

THE SOUTH AFRICAN- GERMAN ENERGY PROGRAMME

SAGEN



Implemented by:

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

SAGEN OVERVIEW

Launched in 2011 (ongoing)

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In cooperation with: South African Department of Mineral Resources and Energy (DMRE), the National Treasury (NT), Eskom and the South African Local Government Association (SALGA).

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SAGEN INTRODUCED

The South African-German Energy Programme (SAGEN) was established in 2011, as part of active bilateral cooperation between South Africa and Germany. It was strategically conceptualised between the two governments to support South Africa's transition to a sustainable energy future.

The SAGEN programme was initiated as South Africa first embarked on its procurement programme for utility scale renewable energy production from independent power producers. This was a momentous milestone towards achieving a more diverse energy portfolio, which set the context for SAGEN's first activities in the country.

Since this early beginning, SAGEN has dynamically journeyed with South African partners – collaborating to improve conditions for investment in renewable energy and energy efficiency. This contributes to improved security of energy supply, new skilled jobs and protection of the environment.

The most recent decade has seen accelerated change within power systems around the world. The main factors driving the energy transition include the economic and political push towards low-cost clean energy solutions, the acceleration of decentralised power generation technologies, increased digitalisation, and energy efficiency across entire power systems. These changes are causing a structural shift in the way power systems and markets are set up and operated.

The South African power sector has been equally affected by these changes and SAGEN has sought to swiftly respond to the emerging shifts. The programme's activities have been guided by the evolving energy landscape and key priorities identified in collaboration with partners from both government and the private sector. Throughout all collaboration, the underlying intention has been to promote a diverse and inclusive energy transition for all.

Photo: Credit to D'Afrique Photo Services for both street lighting photos



*"Affordable, reliable
and sustainable
energy for all"*



PROGRAMME APPROACH

SAGEN provides policy advice, technical support and practical training to government and business; with this support always based on partner needs. The focus is on developing capacity for the independent continuation of initiatives, and thus in South Africa the programme is implemented in close cooperation with SAGEN's South African partners.

In this, the programme's activities are closely coordinated and implemented together with the Department of Mineral Resources and Energy (DMRE), National Treasury (NT), Eskom, South African Local Government Association (SALGA), South African National Energy Development Institute (SANEDI) and several municipalities.

Overall, the programme focuses on two key building blocks of sustainable energy: energy efficiency (EE) and renewable energy (RE). SAGEN thus applies international knowledge, best practices, expertise and experience to create an environment in which both RE and sustained EE can flourish.



Photo: WWTP. ERWAT.
Hartebeestfontein. South Africa.
2018. Brett Eloff.

*“A journey that
has transformed
changes and
challenges into
opportunities”*

THE PROGRAMME JOURNEY

The evolution of SAGEN

The SAGEN programme has been implemented in three phases so far, and is heading into its fourth phase.

With each new phase, the evolving energy landscape has been re-evaluated and the project contribution and programme focus reassessed and refined. This ensures relevant support, in light of the most pertinent developments the sector is likely to face during the next implementation timeframe.

Phase 1 coincided with a new era in renewable energy in South Africa; and the programme was formulated in the lead-up to the launch of South Africa's successful Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). Implementation corresponded with the first REIPPPP bid windows going to market, the announcement of the first successful bidders, and integration of the first utility scale renewable energy independent power producers (REIPPs) onto the power network. SAGEN sought to support these milestones with solutions suitable to the South African context (refer to Figure 1 on page 4).

During Phase 2, South Africa experienced severe electricity supply constraints. Here, technological advances and rapidly falling costs strongly suggested that larger contributions from RE and EE were possible and necessary for security of supply. And while the REIPPPP was stalled during this time, efforts were directed at creating the frameworks that could facilitate, and securely integrate a greater share of anticipated EE and RE throughout the electricity network.

Phase 3 corresponded with a period of accelerated change in the global and local energy landscape. It thus tested the agility of already established frameworks and networks – assessing their ability to respond to this changing environment and effectively support the energy transition. SAGEN's third phase, completed in February 2022, included a decisive focus on advancing the role and capacity of government, municipalities and Eskom to guide the energy transition and overcome challenges.

Broadening the scope

Two new, cross-cutting components were introduced in 2019: (i) Energy Policy and Regulation and (ii) Capacity Building and Technology Innovation. These two components are jointly referred to as “Capacities for an Energy Transition” (SAGEN-CET).

SAGEN-CET emerged out of in-depth collaboration with various partner teams and their expressed requirement for additional capacity to meet the sector's rapidly changing needs. It recognised that a broad knowledge base will be a key enabler of the energy transition, which will allow more stakeholders across the electricity value chain, to guide and shape the evolution of the electricity sector.

The programme sought to extend existing learnings and knowledge – developed as part of prior technically focused engagements – to a broader stakeholder group. Knowledge sharing also aimed to strengthen capacity on key topics of interest, related to the transformation of the energy sector.

The programme at a glance

SAGEN's different phases have evolved in response to the ever-shifting energy context, as well as identified country priorities (refer to Figure 2 on page 5). In this, they offer partners a diverse range of support by facilitating conversations and collaboration, sourcing inspiration and expertise, and sustaining momentum en route to a more sustainable energy future.

As part of this ongoing process, SAGEN-CET complements the scope of initiatives implemented under the SAGEN programme. It seeks to enhance in-country capacity to lead the energy sector transformation.

