CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Our Shared Energy Future: The 2050 Energy Strategy for the City of Cape Town

Draft for Public Participation
June 2023

Making progress possible. Together.

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Executive Summary

The energy system, globally and locally, is rapidly transforming due to the impacts of technology change, regulatory change, and climate change. These changes are affecting every aspect of how energy is generated, distributed and used. Figure 1 provides a summary description of fundamental changes taking place in the electricity system that include increasing use of distributed energy resources and a greater role for distributors and users of energy. In the South African context, changes in the electricity system are being accelerated due to the severity of load-shedding. Since 2019, there has been an unprecedented escalation in load-shedding. While the City of Cape Town has been able to protect City Supply Area customers from up to two stages of load-shedding, the current levels are severely disruptive to the local economy, its future growth and the broader well-being of Cape Town's residents. This context calls for the City of Cape Town to actively engage with and appropriately intervene in both mitigating load-shedding as well as navigating the changing energy landscape to the benefit of all in Cape Town.

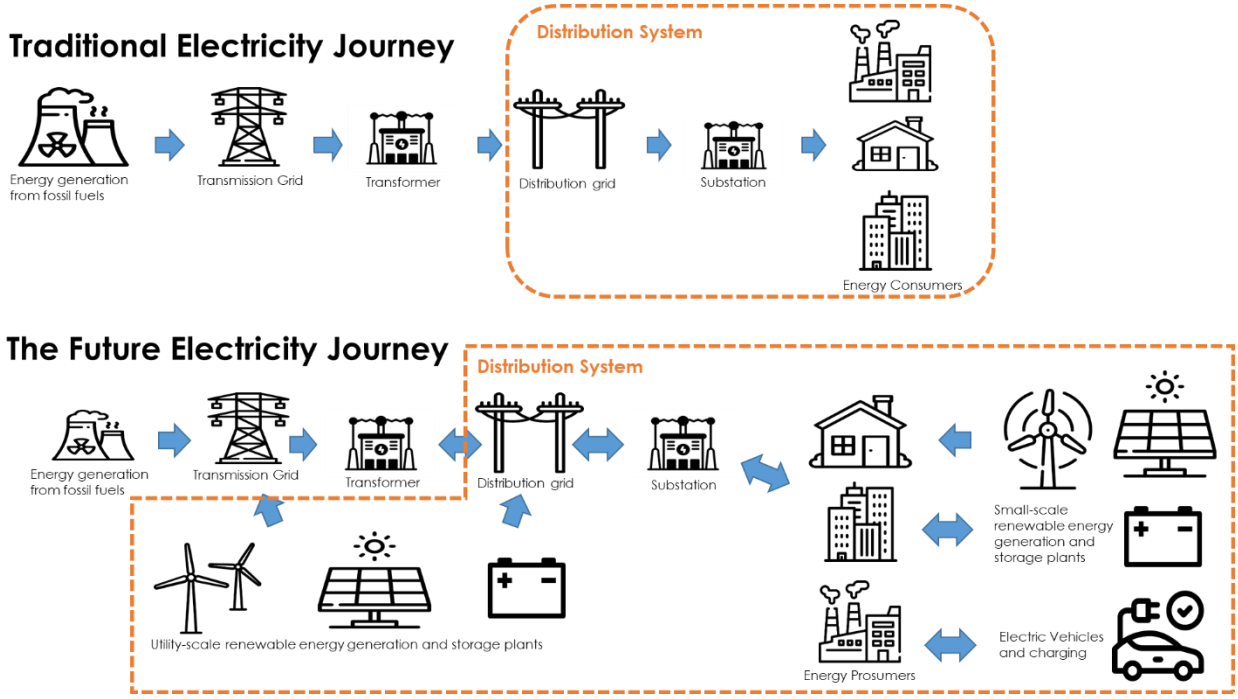


Figure 1: Moving from the traditional electricity system to the future electricity system. Adapted by author from https://www.cleanfuture.co.in/2018/07/03/dso-modernizing-the-power-grid/ using images from Flaticon.com

Energy Strategy Overview

This Energy Strategy therefore sets out a vision and a programme of action to address the current energy supply crisis and to navigate the energy transition to the benefit of residents and businesses. Furthermore, the strategy aims to develop energy systems to propel Cape Town's economic growth, achieve enhanced well-being and poverty alleviation for its residents; to be a City of Hope. It provides a pathway to increase capabilities to mitigate load-shedding in the short term, whilst also driving and enabling the transformation of the municipal electricity utility

and local energy system to sustainably provide Cape Town's residents with reliable, affordable and carbon neutral energy in the long term.

The Energy Strategy aligns with the Integrated Development Plan (2022-2027) and other key City strategies. It is informed by an evaluation of the existing state of the energy system and an assessment of the energy needs of residents, businesses, and the City. These help identify the challenges that the City of Cape Town needs to address in order to achieve 'End load-shedding in Cape Town over time' (IDP objective 3) and 'Well-managed and modernised infrastructure to support economic growth' (IDP objective 4).

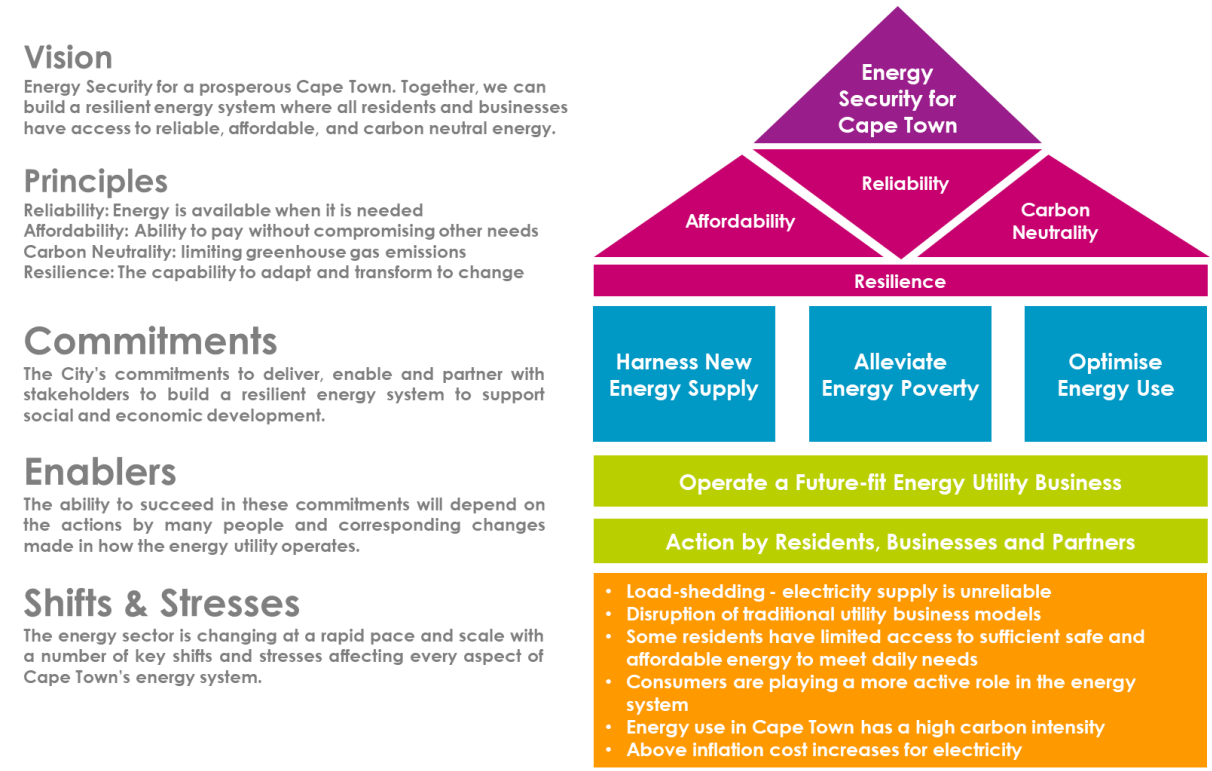


Figure 2: A diagram representing a summary of the structure of the Energy Strategy

As outlined in Figure 2, the Energy strategy answers three key questions:

1. **Where do we want to go?**

   An overarching **vision:** Energy Security for a prosperous Cape Town. This vision is underpinned by **four principles** that describe the kind of energy system Cape Town needs – a resilient energy system that can provide reliable, affordable and carbon neutral energy to all people living and working in Cape Town.

