives uptake of smart meters in the private sector. Aggregation involves integrated metering across multiple facilities and/or energy users and allows for larger energy efficiency project sizes and more co-ordinated, centralised interventions that can deliver higher returns. Aggregation is also particularly effective in improving energy efficiency across commercial and industrial districts to enable load curtailment schemes, which then allow these users to be shielded from load shedding, as well as provide a demand response lever to municipalities during peak demand periods.

Public and private sector demand for smart meters will also both be driven by the regulatory requirement for Energy Performance Certificates for certain building categories. The process of obtaining a certificate is highly data-intensive and the absence of pre-established metering and sub-metering practice can send the certification costs to > R40 000 per building.

The drivers and barriers for the smart meter opportunity are presented in **Table 13**.

Table 13: Drivers and barriers of the smart meter opportunity

Drivers	Barriers
Legislative and regulatory changes for buildings, namely, SANS10400-XA and new energy performance certificate requirement (SANS 1544).	**Raising market awareness** of the available opportunity and building partnerships with facility managers.
Aggregated loads of commercial buildings **improve economies of scale,** and strengthen profit margins and business longevity.	**Recession and the COVID-19 economic downturn** have decreased the appetite for the residential and commercial market to engage in efficient energy (EE) investments.
Energy-as-a-service performance contracting model reduces the need for the user to invest upfront capital or maintain a centralised solution.	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FUNDING AND INCENTIVES

A range of general and sector-specific funding solutions and incentives is available to investors, manufacturers, and service companies in the green economy. It covers Development Finance Institutions, local public and private sector financiers and investors, and a considerable range of tax incentives.


ON/AC
CE/C
check
check
95.91
1.44
1.44
95.91
2.88
-95.91
-95.91
-5.76
95.91
1.44
-97.35
95.91
1.44
1.44
95.91
95.91
1.44
1.44
95.91
2.88
2.88
103.41

The GreenCape Green Finance Desk (GFD) primarily acts as a facilitator in the financing of green projects and green business. The GFD works across all sector desks at GreenCape. For more support please visit https://www.greencape.co.za/content/sector/green-finance Finance databases

5.1. Finance databases

GreenCape's GFD has compiled and continues to maintain a database of climate finance sources and incentives that could be relevant to companies and projects operating in the South African green economy. A few of the available databases are highlighted below and can be sourced here: https://green-cape.co.za/archives/green-finance-databases/

5.1.1. The Green Economy Climate Finance Database 2022

The database contains information on funding opportunities, the types of funding and institutions providing the funding, and contact details. This includes information on national market players (e.g. commercial banks, microfinance banks, private equity/debt, venture capital, angel investors etc.), as well as international climate finance streams (e.g. climate funds, DFIs, multilateral institutions, bilateral development partners) and domestic sources of finance. The Green Economy Climate Finance Database 2022 analysed ~150 financing solutions valued at ~R25 billion.

The database is ideal for any entity seeking a broad range of funding solutions and financial incentives, with a largely South African focus.

Bilateral development partners, local and international development finance institutions, and government departments/ agencies make up the majority of the active financing stakeholders. Still, climate funds, commercial banks, private equity/debt, and venture capital make up most of the capital value available in the database.

Across the more than 150 climate finance opportunities, eight different financial products are available:

Debt [commercial (listed and unlisted) and concessional (listed and unlisted)] – A debt evidenced by a note which specifies, in particular, the principal amount, interest rate, and date of repayment at below-market rates. The concessionality can be achieved either through interest rates below those prevailing on the market, longer maturity or grace periods, or a combination of those.

Venture capital (limited) – Equity capital can be provided at various stages of funding rounds. Common funding rounds include early-stage seed funding in high-potential, growth companies and growth funding.

Mezzanine finance – Subordinated debt or preferred equity instrument representing a claim on a company's assets that is senior only to that of the common shares. Mezzanine financings can be structured either as debt or preferred stock.

Equity – A stock or any other security representing an ownership interest.

Guarantees and Risk Mitigation Instruments (RMIs) – RMIs facilitate access to debt and equity financing by mitigating and transferring risks from project sponsors and private lenders to third parties. Common instruments applied include contractual arrangements, joint ventures, insurance and guarantees.

Grants (very small "ticket size") – Transfers made in cash, goods or services for which no repayment is required.

Government spend – Government development finance or budget spend.

Finance products are available for almost all the sectors (biggest gaps remain in adaptation-focused and new and emerging sectors).

Still, as expected, clean energy is the focus of most of the tracked financial offerings, including energy efficiency and demand-side management and mobility/storage.

How to use the Green Economy Climate Finance Database 2022:

Each sheet is broken down into types of sources of climate finance (public, private and blended). These are covered by the government (local and international), development finance institutions, commercial and others. The diagram below details the five steps you can follow to filter the dataset for the best possible outcome.

STEP 01

Select the relevant source of finance sheet

STEP 02

Sort sheet by sector:

- Clean energy
- Energy efficiency & demand side management
- Low carbon transport
- Water conservation, supply & demand
- Agriculture, food production, fisheries and forestry
- Circular Economy
- Buildings and the built environment
- Material substitution
- General eco-system support
- Cross-sectoral

STEP 03

Sort sheet by investment instrument:

- Grant
- Concessional debt
- Debt / mezzanine debt
- Working capital
- Equity
- Budget expenditure
- Other

STEP 04

Check alignment of the size of investment and investment opportunity information.