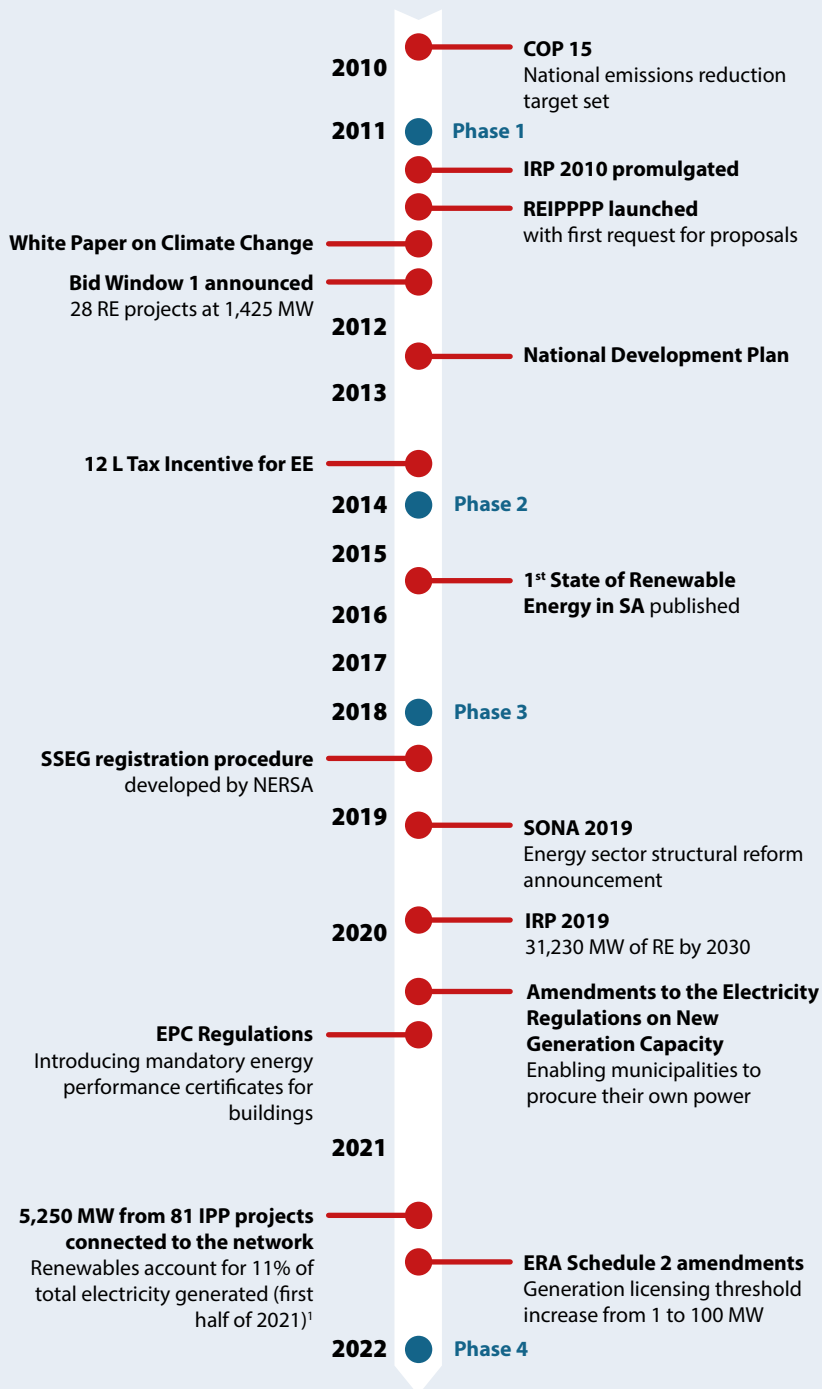


Figure 1: Timeline of pertinent developments and milestones in the South African energy sector

SAGEN	Phase 1	Phase 2	Phase 3	Phase 4
	2011–2014	2015–2017	2018–2022	2022–2024
South Africa's energy sector context	1. A time of 'firsts'	2. Creating a framework for the future	3. Accelerated and broadening scope of change	4. Just energy transition
SAGEN focus	Supporting an evolving renewable energy and energy efficiency landscape in South Africa			
SAGEN programme components	1. Energy Efficiency 2. Renewable Energy	1. Regulatory Framework Development 2. Grid Integration of Renewable Energy 3. Market Development 4. Training and Capacity Building	1. Power Systems Planning and Operation 2. Embedded Generation in Distribution Networks 3. Energy Efficiency Investment 4. Municipal Energy Management Systems	1. Power Systems Planning and Operation 2. Power Sector Reform 3. Municipal Energy Management Systems 4. Embedded Generation in Distribution Networks
Capacities for an energy transition (CET) components				5. Energy Policy and Regulation 6. Capacity Building and Technology Innovation

2019–2023
SAGEN-CET Phase 1

Figure 2: The evolution of SAGEN in response to South Africa's changing energy landscape

FOCUS ON SAGEN 3: 2018–2022

Clean energy, and specifically renewable energy, was well established by 2018 – with strong local expertise already in place at various knowledge centres. Within this context, SAGEN 3's efforts focused on progressing active topics and initiatives. Herein, it sought to broaden the scope and reach of implementation and to expand the network of partners. It also responded to the changing energy policy landscape, including key policy decisions taken by policy-makers with respect to South Africa's intended energy transition.

As stated earlier, Phase 3 was defined around four components, again structured around the topics of EE and RE. The two additional components, introduced under SAGEN-CET, now further support the transition to a sustainable energy system and cut across both EE and RE. These six components are illustrated in Figure 3.