2. **Where are we now?**

   Grounded in understanding the current state of the energy system, how we got here and how it's changing, the Energy Strategy outlines a number of **key shifts & stresses** to be navigated, amongst a range of critical trends that inform decision-making.

3. **How are we going to get there?**

   The vision is implemented through **three commitments** and **two cross-cutting enablers** that each has programmes that unpack the nature of the challenges faced, the opportunities to be harnessed, and the outcome all energy system stakeholders can work towards. The Energy Strategy then further details how the City will deliver, enable and partner with stakeholders to build a resilient energy system and improve energy security over time.

The majority of the programmes within this Energy Strategy focus on the electricity system due to the City's currently significant role and responsibility in the sale and distribution of electricity to a wide range of customers. In the short term, there are opportunities to further expand this role that need to be guided by this strategy.

There are however a few programmes where the focus goes beyond that of electricity and looks to other energy sources, or the energy system more broadly. In the longer term, as new energy technologies gain traction, it will be possible to take hold of opportunities at the utility scale that make use of alternative energy sources and technologies.

The Energy Strategy takes a 2050 view with key priorities and programmes implemented in a **three-phased approach** to enable and drive change within the energy system over time:

- Short Term (by 2026): Increase capabilities to mitigate up to 4 stages of load-shedding
- Medium Term (by 2031): Reforms implemented to maintain a financially sustainable electricity utility with enhanced operations and asset management practices
- Long term (by 2050): Transforming the energy system to be carbon neutral

Load-shedding Mitigation Strategy Overview

The escalating severity of load-shedding in South Africa is the most pressing issue limiting our ability to achieve energy security in Cape Town at present. For planning purposes, the City of Cape Town has taken a cautious outlook on the national electricity supply constraints and this strategy is built on the assumption that load-shedding will continue at an average of Stage 4 until 2032 and reduce to an average of Stage 2 for a further five years thereafter. The City of Cape Town has set the ambitious goal of protecting City of Cape Town customers from up to 4 stages of load-shedding, for a portion of the day based on technical and financial feasibility, between 06:00 - 22:00 on weekdays by 2026. This strategy contains a set of interventions that will deliver on this goal in order to limit the associated negative economic and social impacts across the city.

In practice, the City will intervene to mitigate the impact of load-shedding across three scales as noted in Figure 3 below:

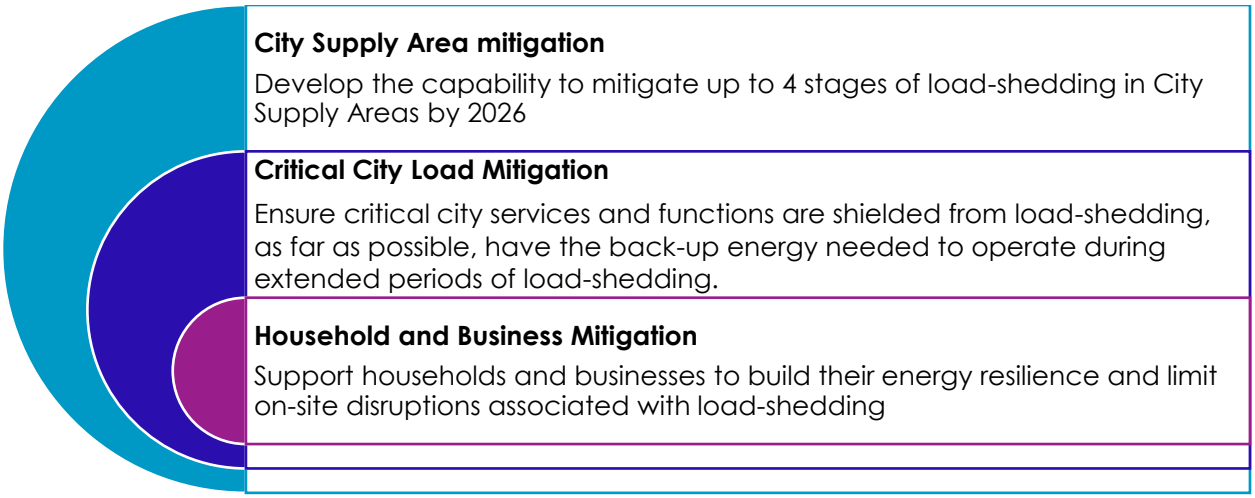


Figure 3: A diagram representing the three scales of intervention for the load-shedding mitigation programme implemented by the City of Cape Town.

Unpacking the Energy Strategy

The tables below provide a summary of the Energy Strategy's commitments and enablers and their related programmes, alongside an indication of the City's role and the status of each programme.

City's role

The Energy Strategy outlines three main roles for the City of Cape Town within the energy system:

- Deliver: The City leads the intervention of activities that will achieve the desired outcome.
- Enable: The City provides support to the stakeholders who lead the implementation of the interventions that will achieve the desired outcome.
- Partner: The City works closely with other stakeholders to jointly implement the interventions that will achieve the desired outcome.

Status of Programme

- New (concept): The programme is being investigated and conceptualised, with options being tested and analysed to inform the City's investments in the future.
- New (in planning): The programme is in the process of being planned in detail, with budget and resources for planning activities allocated.
- Expansion of existing programme: The programme is currently being implemented but will be expanded or scaled up, with budget and resources for implementation allocated.
- Implementation in progress: The programme is currently being put into effect, with budget and resources for implementation allocated.

Commitment 1: Harness New Energy Supply

Cape Town's energy demand is met by a reliable and cost-effective supply of increasingly carbon neutral energy from multiple energy suppliers, with new energy sources introduced to the benefit of residents and businesses.
In the short to medium term, the focus is increasing the supply and storage of electricity from a range of public and private sources in response to the current scarcity of electricity supply due to load-shedding. In the longer term, the focus is exploring the use of new energy sources, whether for direct use or for power generation.

Goals to be achieved within the next 5 years

Where an earlier date is targeted for these goals, this is stated.

- Facilitate increased access to electricity from alternative sources to meet up to 35% of maximum notified demand in City Supply Areas. This equates to approximately 650 MW of energy from small-scale embedded generation, city-owned generation, wheeling arrangements and purchases from Independent Power Producers (IPPs).
- Develop an online registration form for Small-scale Energy Generation (SSEG) applications to streamline the process for customers by the end of 2024.
- Contribute to mitigating load-shedding across City Supply Areas by up to 4 stages through making available a range of dispatchable energy supply options by the end of 2026,
- Mitigate impact of load-shedding at critical city loads through the provision of on-site power generation and/or onsite energy storage.
- Implement wheeling through the establishment of the required systems and processes for these new City energy services.
- Implement systems and related technical requirements to make it easier for Small-scale Energy. Generation (SSEG) prosumers to feed electricity in to the grid by the end of 2024.
- Contracting and design of the refurbishment of Steenbras Hydro Pumped Storage Scheme.
- Decommission and plan for the repurposing of the Athlone Power Station Site.

Programmes	Outcomes	City Role	Status
1.1 City-initiated Energy Generation	The City buys power from the private sector, develops its own generation plants and drives the adoption of innovative energy technologies to facilitate the bulk supply of lower carbon, cost-effective and reliable energy.	**Deliver**	**Implementation in progress**
1.2 Utility-scale Energy Storage	The City mitigates the impact of load-shedding by optimising the use of the Steenbras Hydro Pumped Storage Scheme and installing new	**Deliver**	**Expansion of existing programme**

	battery energy storage systems at critical City services. In the longer term, the City explores the development of new energy storage solutions that provide ancillary services to enhance distribution system functionality and manage distributed and embedded energy resources.		
1.3 Private Sector Embedded Generation	Residents and businesses are empowered to generate their own electricity and sell their excess supply, with distributed energy resources integrated safely into the grid.	**Enable**	**Implementation in progress**
1.4 Wheeling and Trading	Customers and aggregators are able to wheel and trade electricity across the City's distribution network as made possible through the adoption of the necessary contractual and technological arrangements, and the application of cost reflective use-of-system charges.	**Enable**	**New (in planning)**

Commitment 2. Alleviate Energy Poverty

Indigent households and communities in informal settlements are supported to access a range of safe and cost-effective energy services to meet their daily needs for improved well-being and increase economic participation.