STEP 05

Contact relevant financiers (including high-level ask, market size estimate and basic company track record).

For further information and support on any of the content provided here, please get in touch with GreenCape's Climate Finance team at **finance@greencape.co.za**

Additional resources on improving green economy financial resilience are available from: Government Funding and Incentives Database An updated document focused on government funding and incentives is available to view and download **here.**

5.1.2. Allied Crowds Database

This database is ideal for any entity seeking a broad range of financial solutions.

"**AlliedCrowds** is the first complete aggregator and directory of alternative finance providers in the developing world. We help donors, investors, and entrepreneurs navigate the alternative finance space through our reports, data, and Capital Finder, increasing the flow of capital to deserving projects globally."

Sign up to use the Capital Finder is free and allows users to access a global database where you can filter for a sector (including greentech, agriculture and social impact), type of capital (equity, lending, grant) and type of funding (crowdfunding, angel investing, venture capital, impact investing). The Entrepreneur Hub provides important tools and assistance for start-ups, including writing business plans and financial resources.

- In addition, themed databases around the Sustainable Development Goals (SDGs) and the World Green Economy Organization (WGEO) are found **here**. You can also contact Allied Crowds to create a customised funding database for you.
- An Alternative Finance glossary can be found.

ALLIED CROWDS WEBSITE

5.1.3. Finfind Database

Access to finance is the number one challenge experienced by SMEs - Finfind has been specifically developed to address this problem. Finfind is innovative, online access to finance solution that brings the providers and seekers of SME finance with a focus on finance readiness. Finfind has over 250 lenders and almost 500 loan products available to SMEs, and each lender's listing and loan product information are kept up to date daily. This database is ideal for South African SMMEs seeking funding and business advisory services or upskill themselves on finance matters.

FINFIND WEBSITE

5.1.4. RECP Database

The Africa-EU Renewable Energy Cooperation Programme (RECP) is a multi-donor programme that supports the development of markets for renewable energy in Africa. It was launched by more than 35 African and European Ministers and Commissioners under the Africa-EU Energy Partnership (AEEP).

Aside from the Finance Database, the site also hosts the Finance Catalyst, an advisory service geared towards African projects. This is supplemented with market intelligence (including RE potential, country-specific regulatory framework and key stakeholders). This database is ideal for renewable energy project developers looking to work in Africa.

RECP DATABASE

5.1.5. Government Funding and Incentives Database

An updated document focused on South African government funding and incentives is available to view and download online. These incentives cover local manufacturing, critical infrastructure grants, small enterprise development and a diverse set of sector specific incentives (i.e. Aquaculture Development and Enhancement Programme).

GOVERNMENT FUNDING AND INCENTIVE BOOKLET

5.2. South African Climate Finance Landscape

The South African Climate Finance Landscape looks at detailed project-level green economy finance data, understanding source, disbursement, instrument and use. The insights can support public and private role-players with information to shape sectoral strategies and selected policies and improve coherence and coordination between public and private level spending in the sectors. The South African Climate Finance Landscape has tracked R62.2 billion in annual climate finance invested in SA.

ACCESS TO THE SOUTH AFRICAN CLIMATE FINANCE LANDSCAPE

GREEN FINANCE DATABASE

5.3. Further funding sources

Click the buttons below to access the different funding sources.

SA INSTITUTIONS PROVIDING FUNDING FOR ENTREPRENEURS

SA BUSINESS FUNDING DIRECTORY 2016/17

THE GREEN OUTCOMES FUND

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GREENCAPE'S SUPPORT TO BUSINESSES AND INVESTORS

GreenCape is a non-profit organisation that works at the interface of business, government and academia to identify and remove barriers to economically viable green economy infrastructure solutions. Our vision is a thriving prosperous Africa, mobilised by the green economy.


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Working in developing countries, GreenCape catalyses the replication and large-scale uptake of green economy solutions to enable each country and its citizens to prosper. We work with businesses, investors, academia and government to help unlock the investment and employment potential of greentech and services, and to support a transition to a resilient green economy.

We assist businesses by removing barriers to their establishment and growth and provide our members with:

- free, credible and impartial market information and insights;
- access to networks of key players in government, industry, finance and academia;
- an advocacy platform to help create an enabling policy and regulatory environment for green business.

We assist local, provincial and national government to build a resilient green economy by providing:

- support on the development of standards, regulations, tools and policies
- expert technical knowledge on key sectors in the green economy;
- access to networks of key players across business, academia, and internationally

Since inception in 2010, GreenCape has grown to a multi-disciplinary team of over 40 staff members, representing backgrounds in finance, engineering, environmental science and economics.

Our market intelligence reports form part of a working body of information generated by sector desks and projects within GreenCape's three main programmes – energy, circular economy and resources.

Benefits of becoming a GreenCape member

We currently have over 3 050 members, and offer free membership. Becoming a member of GreenCape will give you access to the latest information regarding developments in the various sectors; access to tools, reports, and project information; and offer you the opportunity – through our networking events – to meet and interact with various stakeholders in the green economy.

We have facilitated and supported ~R42 billion of investments in renewable energy projects and manufacturing. From these investments, more than 19 000 jobs have been created.

Through our WISP (industrial symbiosis) programme, by connecting businesses with waste / under-used resources:

435 000 fossil GHG emissions saved (equivalent to the electrical usage of 117 840 households in SA);

Over R150 million in financial benefits (additional revenue, cost savings and private investments);

398 economy wide jobs.

135 00 tonnes of waste diverted from landfill

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