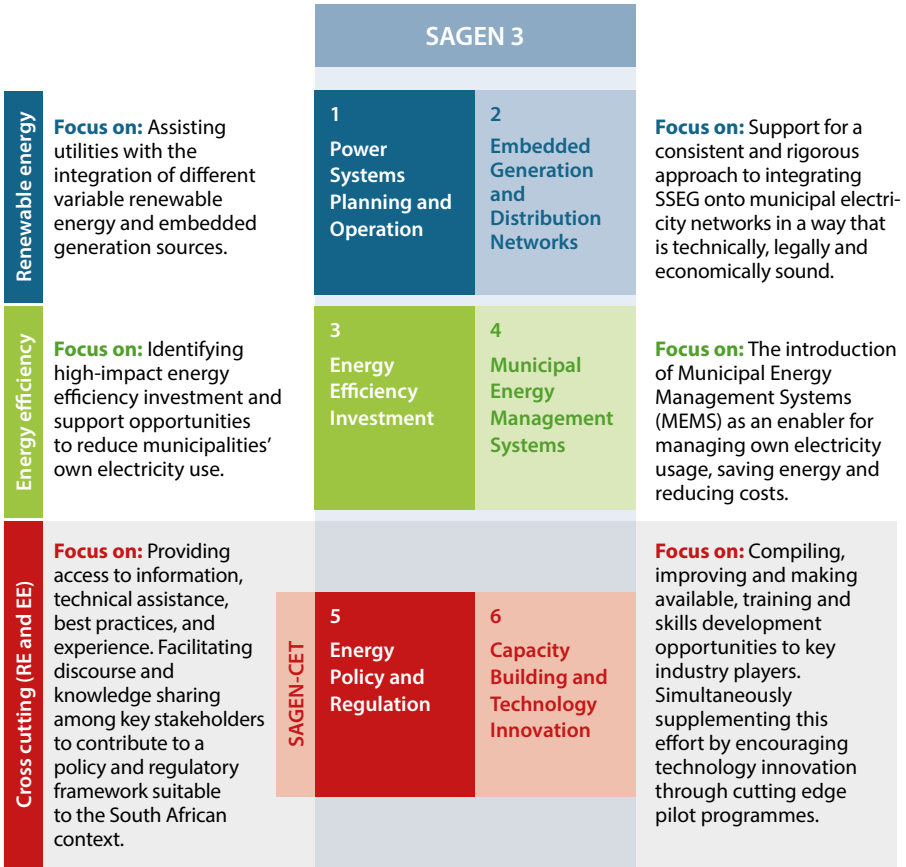


Figure 3: Components of SAGEN 3 and SAGEN-CET

HIGHLIGHTS FROM SAGEN 3

Together with our partners, SAGEN has made a significant contribution across all six listed components, over the last four years of implementation. The components proved exceptionally relevant to the changing energy landscape and responded well in assisting the South African energy sector to face some of the most pressing issues and questions.

In the following pages, each of the components is briefly introduced – accompanied by key selected highlights from the implementation period. Greater detail on the multiple outputs is available on the SAGEN website (www.sagen.org.za).

Component 1: Power Systems Planning and Operation

Four work packages



Grid access



Transmission system planning and operation



Distribution system planning and operation



vRE grid and system integration helpdesk

Context

Variable renewable energy (vRE) and distributed generation sources ensure grid stability, while increasing the complexity of operation of the power system.

Focus of this component

Assisting utilities with the integration of different variable renewable energy and embedded generation sources.

Partners

Eskom (Transmission and Distribution) and National Energy Regulator of South Africa (NERSA

Implementation timeline

2011 – ongoing (SAGEN phases 1–3, and will continue in Phase 4).

Training workshops and events offered:

System stability training:

- 4 webinars with 27 participants each, providing training on voltage, frequency and transient stability

Distribution Network Operation Planning (DNOP) and related training events:

- 33 participants in a two-day training on integrating Battery Energy Storage Systems (BESS)
- 51 participants in DNOP power factory training offered in 10 successive training sessions
- 170 participants in DNOP shift technician training that was presented in 36 half-day webinars

South Africa's commitment to mitigating its climate impact, coupled with technological advances and declining costs, is driving the inclusion of more RE in the country's energy mix. Introducing new generation technologies, in more geographically diverse locations and at different voltage levels, now brings new dimensions to systems planning and operation. This creates additional challenges and greater complexity. South Africa has also initiated a process to unbundle its previously vertically integrated power utility into independent entities for generation, distribution and transmission. This further contributes to a changing operational and planning environment. Successfully managing these changes will result in greater resilience, system flexibility and a significantly improved carbon footprint. Simultaneously, it will achieve a least-cost trajectory for the country.

The Power Systems Planning and Operations component began with initial studies (during SAGEN Phase 1), helping South African stakeholders to create a technical and regulatory understanding of renewable energies. Also, part of this component was developing

capacities to manage the interconnection of the first utility scale RE generators. Since then, the component has continued to evolve to support the integration of more diverse and variable RE, as well as distributed generation resources and grid assets, onto the South African power network.

In Phase 3, SAGEN assisted country partners to refine and streamline the requirements and specifications for grid connection of various generation facilities. This effort was coupled with building capacity for the planning and operation of the power system. It included both transmission and distribution level planning and operation, so as to optimally integrate new generation capacity into the grid. Through this collaboration, locally relevant solutions and approaches could be developed, while drawing on expert input in leveraging extensive international experience and technical expertise.

The initiatives under this component were structured into four work packages (refer to the introductory graphic on page 7). While varied, they all aimed at ensuring system stability – streamlining processes and developing the modelling, planning and operational capability needed by a rapidly transforming power system.

Below is a small selection of highlights achieved during the SAGEN 3 implementation timeframe:

- **Aggregated Generation Connection Code.** Support was provided to the Grid Code Secretariat for the development of a grid code that consolidates all generation requirements into a single code. An aggregated code will facilitate market entry for new players and streamline investment planning, while encouraging compliance and assisting network operators to provide oversight and monitor compliance.
- **System stability studies, modelling and training.** SAGEN provided technical support and capacity building, to enable development of system flexibility and stability studies for the whole power system. Studies considered potential stability challenges in the reference years: 2020, 2025 and 2030. This collaboration helped establish modelling and stability study capability within Eskom, to assess the impact of new and changing complexities in the power system.
- **Distribution Network Operation Planning Standard (DNOP) and workshops.** SAGEN 3 assisted with amendments to the DNOP Standard, to accommodate a changing operating environment at lower voltage levels. The work focused on capacitating planning engineers and control room staff to operate and control local power systems. These include utility-scale variable RE generators and/or multiple embedded generation facilities at a local level. Workshops and training sessions, rolled out across the country, have facilitated capacity building and easy integration of the new requirements into the distribution operating environment. In the next phase, the DNOP Standard and training will be extended to municipal distributors, who will increasingly require similar capabilities.

Way forward

System operations and planning will take centre-stage – particularly as the unbundling and restructuring of the power sector establishes more interfaces and redefines responsibilities for system balancing and stability. Accordingly, the various initiatives under the Power System Operations and Planning component will continue into the next SAGEN phase. Specific focus will fall on (i) grid access for emerging technologies, (ii) supporting and capacitating Eskom and municipal distributors for their evolving roles, and (iii) embedding institutional capacity within entities, to dynamically respond to a rapidly changing global and national energy landscape.



Photo: PV.Tshwane Demo Installations and Training. 2019. GLZ. Manyatsa Monyamane.

Component 2: Small-Scale Embedded Generation (SSEG) in Distribution Networks

Three work packages



Comprehensive Municipal SSEG support and capacity building: SEA



Advanced modelling and planning support and capacity building: CSIR



Installation and maintenance quality assurance and skills development

Context

An unprecedented uptake of SSEG – mainly rooftop solar photovoltaic (PV) – has significant implications for network service providers, in terms of financial, technical and safety impacts.

Focus of this component

Supporting a consistent and rigorous approach to integrating SSEG into municipal electricity networks, in a way that is technically, legally and economically sound.