Goals to be achieved within the next 5 years

- Continue to uphold high electrification rate of informal settlements, where permissible.
- Establish robust datasets to inform targeting of grid enhancements and subsidy reform.
- Free Basic Alternative Energy Policy and Implementation Design.
- Pilot alternative public lighting solutions for unelectrified informal settlements.

Programmes	Outcomes	City Role	Status
2.1 Energy Subsidy Reform	An optimised energy subsidy regime that has a sustainable source of funding and allows unelectrified households to access safe and clean non-grid-connected energy sources.	**Deliver**	**Expansion of existing programme**

2.2 Informal Settlement Electrification	In line with informal settlement upgrading processes, eligible unelectrified settlements and backyard dwellings on public land across Cape Town have access to grid-supplied electricity.	**Deliver & Partner**	**Expansion of existing programme**
2.3 Informal Settlement Public Lighting	Sufficient and cost-effective public area lighting is provided in both electrified and unelectrified informal settlements to improve safety and security.	**Deliver**	**Expansion of existing programme**
2.4 Energy Service Innovations for Backyard Dwellings	Opportunities for improved energy access in informal backyard dwellings across Cape Town are explored and harnessed, contributing towards improved quality and safety of affordable rental accommodation in Cape Town.	**Partner**	**New (concept)**

Commitment 3. Optimise Energy Use

Businesses, households, and municipal services use energy efficiently and are supported to manage the demand for electricity to allow for greater use of renewable energy and contribute to balancing the electricity distribution grid.

Goals to be achieved within the next 5 years

Where an earlier date is targeted for these goals, this is stated.

- Residential demand response programme contracted by 2024.
- Rapidly expand the municipal services energy efficiency programme in buildings and industrial facilities.
- Increase the amount of interruptible supply derived from the existing commercial demand response programme.
- Establish energy performance baseline per occupancy class for all privately owned buildings in Cape Town.
- Energy training material and related communications for micro-developers to build energy efficient, affordable rental accommodation.

Programmes	Outcomes	City Role	Status

3.1 Energy efficient City Services	Municipal service continuity and cost-effectiveness is enhanced through investments in energy efficiency and energy demand reduction in buildings and facilities.	**Deliver**	**Expansion of existing programme**
3.2 Improved Private Building Energy Performance	Property owners and developers are supported and enabled to optimise their building's energy performance through energy efficiency and enhanced building energy management systems.	**Enable**	**Implementation in progress**
3.3 Enhanced Demand Response	Effective commercial and residential demand response programmes are implemented so that the City can efficiently balance electricity supply and demand through the distribution network and mitigate load-shedding.	**Partner**	**Expansion of existing programme**
3.4 Support Uptake of Electric Vehicles	Cape Town is a leading Electric Vehicle-friendly city in South Africa, with the City proactively introducing EVs into the public sector over time and enabling EV charging infrastructure to develop in support of the industry.	**Partner**	**New (in planning)**

Enabler A. Operate a Future-fit Energy Utility Business

A municipal electricity utility with enhanced asset management of energy infrastructure that adapts its business model and systems to provide financially sustainable energy services in an increasingly competitive and distributed energy system.

Goals to be achieved within the next 5 years

Where an earlier date is targeted for these goals, this is stated.

- By 2026, operate the distribution system so as to harness dispatchable energy supply and curtailment programmes to allow the City of Cape Town to mitigate up to 4 stages of load-shedding in City Supply Areas between 06:00 - 22:00 on weekdays.
- Implement systems and processes to improve access to the grid to enable the connection, operation and management of distributed energy resources.
- Design of electricity tariff restructure to enable improved cost recovery for fixed distribution system costs.

- Design of enhanced distribution grid communications network and increased functionality as a distribution system operator.
- Implement required institutional and financial reforms to enhance the separation of the electricity business units – generation, grid services and retail.
- Investigate avenues for retaining and growing revenue streams for utility, including wheeling, EV charging and hydrogen, to name a few, and mechanisms for growing the customer base.

Programmes	Outcomes	City Role	Status
A.1 Institutional and Workforce Reform	A restructured and capacitated electricity utility department that is agile and viable within a changing energy system and has the skills to respond to the changing needs of customers and the energy system more broadly.	**Deliver**	**New (in planning)**
A.2 Tariff and Financial Reform	A financially sustainable utility department that encourages private sector participation in energy supply, safeguards the provision of subsidised energy access to indigent households, and ensures that the cost of providing and maintaining electricity infrastructure is fairly distributed across customers.	**Deliver**	**New (in planning)**
A.3 Infrastructure & Technology Reform	Enhance utility operations through proactive infrastructure maintenance and leveraging digital technologies to ensure safe and cost-effective distribution grid services, enhanced system operator functionality, and to support the integration of more distributed energy resources on the grid.	**Deliver**	**Expansion of existing programme**
A.4 City-level Energy Planning	The utility makes use of detailed and accurate data sets in system-wide planning and modelling to optimise the functioning and investment in the local electricity system, as supported by the digital and spatial representation of electricity infrastructure systems.	**Deliver**	**Expansion of existing programme**

Enabler B. Action by Residents, Businesses & Energy Services Sector

All stakeholders in the energy system have the knowledge needed and are supported to take action that contributes to the achievement of energy security in Cape Town.

Goals to be achieved within the next 5 years

Where an earlier date is targeted for these goals, this is stated.

- Annual publication of updated energy data on City Open Data Portal.
- Revised State of Energy and Carbon Report published.
- Energy Festival to engage citizens on energy innovations.
- Energy services industry support roadmap.

Programmes	Outcomes	City Role	Status
B.1 Awareness & Engagement	Residents and businesses are capacitated to make informed energy decisions which support the achievement of key energy priorities in Cape Town	**Deliver**	**Implementation in progress**
B.2 Energy Data Access	Up-to-date and comprehensive energy datasets and related analysis are made available to applications and are accessible by all energy system stakeholders to enable evidence-based decision-making.	**Deliver**	**Expansion of existing programme**
B.3 Energy Services Industry Support	Leveraging existing support programmes in the City, empower entrepreneurs, youth, and job seekers to take hold of opportunities offered by a growing energy services sector to increase economic participation and support a thriving energy market in Cape Town.	**Partner**	**New (concept)**

Definitions

Word/Phrase	Definition
Ancillary Services	Ancillary Services are services provided to the System Operator by Generators or Customers apart from primary energy to support the reliable and secure transport of power from Generators to Customers.

Arbitrage	Arbitrage is the practice of storing last night's off-peak, cheap energy for use during today's expensive peak energy period ("buy low, sell high").
CAIDI	The Customer Average Interruption Duration Index (CAIDI) is a measure of how long an average interruption lasts for a measurement period, typically a supply period of a year.
Carbon Neutral Energy	Energy produced from renewable sources and/or nuclear power that does not produce greenhouse gas emissions during power production and, after taking into account any potential carbon sinks, the net greenhouse gas emissions from all sources are zero.
City Supply Areas	Geographical areas that purchase electricity from the City of Cape Town.
Dispatchable power	An electrical power system, such as a power plant, that can be turned on or off to deliver power as needed.
Energy	Active energy is the integral of the instantaneous power over a time interval. The International System of Units (SI) unit of active energy is Joule. An alternative, non-SI unit of active energy is Watt-hour (Wh) and is derived from the notion that energy is the equivalent demand value over a period of time.
Eskom Supply Areas	Geographical areas that purchase electricity from Eskom.
Fossil Fuels	A hydrocarbon-containing material such as coal, oil (refined into petrol and diesel), and natural gas, formed naturally in the Earth's crust from the remains of dead plants and animals that is extracted and burned as a fuel.
Load-shedding	Load-shedding is an energy utility's method of reducing demand on the energy generation system by temporarily switching off the distribution of energy to certain geographical areas.
Non-dispatchable Power	Generates electrical energy but cannot be turned on or off in order to meet societies fluctuating electricity needs.
Notified Maximum Demand	The maximum demand or capacity notified in writing by the consumer and accepted by the Service Provider as that which the customer requires the Service Provider to be in a position to supply on demand.
Prosumer	A prosumer is someone that both produces and consumes energy. In some cases, they may also provide energy services such as energy storage and demand flexibility.
Regulated Energy Market	The regulated market refers to that portion of energy sales (whether kWh or energy services, such as use of distribution services) where prices are approved through a formal application process submitted to the National Energy Regulator of South Africa. These prices are agreed to on a regular basis, often annually.
Renewable Energy	Power generated from one or more of the following sources: sun (Photovoltaic or Concentrated Solar Power), wind, water (Hydro power), and/or biomass (Landfill Gas, Biogas, Biomass).