Partners

DMRE, SALGA, municipalities, Sustainable Energy Africa (SEA) and Council for Scientific and Industrial Research (CSIR)

Implementation timeline

In the current format, the component ran from 2018 to 2022, and will continue in Phase 4.

Electricity supply constraints, together with escalating electricity tariffs and decreasing prices of renewable energy technologies, have driven substantial uptake of SSEG in South Africa. By 2021, approximately 1,150 MWp of solar rooftop PV systems are estimated to have been installed. Significantly, between 250 and 400 MWp of this installed capacity has been added during the preceding 12 months¹. Market forecasts predict that technological advances and reduction in deployment costs will continue – resulting in market growth potentially increasing more than six-fold in the next decade.

Thus, as recognised by the Integrated Resource Plan (IRP) 2019, rooftop PV is fast becoming an important contributor to the growing share of solar energy in the energy mix; largely as a result of private sector investment. Most of these systems are located in municipal areas, with their capacity contributing to the overall power system. Therefore, urgent consideration of the technical, financial and administrative impact of this growing sector on municipal distributors was required. It was already recognised in 2012, during the initial phase of SAGEN, that municipalities would need to understand and interface with rooftop PV as an emerging technology. In response, SAGEN's initial support focused on (i) facilitating collaboration among key stakeholders and (ii) capacity building related to technical and regulatory aspects.

This early work led to the development of a comprehensive support package to assist municipalities with effectively integrating and responding to SSEG. This package drew on pioneering work by the City of Cape Town and GreenCape's support to Western Cape municipalities. The expanded initiative was established by SALGA, the Association of Municipal Electricity Utilities (AMEU) and SAGEN with SEA and CSIR as implementation partners. The intention of the package was to ensure a supportive regulatory environment, to understand and mitigate revenue impacts, and to enhance technically sound grid integration, business model innovation and capacity building. Over the years, this has grown into an invaluable and extensive online resource portal for SSEG. It is available on the municipal support website, www.sseg.org.za.

SAGEN also supported capacity building within the solar PV sector – targeting high quality installations, maintenance and operation of installed solar PV systems. This ensures sustained benefits to the consumer, the economy and the environment.

During SAGEN 3, this programme focused on enhancing the established SSEG knowledge platform. Here emphasis fell on (i) proactive impact assessment and planning, for effective integration of SSEGs onto the grid, (ii) suitable municipal business models for the changing context, (iii) streamlined procurement solutions for municipal owned RE generation assets, and (iv) maintaining and growing the support available to municipalities through the online resource portal.

Capacity building has been embedded in all aspects – specifically addressing challenges such as revenue and tariff setting, cost of supply studies and grid impact assessments, as well as assessment and approval of SSEG applications.

Under this component, work continued to build on previous phases. This contributed to an extensive set of resources, with technical depth and a deep understanding of the municipal environment and challenges. From this, four interventions are highlighted:

¹ GreenCape, 2021. *Energy Services Market Intelligence Report, 2021*. <https://www.greencape.co.za/market-intelligence/>

- Municipal SSEG training.** The portal with online resources has been complemented with annual training courses run by SEA and fully funded by SAGEN. The central course, offered over a full week, introduces municipalities to the various aspects of accommodating SSEG on the municipal network. During the training, municipalities are assisted with interpreting the standard resources, understanding the relevance within their own context, identifying options that are best suited and then customising the standard set of documents for their municipal environment and needs. At the end of the week, each participating municipality leaves with a finalised set of documents that are ready for adoption and implementation. During the COVID pandemic the entire course was successfully transitioned to an interactive online offering, making it even more accessible to more participants in future (<http://training.sseg.org.za/>).
- Cost of supply tool for municipalities.** SEA developed a spreadsheet-based cost of supply tool to help municipalities better understand and interpret their business models. The tool was developed in close collaboration with Eskom, NERSA and a selection of private sector cost of supply consultants. It is populated with basic assumptions and proxy data to develop an indicative cost of supply, but can be refined with actual data, where available within the municipality. As a trial, the tool was used to develop cost of supply studies for six municipalities in mid-2021. It enabled greater transparency at the participating municipalities and NERSA – particularly with the respective municipalities’ cost of supply analysis and the input values that informed the study. The process has facilitated communication between NERSA and municipalities – thus ensuring that regulatory requirements are understood and that municipalities can effectively respond. NERSA is encouraging municipalities to use the tool and it has already been adopted widely by municipalities and consultants in the sector.
- Municipal energy master planning.** The CSIR developed an energy master plan, with accompanying procurement strategy, for the Garden Route District Municipality (GRDM). Municipal energy master plans establish a planning and decisionmaking framework for procuring new generation capacity (both SSEG and municipal own generation). It also empowers municipalities to make economically sound investment decisions, and can facilitate discussions with investors and financiers. These benefits were already demonstrated for the GRDM, with the least-cost plan showing significant potential savings. Here, given the prospect of

SSEG training and tariffs

- 6 annual municipal trainings and 6 Specialist Trainings offered.
- 70 municipalities (of 160) participated in training
- 30 SSEG tariffs approved

GRDM’s energy master plan helped identify opportunities to:

- reduce costs by 24%,
- save 53% on CO2 emissions, and
- reduce water use by 49%, relative to business-as-usual for the planning period to 2040.

municipalities to procure directly from independent power producers (IPPs), this municipal role in planning and procuring will substantially increase in complexity. This underscores the growing need for energy master planning at municipal level.

Way forward

As from 2021, amendments to the regulatory environment have opened the embedded generation market. This allows considerably larger systems to be developed, without requiring a license. Accordingly, the number of systems larger than 1 MW is expected to increase, and with this, so too the responsibility of municipal distributors to legally and safely connect embedded generation capacity. In Phase 4, SAGEN's support will be tailored to support municipalities to adjust and effectively respond to this evolving environment.

Component 3: Energy Efficiency Investments

Three work packages



EEDSM Management and implementation support



SECO co-funded EE streetlighting retrofit project



Diverse EE Investment projects

Context

In the context of electricity supply shortages, escalating electricity costs and pressure on municipal finances, the opportunities to reduce municipalities' own consumption offer a compelling option for improved financial and environmental sustainability.

Focus of this component

Identifying high-impact EE investment and supporting opportunities to reduce municipalities' own electricity use.

Partners

DMRE, SANEDI, Innovation Hub, SEA and participating municipalities

Implementation timeline

2018–2021. Component concludes in Phase 3.

The changing global and national energy landscape, combined with a challenging economic environment, necessitate local government giving urgent consideration to its energy consumption. Indeed, improved energy efficiency is becoming imperative for environmental and financial sustainability at municipal level. It is also a requirement of national policy, as related to (i) municipal management and finances, (ii) the construction, renovation, occupation and operation of public buildings and (iii) the country's EE strategy.

Numerous efficiency opportunities exist within municipalities. These range from municipal-owned and occupied buildings, to water reticulation, waste water treatment plants, street and public lighting, and other public facilities. Considerable savings can be achieved through improved energy management, together with upkeep of systems and employment of energy efficient technologies. Typically however, municipalities are capacity and resource constrained. To unlock these savings opportunities, they require support around capacity building, in solving technical issues, and for information development.

An important focus of the SAGEN programme has been to support local government with identifying and implementing viable EE initiatives. Under the Energy Efficiency Investments component, SAGEN 3 focused on two primary areas. The first was Energy Efficient Demand Side Management (EEDSM) and efficient streetlighting. The second comprised of an array of smaller, complementary initiatives, targeting various areas of high energy use within the municipal environment. These smaller projects generally tackled EE through training and capacity building. They were geared at improving access to and development of the energy service company (ESCO) market and promoting specific technologies and methods. A few highlights amongst these multiple and varied initiatives are showcased below:

- **SECO co-funded Energy Efficient Streetlighting Retrofit Project.** A pilot project was implemented to determine the real savings achievable with upgrading municipal public area and street lighting. This spanned five municipalities in four provinces, which received assistance in planning, procurement, overseeing the actual replacement and documenting the results. The findings, plans, selection processes and standardised technical specifications will contribute to successful duplication elsewhere. They will also increase willingness among other municipalities to embark on similar initiatives.

Key achievements

More than **30 municipalities** were supported across South Africa through technical support and direct investment on EE initiatives.

5 municipalities in 4 provinces participated in the streetlighting retrofit project:

~**5800 streetlights were replaced** (both street and area mast poles)

~**3.4 million kWh annual saving** in electricity consumption

~**3,155 tons of CO₂-emissions reduced** per year.

12 municipalities in 7 provinces received EEDSM support – with **5,051 MWh in annual energy savings** reported for **9 of these municipalities**.

Training was provided to **56 representatives** from 14 wastewater treatment plants in **11 municipalities**.

(These reductions were triggered by EEDSM funding, SECO grant funding and the direct impact of the unquantifiable technical assistance provided.)

Photo: Power Systems GRID. South Africa. 2015. GIZ. Glenn McCreath.



- **EEDSM management and implementation support.** Dedicated support was provided to the DMRE and participating municipalities for the implementation of the EEDSM municipal programme. A seconded technical advisor strengthened the capacity of the EEDSM team at the DMRE. Such support was also made available to 12 municipalities that were new recipients of grant funding. Nine municipalities successfully implemented planned interventions within the allocated timeframes – achieving savings of 5,051 MWh. Learnings were well documented and will be made available to assist more municipalities to attain similar successes.
- **Municipal waste water treatment plants (WWTPs).** A two-fold approach to municipal WWTPs was followed on behalf of the DMRE, to ensure maximum impact: (i) training and development of municipal resources, to address inefficiencies at municipal WWTPs and improve management of operations, and (ii) aiding in the preparation and research for the implementation of biogas generation. This resulted in the development of two practical guidelines. The first guideline, “Anaerobic Digestion of Municipal Wastewater Sludge”, promoted opportunities in the recovery of biosolids and energy from municipal wastewater sludge and organic substrates. It was the first time that a publication of its sort had been made available in South Africa. The second, “A Practical Guideline for Energy Efficiency Audits at Wastewater Treatment Plants”, trained energy managers involved in WWTP management and operation to identify energy efficiency interventions.

Way forward

Most of these initiatives have concluded under SAGEN 3 and will not continue in their current form. Relevant initiatives and interventions will be integrated as part of a more holistic energy management approach, under the Municipal Energy Management Systems component in SAGEN 4.



Component 4: Municipal Energy Management Systems

Two work packages



Energy action plans,
use of MEMS in
metros



Fundamentals
of energy
management,
use of MEMS in
municipalities

As already outlined in Component 3, the improved energy efficiency of municipal infrastructure and buildings, offer both budgetary savings on electricity bills and a wide range of environmental and socioeconomic benefits. Energy cost savings can also make funding available for other much needed municipal functions.

Municipal Energy Management Systems (MEMS) provide a systematic approach to understanding and managing energy use. The MEMS philosophy considers energy systems holistically for improvement opportunities. This allows it to introduce a structured process of energy management, which is embedded throughout the municipality. It thus enables integration within policy, budgets, organisational structures,

Context

Energy security concerns and rising electricity prices are among the many challenges threatening financial sustainability of municipalities in South Africa.

Focus of this component

The introduction of Municipal Energy Management Systems (MEMS) as an enabler for managing own electricity usage, saving energy and reducing costs.

Partners

DMRE, SALGA, participating metros and municipalities and SEA as implementation partner for metros

Implementation timeline

2019 to 2021. The component will continue in Phase 4.

MEMS helped identify cost savings in six municipalities and two metros

MEMS implementation was supported within the Buffalo City and Nelson Mandela Bay Metros (NMBM).

R1,5 million savings were identified by NMBM through changes in tariffs and notified maximum demand (NMD).

The fundamentals of energy management were introduced in six municipalities. They made significant progress with implementation and identified noteworthy opportunities for cost savings:

	1	2	3	4	5	6
Policy						
Organisational structures						
Skills and knowledge development						
Information systems and data						
Communications						
Implementation						

Ready for implementation

Final approval/last step

Approval process underway/implementation to commence

training, awareness campaigns, communication plans and energy management action plans. This systemic integration facilitates engagement across departments and levels of authority and this approach clearly identifies aspects of energy management that can be enhanced, even in municipalities that have explored energy efficiency opportunities before.

To this end, SAGEN 3 introduced an initiative to assist municipalities interested in advancing their energy management through the development of MEMS. This initiative differentiated between metros and municipalities, in recognition of their substantial differences, which include size, capacity and resources, as well as levels of awareness and prior implementation of internal EE measures. Accordingly, the initiative was structured into two workstreams: (i) supporting the scale-up of EE work by using and further developing MEMS within metros, and (ii) introducing the fundamentals of energy management and the use of MEMS to aspirant municipalities.