SAIDI	System Average Interruption Duration Index (SAIDI) is a measure of how long a customer would experience sustained interruptions on average for a measurement period, typically a supply period of a year.
SAIFI	System Average Interruption Frequency Index (SAIFI) is a measure of how often a customer would experience sustained interruptions on average for a measurement period, typically a supply period of a year.
Unregulated Energy Market	The unregulated market adopts a 'willing buyer, willing seller' approach to price setting, without approval from a third party regulator, and is most often applied to the price that a private off-taker will pay a private energy generator for energy in a wheeling contract.

Chapter 1: The Vision: The Energy System we want

1.1 Vision Statement

The energy system is changing at a pace and scale not seen in generations, with these changes affecting every aspect of how energy is generated, distributed and used. South Africa is currently in an energy supply crisis, with higher stages of load-shedding being experienced across the country at increasing frequencies. The City of Cape Town is working with residents and businesses to take up every opportunity to limit the impacts of load-shedding and build an energy system that is resilient to a range of shocks and stresses over time.

In Cape Town, many indigent households do not have access to safe sources of energy and experience energy poverty, which severely limits their economic participation and well-being, and increases the risk of fires within informal settlements. The City of Cape Town recognises the role government plays in improving access to safe and affordable energy for all residents and the need to ensure that equity and inclusion remain core to our city's changing energy system.

This Energy Strategy therefore comes at a critical time to ensure that Cape Town can harness the opportunities available in a changing energy system, in partnership with residents and businesses. The strategy takes a system-wide perspective on energy, which means not only looking at electricity, for which the City currently has a significant mandate, but also engaging on broader energy-related matters over time.

Energy Strategy 2050 Vision
Energy security for a prosperous Cape Town: Together, we can build a resilient energy system where all residents and businesses have access to reliable, affordable, and carbon neutral energy services.

This Energy Strategy is in support of the current IDP vision (2022-2027) of a ***City of Hope for all* - a prosperous, inclusive and healthy city where people can see their hopes of a better future for themselves, their children and their community become a reality.** Cape Town's energy system is one of the core foundations of a healthy and prosperous city. Making Cape Town's energy

system more resilient and better able to deliver reliable, affordable and carbon neutral energy, is critical for the economic growth needed in order for more Capetonians to participate meaningfully in the economy and for their families to prosper.

1.2 Principles for Good Energy Decisions

The vision of energy security is achieved through the application of four principles across decisions related to the energy system. These principles guide good energy decision-making by the City and can be used by other stakeholders too.

Reliability

Definition:
Sufficient energy of a suitable quality is available when it is needed.

Application:
A reliable supply of energy to residents and businesses is critical for economic growth and poverty alleviation.

The reliability of energy is impacted by the stability and availability of the energy source as well as the network needed to transport and distribute energy to residents and businesses.

Affordability

Definition:
The ability of residents, especially indigent households, to pay for the energy services they need without compromising their ability to meet other basic needs.

The ability of businesses in Cape Town to pay for the energy needed to operate without undermining their viability and with predictable energy costs over time, providing for an enabling environment to start and grow businesses. The cost-effective supply of energy can be a significant competitive advantage for businesses to locate in Cape Town.

Application:
Affordability is driven by the price of energy services and the predictability of prices over time, the cost-effectiveness of energy services, and the ability to choose appropriate service options. It is important to consider an equitable approach to affordability, with eligible customers able to access direct energy subsidies that aid the achievement of affordability.

Carbon Neutrality

Definition:
After taking into account any potential carbon sinks (for example vegetation that absorbs carbon), the net greenhouse gas emissions from all energy sources are zero.

Application:
South Africa has a common, but differentiated, responsibility to contribute to the global effort to reduce greenhouse gas emissions, with the City of Cape Town being an important contributor to this effort.

Resilience

Definition:

A resilient energy system is one that can adapt to changes and disruptions, whether sudden or occurring slowly, and continue to deliver the energy services needed without causing significant harm to those who rely on it.

Application:
As adaptation takes place, the energy system could return to previous functionality or transform to offer a new type of functionality in order to meet the needs of users.

This is an important criteria to achieve energy security in Cape Town as the energy system is not static and will continue to evolve over time, sometimes in unpredictable ways. With many more stakeholders becoming active participants in the energy system and generating, consuming, storing and using energy in new ways, it is critical that the interests of any one stakeholder group do not undermine the ability of the energy system to provide reliable, affordable and carbon neutral energy to all who rely on it.

Chapter 2: The Context: The State of Energy

The energy system globally and locally is under a rapid phase of transformation due to the impacts of technology change, regulatory change, and climate change. There are a number of key global and local trends that influence how the energy system operates in Cape Town, both now and into the future. Beyond these known trends, there are also trends that have a significant impact, yet how these trends are going to behave over time is highly uncertain. Considering how the system will behave over time is important in building an energy strategy that can withstand and navigate changes and disruptions occurring across the institutional, financial, economic, environmental or technical components of the energy landscape. The City and other stakeholders will need to navigate both known and unknown trends in the energy system in order to deliver, enable, and partner with others to realise reliable, affordable and carbon neutral energy in Cape Town.

This chapter briefly describes both the known and uncertain trends and the potential impact of these on Cape Town's energy system over time. The Energy Strategy is built on assumptions based on the best information available at present. Over time, key data and information will be tracked to inform how these assumptions need to change and when the implementation of the strategy needs to be adjusted. It is important to note that this chapter will provide more detailed data on the electricity component of the energy system, in response to current City mandates and data availability.

The City of Cape Town has a wealth of energy data that is captured in the State of Energy & Carbon Report (2021) and available through the City's Open Data Portal. For a more in-depth description of the current state of the energy system in Cape Town, please refer to these resources.

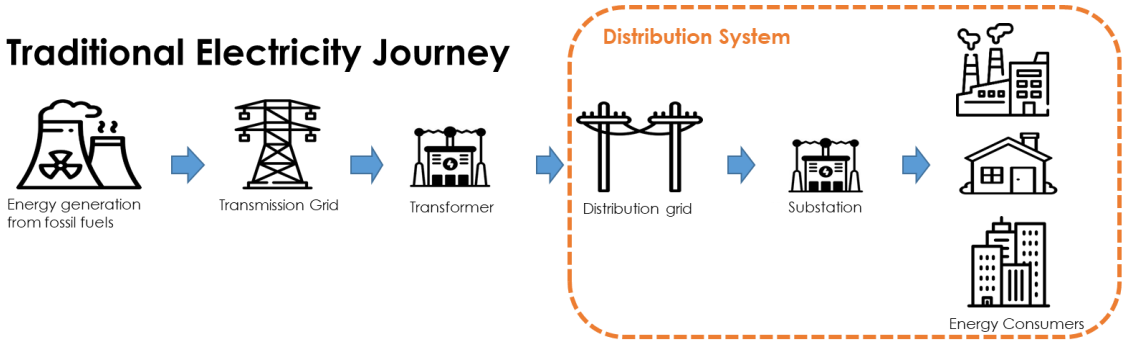
2.1 Global Trends

Globally, there are a number of megatrends being experienced in the energy sector. Cape Town's energy system is experiencing similar trends and must therefore respond to and prepare

for these appropriately. A brief description of these megatrends and their impacts are provided in this section. It is also important to note that while these trends are represented individually, they are, in fact, interdependent.