While the MEMS initiative is relatively new, it has already demonstrated significant energy and cost savings. It has also driven the shift away from project-based energy efficiency interventions to a more programmatic energy management approach. The implementation process has also helped identify the next tier of challenges for improved energy management. Many of these relate to metering, billing and asset management. Data availability and quality were also noted as key hurdles facing the effective development and use of MEMS. This will receive continued focus during the next phase.

Key highlights from the two workstreams are included below:

- **Support to two metros to implement MEMS and energy action plans.** The Nelson Mandela Bay and Buffalo City Metropolitan municipalities in the Eastern Cape, were both supported with implementing MEMS and developing accompanying energy action plans. The process involved extensive engagement with the municipal staff, with both formal and informal training sessions to build capacity within the metros. Such collaboration and support has contributed to both metros achieving more ambitious progress than originally foreseen; and has already resulted in tangible energy and cost savings. Outcomes of this project will be shared with other metros through bilateral exchanges and/or the Urban Energy Network and related information platforms.
- **Introducing the fundamentals of MEMS.** Six municipalities in five provinces participated in this pilot project. It established a framework for energy management within the municipal structures, (i) introducing an energy management policy, (ii) launching an energy management committee and (iii) creating Municipal Energy Management Action Plans (MEMAPS). By improving data collection and management, it was possible to systematically identify

Cost saving opportunities:

4 of the 6 municipalities	Savings identified over 5-year period
Account management	R 16 014 987
Tariff structure changes	R 31 523 870
Interventions at municipal buildings	R 778 820
	R 48 317 677

EE interventions, which could then be developed into implementable projects. Savings opportunities, worth hundreds of thousands of rands per year within each municipality, were identified. Most importantly, this small but diverse group of municipalities has brought learning to the surface, which is equally relevant to municipalities throughout the country.

- **MEMS Support Toolkit.** The knowledge resources developed as part of the MEMS work has been consolidated into a Municipal Energy Management Support Toolkit. It is available on the SAGEN website under “Support for Municipalities” (www.sagen.org.za/support-for-municipalities/municipal-energy-management-support-toolkit?own=0) and provides practical support in establishing the groundwork to embed energy management within a municipality. Adopting this framework allows for integration of energy management across municipal operations, while empowering municipalities to understand and manage their energy use. The toolkit is universally relevant, and available to all municipalities, as they embark and progress on their MEMS journey.
- **MEMS resources.** The workstream that focused on metros also produced a number of tools and guides to facilitate MEMS implementation. It was developed by Sustainable Energy Africa (SEA) (who led the roll-out of support to metros). All tools and guides are publically available and actively shared with municipalities, through SEA’s established networks and platform. The tools are the “Municipal Energy Management Action Plan Monitoring Tool” and “Monitoring Tool Template” and the “Guide to Developing a Municipal Energy Management Action Plan”, all available from the cityenergy.org.za website.

Way forward

Outcomes of this initial implementation period have underscored the value and importance of embedding a systematic approach to energy management, throughout municipal structures and operations. Thus, assistance to municipalities in establishing their own MEMS will continue in Phase 4. Here, the focus will turn towards more comprehensive integration – particularly in building capacity to act on, and respond to, the next tier of energy management challenges, identified by the MEMS process.

It is important to note that from the end of 2022, municipalities will be required to display Energy Performance Certificates (EPCs) for all municipal buildings exceeding 1,000 m². It is foreseen that MEMS will be a useful tool in assisting municipalities to comply with this and other more comprehensive energy performance requirements, which are likely to be introduced in future.

Photo: Credit to GIZ SAGEN



Component 5: Energy Policy and Regulation (SAGEN-CET)

Three work packages



Power sector reform



Alignment of policy and regulation for distribution utilities



Supporting a just energy transition

Context

The preceding decade has seen profound technological and market developments. These necessitated urgent reassessment of the policy and regulatory framework, which will guide the transformation of the electricity sector in South Africa.

Focus of this component

Providing access to information, technical assistance, best practices, and experience. Simultaneously facilitating discourse and knowledge sharing among key stakeholders. Thus making a contribution to carving a policy and regulatory framework suitable to the South African context.

Partners

Eskom, SALGA, National Treasury and contributing to the Presidency's reform agenda via Operation Vulindlela

Implementation timeline

2019–2023

The launch of the REIPPPP in 2011 actively introduced private sector participation into the South African power system. By mid-2021, 81 IPPs had been connected to the power network, contributing more than 5 GW of new generation capacity. The IRP 2019 decisively opened the door for more renewables, energy storage and gas generation. New bid rounds are planned to procure some of this capacity from IPPs – inviting more independent actors to the generation sector. The strain on public funds has made private sector investment in new power infrastructure increasingly more necessary. Technology and digital developments have also enabled cost-effective integration of smaller, distributed generation facilities, that can be embedded throughout the power network. This has created an opportunity for even broader participation by municipalities, IPPs and consumers, which can help ease the burden on Eskom and the fiscus.

In 2019, South Africa's president, Cyril Ramaphosa, announced that Eskom, one of the few remaining vertically integrated utilities in the world, will be unbundled. This would separate generation, transmission and distribution functions into separate state-owned entities – setting in motion a fundamental, structural transformation of the South African power system – outlined in a roadmap published in 2019 by the Department of Public Enterprises. While still wholly state-owned, the new structure establishes new roles, responsibilities and interfaces, with distinct regulatory requirements. It also foresees an eventual opening of the electricity

market. This would entail the introduction of an independent transmission system and market operator (ITSMO) that can procure electricity from a diversified, competitive generation sector on economic grounds and at least cost.

Recent regulatory amendments provide for municipalities to procure power from any suppliers. The licensing threshold for generation facilities was also lifted from 1 MW to 100 MW. Both new regulations are anticipated to expedite participation by more and diverse players in the sector and, inadvertently, devolve additional responsibility for power system planning and operation to municipal distributors.

The existing policy and regulatory framework was established in support of the vertically integrated, national utility model. The rapidly and substantially changing electricity landscape has thus prompted an urgent re-evaluation of this framework – addressing the way the sector is structured, and providing for non-discriminatory participation by newcomers to the sector.

SAGEN formulated the Energy Policy and Regulation component to support the policy and regulatory revisions necessary to enable this transformation. It is intended to facilitate access to information, the exchange of knowledge and discussion between key stakeholders. Discourse is focused on policy and structural reform that is suitable to an emerging market and supportive of a just energy transition.

With the Energy Policy and Regulation component, SAGEN-CET is providing support and technical assistance to key strategic partners on the policy, legal and regulatory frameworks in the energy sector. The aim is to promote, and contribute, to the transition of the South African power sector.

The Energy Policy and Regulation component was initiated in February 2020 and will continue until 2023. To date, because of the immediacy of the reform process, and despite the COVID-19 pandemic, a significant contribution has already been made. Some notable highlights from this component are discussed below.

- **Series of webinars, seminars and discussion forums pertinent to sector reform.** This workstream enabled a series of knowledge sharing events – originally initiated by Eskom and attended by government institutions and industry participants. Its intention is to foster the capacity to develop locally-relevant solutions, which draw from, and build on, international best practice, multi-stakeholder discussions and active collaboration. Seminars, webinars and discussion forums were held, covering a range of power sector reform and electricity market design topics. These events have successfully facilitated active stakeholder

Successful stakeholder engagement included:

- Seminar series on international best practices for power sector reform and pathways for South Africa: **24 participants** from Eskom and academia
- Workshop series on non-discriminatory grid access and bilateral electricity trading models (wheeling): **264 participants** (private and public sector)
- Workshop on strategy development, Just Energy Transition and Green Hydrogen: **50 Eskom participants.**

engagement and deliberation, enabling a nationally relevant response to the restructuring process. An outcome of stakeholder deliberations has been to inform policy direction, as evidenced by the draft amendments of the Electricity Regulation Act, published early in 2022 for public comment.

- **Electricity cost of supply studies and pricing framework analyses for distributors.**

The SAGEN-CET team assisted Eskom Distribution and municipalities with the following: (i) developing and implementing Electricity distribution pricing policies – together with a Cost of Supply Framework, to facilitate a consistent, industry-wide transition to cost-based electricity tariffs, and (ii) developing unbundled electricity tariffs, which reflect the underlying electricity services costs for sustainable electricity distribution sectors. Part of the latter component was to review and analyse Eskom’s Tariff design methodology for generators and making recommendations for enhancing the cost reflectivity of tariffs. The intent is to provide a better view of costs and to effectively translate revenue requirements and costs into rate design. Further developments will focus on standardised support tools and guidelines, to assist with implementation the cost of supply modelling and tariff design.

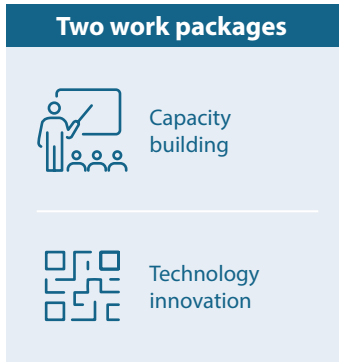
Way forward

The 2021 State of the Nation Address reiterated the importance of energy security and “an efficient, modern and effective power system”. Structural changes to Eskom have advanced significantly; and strong momentum has been established for power sector reform. SAGEN-CET has successfully supported the establishment of an enabling platform for engagement and the convening of different entities. This provides support for collaborative formulation of a robust, new regulatory framework that facilitates the various sector developments. Going forward, this work will continue, grow and expand. It will seek to co-create more active engagement of the various national and local government and regulatory entities, while growing national capacity to carry the changing organisational environment. This component will also increasingly focus on supporting South Africa’s overarching goal of a transition to a modernised power system that is inclusive and just.

Photo: Credit to GIZ SAGEN



Component 6: Capacity Development and Technology Innovation (SAGEN-CET)



Context

Implementing and shaping sustainable solutions for energy transition and power sector reform, requires knowledgeable and trained key stakeholders to drive and manage the change.

Focus of this component

Compiling, improving and making available, training and skills development opportunities to key industry players. Simultaneously supplementing this effort by encouraging technology innovation through cutting edge pilot programmes.

Partners

EPPEI, African Energy Leadership Centre at WITS Business School, Power Futures Lab at UCT-GSB

Implementation timeline

2019–2023

The South African power sector is undergoing a major transformation of its electricity supply and distribution industry. The effective implementation of energy transition and sector reform requires that continuous new knowledge, skills and competencies be developed amongst sector professionals and specialists. With the progress of the pending reform processes and as the number of role-players in the market increases with decentralisation, the demand for suitably qualified people and skills will continue to grow. This component focused on two aspects: (i) capacity building and (ii) technology innovation.

In terms of capacity building, initial scoping and industry-wide consultation identified three immediate training opportunities that correspond with the SAGEN-CET objectives; (i) augmentation of the Eskom Power Plant Engineering Institute (EPPEI) programme, so as to include topics pertinent to power system planning

New courses introduced at 3 institutions:

- Power system planning and operations short courses at EPPEI (eppei.co.za)
- Power Futures Lab courses. UCT Graduate School of Business (uct.ac.za)
- Postgraduate Diploma in Management in the field of Energy Leadership, Wits Business School (www.wbs.ac.za)

By the end of 2021, these courses had been attended by more than 430 participants.

Technology innovation:

By February 2022, 70 HotBots had been installed in 70 homes in the City of Cape Town.

and operation – specifically in systems with higher shares of renewable energy (commenced in 2021), (ii) supporting the revision and expansion of the course offering at the Power Futures Lab at the UCT Graduate School of Business (completed for first intake in 2022), (iii) inauguration of a new “Electricity Stream”, as part of a postgraduate diploma on “Energy Leadership”, at the African Energy Leadership Centre (AELC) at WITS University (first intake in 2022).

Together with its partners, SAGEN-CET is assisting with various aspects of these programmes, by supporting course development and providing funding to South African universities.

Concurrently, the second workstream, technology innovation, developed independently from the capacity building workstream. It progressed from a need (i) to bring innovation into the public sector and (ii) showcase the ability of local industry to provide ready-made solutions to the energy sector. Its goal is to identify technological or digital innovations that support the energy transition. This involves testing and piloting specific innovations, and then disseminating results to industry, to encourage uptake. This workstream is exploring ways to support local private sector initiatives and increase the capacity of existing local start-ups. It thus also trials different options for contractual partnerships, while secondarily, testing the suitability of using SAGEN-CET as an innovation platform.

Two highlights from the programme are showcased below.