Digitalization	The digitalisation of energy systems speaks to the use of digital technologies across energy demand, supply, and distribution processes to enhance performance and cost effectiveness of operations, as well as communicate in real-time.
Decentralisation	Decentralisation, especially in electricity generation, in the energy sector has taken place both through shifts in regulation in South Africa and through the emergence of smaller, more modular energy technologies.
Disruptive Technologies	The rapid pace of technological innovation has resulted in the emergence of technologies that radically alter how our energy systems function.
Decarburization	The threat that climate change poses to humanity's prosperity and survival on Earth requires urgent efforts to reduce greenhouse gas emissions, while also adapting to the changing climate systems.
Democratisation	There is a growing demand from cities, residents, organisations, and communities to have increased participation in decision-making regarding energy: whether the source of energy, how energy is used, and the business models that govern the energy system.

Within the electricity sector in particular, these global trends are manifesting in significant changes to how the electricity system operates. The traditional electricity network (Figure 4) is built for a one-way flow of electricity from large, centralised power plants, to customers and assumes that customers would only consume electricity provided by the grid, known as a more passive role. Within this traditional energy system, there is a low level of monitoring and control as most issues are assumed to be dealt with in the design and planning stage. The future electricity network, however, should be able to accommodate a two-way flow of electricity at certain points, where a customer is both a producer and consumer of electricity, known as a prosumer and plays a more active role in energy management. This future network requires far greater levels of real-time monitoring and control with active system management as more issues are expected to arise during operations and must be responded to quickly.



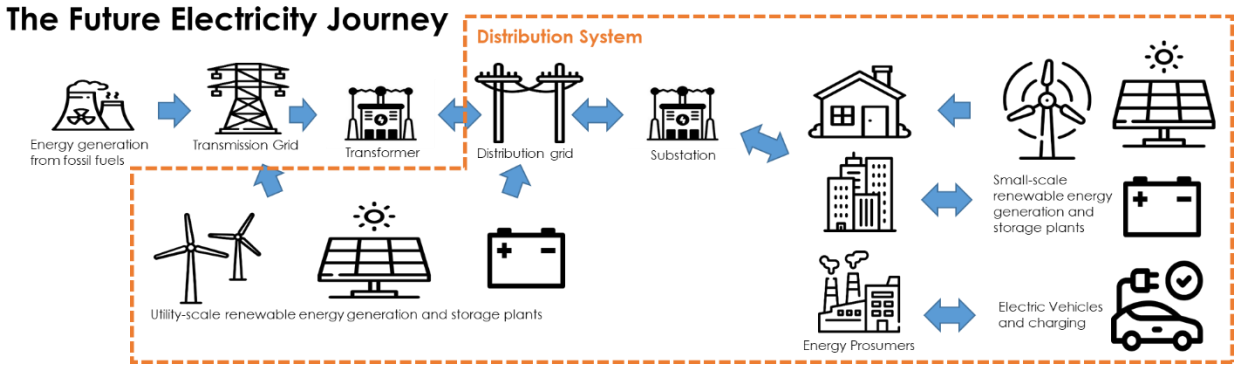


Figure 4: Moving from the traditional electricity system to the future electricity system. Adapted by author from https://www.cleanfuture.co.in/2018/07/03/dso-modernizing-the-power-grid/ using images from Flaticon.com

2.2 Local Trends

Change in Cape Town's energy system is interconnected with global or national energy trends. However, the way in which these trends manifest within a city are unique and therefore need to be understood as a basis for decision-making with the strategy. Through combining data from the four focus areas noted below, it is possible to establish a baseline of key shifts and stresses that are core components of the changing energy system in Cape Town.

The City of Cape Town anticipates a steady increase in population, with the majority of new city households expected to be in the lower income categories, with a low rate of economic growth over the foreseeable future. It is anticipated that energy demand will continue to be suppressed due to lower economic activity and growth in lower income customer segments that use less energy per capita. This will impact on the availability of financial resources to finance critical activities and projects needed to navigate the energy transition, along with ensuring sustainable sources of funding for subsidised energy services to lower income households.

Energy Governance	Historically, the governance of the South African energy system has been predominantly held by national government. With new regulations, this is now increasingly decentralised with a wider range of decision-making in the energy governance system, whether municipalities, residents and the private sector. The City also now has more levers available to take a stronger role in energy governnace within the municipal boundaries.
Energy Supply	In Cape Town, ESKOM has been the majority supplier of electricity, accounting for 99% of supply historically, with the City being the only reseller to customers. The electricity supplied is mainly from coal and has a very high grid emissions factor and carbon intensity. Load-shedding has resulted in there being an increase in disrupted electricity supply. Most new electricity supply is from renewable energy sources resulting in some decarbonisation. There has been a noticeable increase in small-scale embedded generation projects by customers and the emergence of wheeling between private generators and customers over the City's grid.

Energy Demand	Overall, energy demand in Cape Town has been increasing over time, with the energy demand reductions experienced during the Covid-19 Pandemic (2020 - 2021) rebounding. The daily demand for electricity is still characterised by high morning and evening peak loads. There has been a decline in electricity purchases from the City of Cape Town due to investments in energy efficiency and small-scale embedded generation, especially by higher income residential customers and commercial customers. With the increase in load shedding, there has been increased use of diesel and gas as alternatives to electricity.
Energy Cost	The cost of electricity is still regulated at the national level with above-inflation increases being experienced annually over the past 15 years - with the cost of electricity now being 400% greater than the cost of electricity in 2004. For liquid fuels, there has been an increase in price volatility due to supply chain disruptions and global geo-political shocks that have disrupted value chains across the world.

Electricity Supply Areas

Two electricity service providers[1] operate within the municipal borders of Cape Town, as shown in Figure 5, namely the City's Electricity Generation and Distribution (EGD) Department, and the national power utility, Eskom. Each of these entities holds an electricity distribution licence for a specific supply area in Cape Town. This means that approximately two thirds of electricity customers are served directly by the City of Cape Town, with the remaining third of customers served by Eskom.

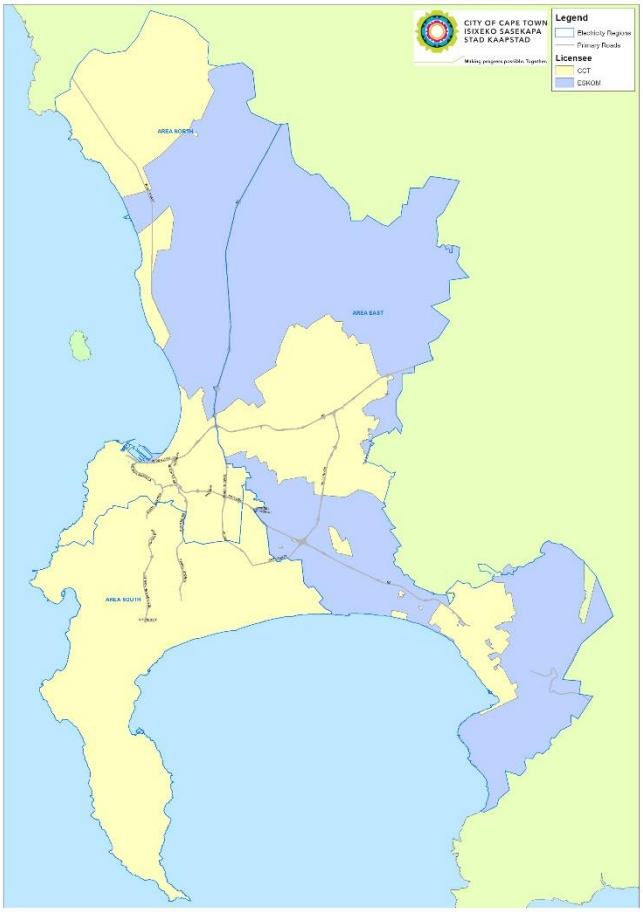


Figure 5: Licensed distribution service authorities - yellow is City Supply Areas and Blue is Eskom Supply Areas.