- **The multi-university collaboration and new EPPEI course offering.** Supported by SAGEN-CET, EPPEI provided a unique vehicle for the development and dissemination of training material and courses, which support the goals of the capacity building workstream. EPPEI is a partnership, established in 2012, between Eskom, six South African universities² and nine Universities of Technology³. They form a consortium whose purpose is improving the technical skills and knowledge of the power industry. The consortium is tasked with ensuring quality research, continuous improvement and sustainability, within nine⁴ specialisation centres. The consortium’s guidance and the vetting of material for dissemination ensures world-class, relevant, and up-to-date material⁵. The “Power Systems Planning and Operation” courses are the first contributions developed with support from SAGEN-CET. The courses aim to develop capacity for the planning and operation of power systems, which will soon incorporate significantly increased amounts of vRE generation. Further courses are also planned on “Green Hydrogen”.
- **First technology innovation product: HotBot.** The first innovation product identified through the technology innovation component is an intelligent geyser control device called a HotBot. The HotBot is developed by a South African start-up called Plentify. The device uses artificial intelligence

Photo: Aman Baboolal at Plentify.



to shift or reduce demand thereby (i) decreasing bulk electricity costs, (ii) preventing load shedding, and (iii) supporting vRE grid integration. In collaboration with the City of Cape Town, Plentify are installing 100 devices in homes in the metro. Through the pilot programme, Plentify has also leveraged further grant funding from EEP Africa for an additional 400 devices. Pilot installations will test the performance of the HotBot in delivering the different services. A one-year testing phase will commence at the end of the first quarter of 2022 for the installed devices. Installations of the remaining devices will take place throughout 2022. SAGEN-CET will support the dissemination of product information and pilot results to potential users, such as industry and other municipalities.



Photo: Aman Baboolal at Plentify.

Way forward

SAGEN-CET's capacity building and technology innovation support commenced in 2020 and is currently planned to continue to the end of 2023. Development of new course modules and further expansion of content will continue. Currently, courses related to the topics of "energy policy and regulation" and "green hydrogen" have already been identified.

In future, it is foreseen that the new course offerings will have broader relevance to the region, especially given the opportunities that low-cost renewable energy presents in ensuring power supply and reaching international climate goals. Therefore, the possibility of a regional offering is under investigation.

Surveying of the technology innovation component will continue. The first results will be made available by the end of 2022; and the programme is in the process of identifying additional innovation partners.

- 2 Nelson Mandela University, North-West University, University of Cape Town, University of Pretoria, Stellenbosch University, and University of the Witwatersrand.
- 3 Cape Peninsula University of Technology, Central University of Technology, Durban University of Technology, Mangosuthu University of Technology, Tshwane University of Technology, University of Johannesburg, University of Kwa-Zulu Natal, Vaal University of Technology, and Walter Sisulu University.
- 4 Engineering Efficiency (UCT), Combustion Engineering (Wits), Emissions Control (NWU), Asset Management (UP), Materials and Mechanics (UCT), HV Engineering DC (UKZN), HV Engineering AC (Wits), Renewable Energy (US), Engineering Project Management (University of Johannesburg)
- 5 EPPEI website available at <https://www.eppei.co.za>, Power Systems Planning and Operations Training Overview Brochure available at <https://www.sagen.org.za/publications/capacity-building-technology-innovation/123-power-systems-planning-and-operations-training-overview-brochure>

OUR NEXT PHASE: 2022–2024

SAGEN programme development for Phase 4 aims to contribute to South Africa’s commitment to a just energy transition – to “a cleaner and greener future”. This next phase has been defined in collaboration with numerous partners to strongly support various parallel areas of development. As such, it builds on a solid understanding of the energy sector, garnered over previous phases and experiences. It also harnesses the existing goodwill and streamlined systems of well-established connections and working relationships. Phase 4 will benefit from SAGEN-CET’s parallel support, directed at establishing a conducive policy and regulatory framework, together with enhanced national capacity to lead change in the sector.

South Africa has committed to a sustainable energy future, reflected in its climate commitments and energy policy objectives. Simultaneously, it is paramount to ensure that decarbonisation is implemented in a way that promotes and sustains employment, livelihoods and economic inclusion – especially for historically marginalised communities and sectors of society.

The country has also initiated a parallel but related process of reforming the power sector. This involves unbundling the national utility and opening market participation for more and diverse stakeholders, throughout the electricity value chain. Significantly, this has commenced amidst the challenging reality of current power shortages and an industry-wide undertaking to lower energy consumption.

SAGEN’s programme has been structured to support partners and various participants in the groundbreaking process of reform and transition. In this fourth phase, SAGEN will continue its work in six components (Figure 4); with significant focus on (i) supporting municipal distributors with their increased roles and responsibilities and (ii) enabling the structural/technical and regulatory capacities required for crucial power sector reform.



Figure 4: SAGEN phase 4 consolidated

We are delighted to continue this journey with our partners, steadily advancing the goal of affordable, reliable and sustainable energy for all.

LIST OF ACRONYMS AND ABBREVIATIONS

AMEU	Association of Municipal Electricity Utilities
BMZ	German Ministry of Economic Development and Cooperation
CET	Capacities for an Energy Transition
CSIR	Council for Scientific and Industrial Research
DMRE	Department of Mineral Resources and Energy
DNOP	Distribution Network Operation Planning Standard
EE	Energy efficiency
EEDSM	Energy Efficiency Demand Side Management
EPC	Energy Performance Certificate
EPPEI	Eskom Power Plant Engineering Institute
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IPP	Independent power producer
IRP	Integrated Resource Plan
MEMS	Municipal Energy Management System
NERSA	National Energy Regulator of South Africa
NT	National Treasury
PV	Photovoltaic
RE	Renewable energy
REIPP	Renewable Energy Independent Power Producer
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SAGEN	South African-German Energy Programme
SALGA	South African Local Government Association
SEA	Sustainable Energy Africa
SECO	Swiss State Secretariat for Economic Affairs
SONA	State of the Nation Address
SSEG	Small-Scale Embedded Generation
vRE	Variable renewable energy
WWTP	Waste water treatment plant



Photo: WWTP, ERWAT, Hartebeestfontein, South Africa, 2018. Brett Eloff.

SAGEN's partners SAGEN works in cooperation with the Department of Mineral Resources and Energy (DMRE) as its political partner. Other implementation partners include the South African Association of Local Governance (SALGA) and the national power utility Eskom.