[1] In Cape Town, there is one distribution service authority with two licence holders, one being the City of Cape Town and the other Eskom

2.3 Critical Uncertainties and Key Assumptions

In developing this Energy Strategy, it was necessary to establish a set of assumptions around the critical uncertainties[2] that will have a significant impact on the energy system over the coming decade. The key assumptions described below provide a basis for decision-making for at least the next 5 years, if not longer. These key assumptions will be tracked and, where data indicates that the underlying trends have changed, the City will adapt the pace and prioritisation of the programmes outlined in this Energy Strategy, harnessing opportunities and limiting risks where it can.

Electricity Supply

Critical Uncertainties

- **Availability of electricity from Eskom:** The severity of the stages of load-shedding experienced nationally and the length of time that load-shedding is a necessary intervention due to electricity supply constraints. This factor is determined in large part by the performance of Eskom coal power stations over time (Energy Availability Factor), together with the rate at which new energy generation can be brought online and transported via the national transmission network.
    - *Data to Track: Eskom's Energy Availability Factor (EAF).*
- **Price trajectory and structure of Eskom electricity tariffs:** The degree of escalation in cost of electricity to customers, the changes in how Eskom charges customers and the City for electricity between fixed and variable charges, and the relative cost-effectiveness of other sources of electricity. This factor is determined in large part by the year-on-year increase in the price of bulk electricity from Eskom and the pace of the unbundling of Eskom Tariffs into fixed and variable charges.
    - *Data to track: Wholesale Electricity Price and other charges.*
- **Cost and availability of embedded energy supply:** The pace of new electricity supply becoming available on the City's distribution grid and the degree to which renewable energy makes up a growing share of Cape Town's electricity mix. This factor is determined in large part by the build rate for IPP and embedded energy generation plants within the City's distribution network, and storage technology options and costs.
    - *Data to track: Cape Town's Electricity Supply Profile (sources and quantities).*

Key Strategy Assumptions

- Consumers of energy are increasingly active participants within the energy system and must be supported to make good energy management decisions to use energy in a way that is beneficial to the energy system overall.
- The national electricity supply system will be highly constrained (average of 4 stages of load-shedding) in the short to medium term (5 -10 years) and will move to a status of moderately constrained (average of 2 stages of load-shedding) in the medium to long term.

[2] For the purposes of this Energy Strategy, critical Uncertainties are defined as those trends that have a high impact, yet have a high degree of uncertainty.

Electricity Demand

Critical Uncertainties

- **Total energy demand**: The total amount of electricity (kWh) demanded by Cape Town customers and what time of day this electricity is demanded. This factor is determined in large part by the total electricity demand from Industrial and commercial customers during the day and residential customers during peak periods in the morning and evening and the pace of growth in investments in energy efficiency and on-site small scale embedded generation (SSEG).
    - *Data to track: Cape Town's Electricity Demand Profile - Annual and Daily in Summer and Winter (per customer type and time of use) and electricity sales (per customer type).*
- **Proportion of customers receiving subsidised electricity:** Customers (e.g. SSEG Feed-in Tariff Incentive and Lifeline Tariff Customers) that do not pay tariffs that allow for full cost recovery and are cross-subsidised by other customers. This factor is determined in large part by levels of poverty and unemployment in Cape Town as well as the need to support the development of the SSEG market.
    - *Data to track: Percentage of total customers that are receiving a subsidy for Lifeline Tariff and SSEG Feed-in Tariff.*
- **Proportion of non-technical losses:** The extent to which the City can contain the losses from theft of electricity and infrastructure, often through illegal connections, and vandalism of infrastructure. This factor is determined in large part by increasing operational costs and associated increases in price of electricity, along with the speed of detection and response by the City.
    - *Data to track: Analysis of Electricity Loss and Damage Register and percentage of overall revenue attributed to non-technical losses.*

Key Strategy Assumptions

- The financial risk exposure of the municipal electricity utility is increasing in a rapidly changing energy system and therefore threatening the financial sustainability of the utility and the municipality more broadly.
- Subsidised customers will outpace the rate of growth of other customer segments with increased direct support needed for unelectrified households to access energy.

Electricity Governance

Critical Uncertainties

- **Market structure and governance arrangements:** The range of options available to municipalities in taking on the role of generator, distribution system operator, and enhanced retail functions. This factor is determined in large part by the pace and nature of regulatory and functional shifts and the degree of liberalisation within the electricity system.
    - *Data to track: Results of relevant court cases in South Africa, and new regulations and amendments to existing regulations governing electricity and energy.*

Key Strategy Assumptions

- The City does have a level of autonomy in shaping the local energy system through enhancing local electricity generation, distribution and retail capabilities, but cannot act fully independently as the Cape Town electrical system will be interconnected within the national electricity system in the long term.
- The City is able to take decisions on how to structure the governance of electricity distribution in Cape Town and is incrementally evolving the municipal utility's structure and functions in the governance of local supply, within the context of transitions in the national energy governance system.

Energy System

Critical Uncertainties

- **Petroleum fuel and gas price and availability**: The price and availability of petroleum fuel and the volatility of these over time. This factor is determined in large part by the accessibility of fuel through the international import market and the degree to which geo-political conflicts or shocks result in supply chain disruptions.
    - Data to track: Price and storage of petrol, diesel and gas in Cape Town.
- **International and local response to carbon intensity of Cape Town's economy**: The degree to which additional taxes are imposed in relation to national benchmarks for carbon intensity. This factor is determined in large part by global corporate carbon targets and the extent to which these impact on South African companies included in their supply chains.
    - Data to track: the price of carbon-related tariffs imposed on exports and imports to key markets, and the carbon targets of the largest corporations based in Cape Town.

Key Strategy Assumption

In the short term these uncertainties are not expected to have a significant impact on the energy system in Cape Town, but this may change in the medium to long term, particularly as the City considers an expanded role with regards to other energy sources.

2.4 Key Shifts and Stresses

In summary, the Energy Strategy has prioritised the following key shifts and stresses currently being experienced as primary informants to the design of the strategy and programmes discussed in the next chapter:

- Increased severity of load-shedding - electricity supply is unreliable;
- A changing electricity system disrupts traditional utility business models and sources of revenue;
- Above inflation cost increases for electricity have become the norm;
- Some residents have limited access to sufficient safe and affordable energy to meet daily needs which undermines their well-being and ability to participate in the economy;
- Consumers are playing a more active role in the energy system and should be supported to make good energy decisions;
- Energy use in Cape Town has a high carbon intensity.

Chapter 3: The Strategy: A Framework for Action

Using the key trends and assumptions as a base for decision-making, this chapter outlines the strategy that will be implemented to achieve the vision and key priorities over time.

3.1 Prioritisation Framework

The Energy Strategy takes a 2050 view on enabling, navigating, and driving changes within the energy system. The changes occurring in the different parts of the energy landscape will start to have an impact on the energy system as a whole, with the City of Cape Town's direct intervention in this transformation being achieved over three time horizons. Making use of a consistent set of principles over time, as described in the vision statement, ensures that short term priorities are implemented in such a way as to achieve, and not undermine, longer term objectives. For example, the City is increasing electricity supply from alternative sources, predominantly renewable energy, to meet up to 35% of maximum electricity demand in City Supply Areas by 2028. This represents a significant investment towards a carbon neutral energy system for Cape Town even in the short term, while also contributing to mitigating load-shedding.

Short Term (by 2026): Increase capabilities to mitigate up to 4 stages of load-shedding
Due to the current severity and frequency of load-shedding and the devastating impact this is having on the economy, it is necessary to prioritise interventions and investments that will directly contribute to stabilising electricity supply in the short term.

Medium Term (by 2031): Reforms implemented to maintain a modernised and financially sustainable electricity utility
In the medium term, a financially resilient and operationally efficient electricity utility is critical to ensure the long term provision of core utility services, such as network service provision and the continued provision of the energy social package to economically vulnerable households.

Long term (by 2050): Transforming the energy system to be carbon neutral
In line with global, national, and local climate commitments for carbon neutrality by 2050, it is critical that the carbon intensity of the energy system is reduced, as a major contributor to greenhouse gas production. This not only speaks to the sources of energy used, but also ensuring that the systems and value chains are in place to support a carbon neutral energy system.

The prioritisation framework also provides guidance on the structured application of the four energy principles, as shown in Figure 6. Currently, due to the energy supply crisis, pursuing a reliable supply of energy is the primary driver for investments as the energy system fails without this. Then, within the context of a sufficiently reliable energy supply, more affordable and carbon neutral energy become the primary drivers of investment decisions in the energy system. The principle of resilience remains constant and ensures that no decision compromises the ability of the energy system to adapt to changes and to continue to deliver services over time.

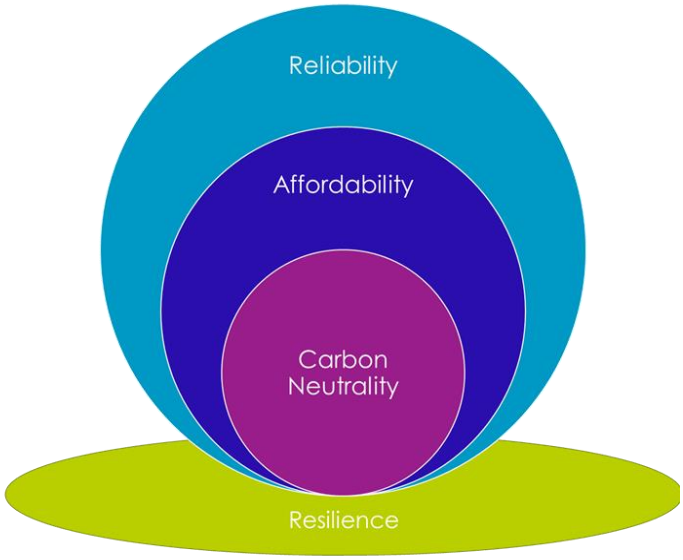


Figure 6: A diagram indicating the prioritised implementation of the Energy Strategy's four guiding principles.

3.2 Implementing the Strategy

The Energy Strategy is built upon three commitments, each underpinned by programmes that will deliver the individual outcomes that come together to achieve energy security for Cape Town. These three commitments are then underpinned by two cross-cutting enablers that are critical for delivery. A summary diagram of this is provided in Figure 7. The three commitments and two enablers are not independent areas of action, but rather are interrelated. This means that actions taken in one area may have implications for the opportunities and risks in another commitment or enabler.

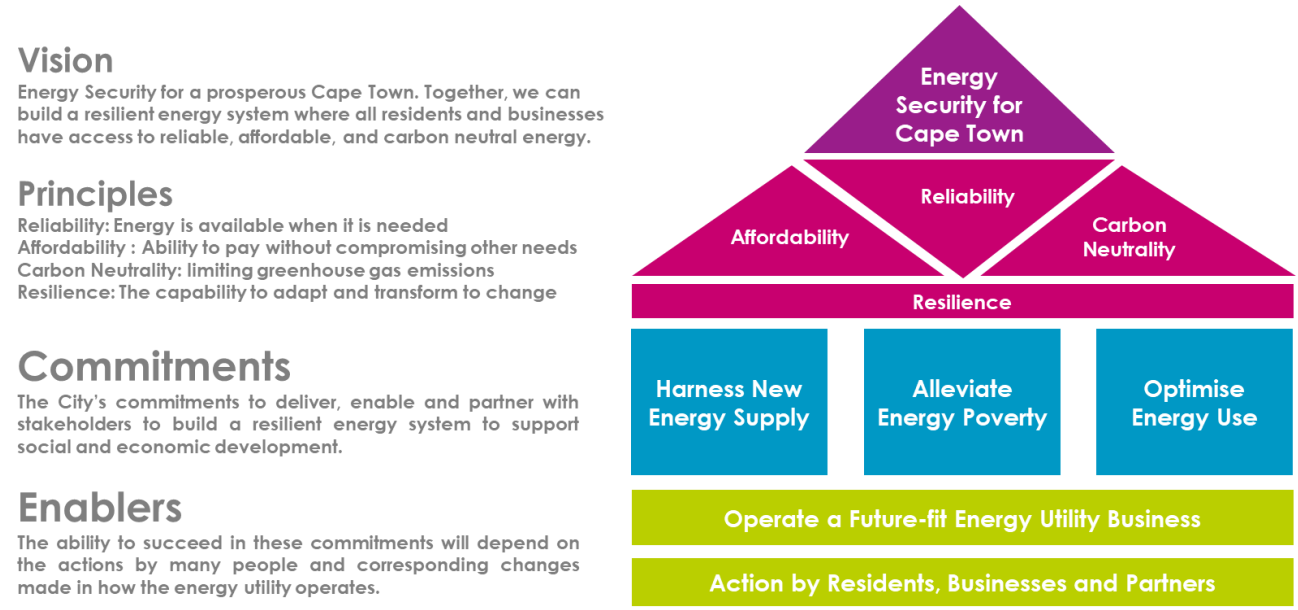


Figure 7: A diagram representing a summary of the structure of the Energy Strategy.

The Energy Strategy will be implemented through the development of a detailed implementation plan that assigns resources (budget and staff) to each programme with the responsible City department clearly articulated. This is further supported through the annually updated Energy Sector Plan that lays out the 10-year capital expenditure plan for the Energy Directorate. Targets and Key Performance Indicators will be refined, monitored and evaluated along with the overall progress on Energy Strategy implementation as guided by the Performance Management Plan that will also be developed.

Programme Focus: Electricity vs Energy

The majority of the programmes within this Energy Strategy focus on the electricity system due to the City's currently significant role and responsibility in the sale and distribution of electricity to a wide range of customers. In the short term, there are opportunities to further expand this role that need to be guided by this strategy.

There are however a few programmes where the focus goes beyond that of electricity and looks to other energy sources or the energy system more broadly. This is particularly where the City has a role in improving the reliability, affordability, and carbon neutrality of a broader set of energy sources and their use. In the longer term, as new energy technologies gain traction, it will be possible to take hold of opportunities at the utility scale that make use of alternative energy sources and technologies. This will allow the City to diversify its focus from predominantly electricity to other energy sources and their uses.

Understanding the City's Different Roles in the Energy System

The Energy Strategy outlines three main roles for the City of Cape Town within the energy system:

- Deliver: The City leads the intervention of activities that will achieve the desired outcome;
- Enable: The City provides support to the stakeholders who lead the implementation of the interventions that will achieve the desired outcome;
- Partner: The City works closely with other stakeholders to jointly implement the interventions that will achieve the desired outcome.

Across all three roles there may include actions that require the City to advocate for change where another stakeholder, such as the national government, holds the mandate to take action on a matter that directly affects the energy system in Cape Town.

Alignment with other City Strategies

The Energy Strategy is informed by and aligns with existing City Strategies, such as the Integrated Development Plan 2022 - 2027, the Climate Change Strategy, the Water Strategy, the Human Settlements Strategy, amongst a number of others. An analysis of this alignment is represented in Annexure A in the Addendum.

3.3 Applying the Energy Strategy in different Electricity Supply Areas

The Energy Strategy applies to all energy users and stakeholders within the municipal boundary of the City of Cape Town; whether permanent or temporary. For electricity, as there are two distribution authorities, the City has different levers available to affect change depending on the

location of a customer. Across all commitments, the role of the City of Cape Town in City Supply Areas is more direct with a focus on planning, partnering, and delivery. In Eskom Supply Areas, the City would take on a role that focuses more on engagement, alignment, and advocacy.

3.4 Priority Implementation Programmes

By applying the Prioritisation Framework to the implementation of the four commitments outlined above, certain programmes are prioritised across the above mentioned time horizons in order to meet the agreed time-bound goals:

	No.	Programmes	Short Term: Load-shedding Mitigation	Medium Term: Utility Reform	Long Term: Carbon Neutral Energy
Commitment 1. Harness New Energy Supply	1.1	City-initiated Energy Generation	X	X	X
	1.2	Utility-scale Energy Storage	X	X	X
	1.3	Private-led Energy Generation	X	X	X
	1.4	Energy Wheeling and Trading	X	X	X
Commitment 2. Alleviate Energy Poverty	2.1	Energy Subsidy Reform		X	X
	2.2	Informal Settlement Electrification		X	X
	2.3	Informal Settlement Public Lighting		X	X
	2.4	Energy Service Innovations for Backyard Dwellings		X	X
Commitment 3. Optimise Energy Use	3.1	Energy Efficient City Services	X		X
	3.2	Improved Building Energy Performance	X		X
	3.3	Enhanced Demand Response	X	X	X
	3.4	Support Uptake of Electric Vehicle			X
Enabler A. Operate a Future-fit Utility	A.1	Institutional and Workforce Reform		X	
	A.2	Tariff and Financial Reform		X	X
	A.3	Infrastructure and Technology Reform	X	X	X

	A.4	City-level Energy Planning	X	X	X
Enabler B: Action by Residents, Businesses and Partners	B.1	Energy Awareness and Engagement	X	X	X
	B.2	Energy Data Access	X	X	X
	B.3	Energy Services Industry Support			X

3.5 Detailing the Short Term Priority Area: Load-shedding Mitigation Strategy

The escalating severity of load-shedding in South Africa is the most pressing issue limiting our ability to achieve energy security in Cape Town at present. For planning purposes, the City of Cape Town has taken a cautious outlook on the national electricity supply constraints and this strategy is built on the assumption that load-shedding will continue at an average of Stage 4 until 2032 and reduce to an average of Stage 2 for a further five years thereafter. The City of Cape Town has set the ambitious goal of protecting City of Cape Town customers from ***up to 4 stages of load-shedding, for a portion of the day based on technical and financial feasibility, between 06:00 - 22:00 on weekdays by 2026*** in order to limit the associated negative economic and social impacts across the city. This strategy contains a set of interventions that will deliver on this goal.

In practice, the City will intervene to mitigate the impact of load-shedding across three scales as indicated in Figure 8 below:

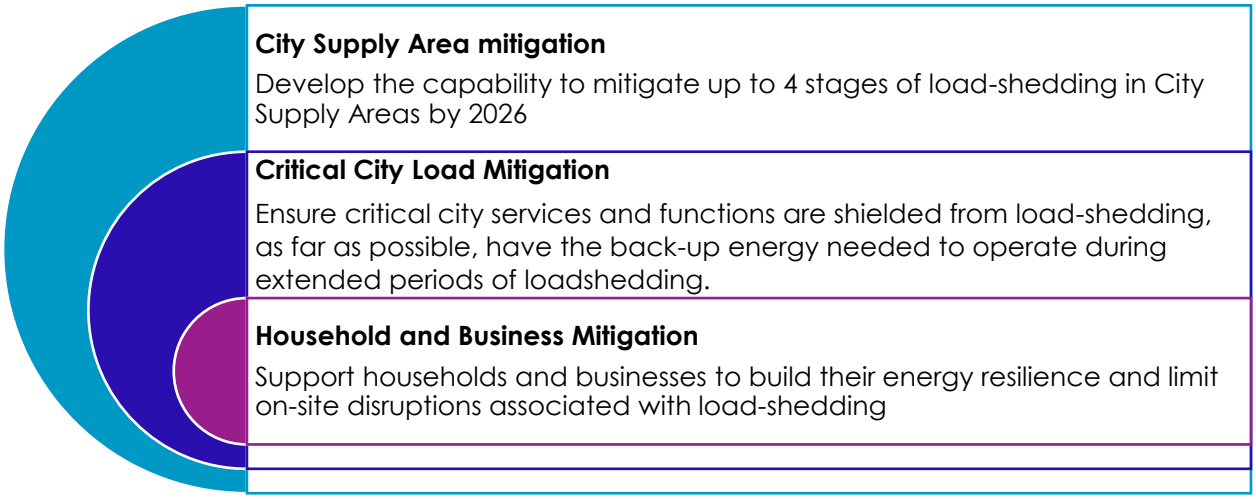


Figure 8: A diagram representing the three scales of intervention for the load-shedding mitigation programme implemented by the City of Cape Town.

Load-shedding mitigation undertaken by the City of Cape Town makes use of a combination of one or more of the prioritised interventions listed in the table below. It is necessary to note that the ability of the City of Cape Town to mitigate load-shedding outside of the City Supply Areas is

limited, however any mitigation efforts undertaken will also have a broader benefit by reducing strain on the national energy supply system.

Scale of Impact	**Intervention**	**Stages of Load-shedding Mitigated**	**Availability**
City Supply Area Mitigation	Use of stored power from Steenbras Hydro Pumped Storage Scheme: 4 x 40 MW turbines, with 50% capacity (80 MW) reserved for load-shedding mitigation.	1 stage of load-shedding mitigated with up to 2 stages for short periods of time.	Currently available within the constraints of ongoing planned maintenance and a major refurbishment project.
	Up to 500 MW of dispatchable energy purchased from Independent Power Producers (IPPs).	Up to 4 stages of load-shedding mitigated, for a portion of the day based on technical and financial feasibility.	First power from IPPs expected in 2026, to allow time for the power plants to be built and commissioned, with a minimum contract period of 10 years.
	Interruptible power/ Demand Response (minimum of 60 MW): Large Power Users (LPU) Curtailment Residential Demand Response Aggregation (Power Heroes)	Up to 1 stage of load-shedding mitigated for short periods of time.	LPU curtailment is currently active but will be enhanced to increase the amount of interruptible power available. Residential Demand Response Aggregation to be fully active in 2025, after a 2-year ramp-up period.
Critical City Load Mitigation	• Implement a battery energy storage pilot at critical loads. • Invest in generators at pump stations, WTP, WWTW, key office sites. • Develop Stage 8 / black out recovery plans for all departments to ensure business continuity. • Expand and invest in energy efficiency, renewable energy, and storage at critical loads.		

Household and Business Mitigation	• SSEG Registration Streamlining through an online registration system. • Load-shedding Communication Campaign: Supporting good decision making for the installation of back-up power systems, such as batteries and UPS. • Wheeling pilot launched then rolled out. • Enable commercial net generation. • Enable residential net generation.

It is important to note that the dispatch or use of the interventions at the City Supply Area scale is carefully administered by the City of Cape Town in accordance with the following:

- The national grid code, NRS 048-9;
- The current need for load-shedding mitigation in terms of severity and time span;
- The forecasted need for load-shedding mitigation;
- The availability of energy from each intervention, and
- The budget available to pay for these additional energy services, amongst other factors.

This means that although the City of Cape Town will always seek to maximise the number of load-shedding stages mitigated (up to 4 stages), the actual number of stages mitigated may vary on any given day due to the combination of factors noted above. This strategic approach to mitigating load-shedding allows the City to balance concerns regarding energy availability and affordability in order to have the greatest positive economic and social benefits from the additional costs associated with implementing these interventions.

Chapter 4: Energy Strategy Commitments and Programmes

In this chapter, each commitment is unpacked by providing:

- The strategic shift embodied through action in this commitment;
- A description of the commitment;
- Key goals for the commitment to achieve in the next 5 years;
- Consideration for how this commitment is implement across the municipal area in the two electricity supply areas;
- The outcomes of this commitment that can be achieved through the contributions and activities of many energy system stakeholders;
- A description of the programmes, noting the outcome, the City's role, and Key City Action Areas;
- Case Studies that demonstrate how the commitment builds on existing work.

4.1 Commitment 1: Harness New Energy Supply

Where We Were	**Where We are Going**
From the centralised supply of unreliable and costly energy, relying mainly on fossil fuels…	…To an increasingly decentralised supply of reliable and cost-effective energy, relying on carbon neutral sources of energy, and with the

	City and customers purchasing energy from a diverse range of energy suppliers.

The City is committed to using all available levers to support and enable the use of new electricity sources and technologies, in order to make the energy system more resilient. The expectation is that with more suppliers, the City will have a lower exposure to the risk of any one particular energy supplier failing. The levers available to the City to harness new energy supply include:

- Building, operating and maintaining generation assets that are owned by the City using internal skills;
- Contracting and partnering with the private sector to deliver and operate generation assets that the City would ultimately own, fully or in part;
- Entering in to power purchase agreements with independent power producers for an agreed minimum capacity for a fixed term at a fixed price;
- Developing and streamlining the systems and processes needed to support customers to access private generation using the City's network safely or to legally install onsite generation.

Going forward, the City will make infrastructure investment decisions which deliver multiple benefits for the electricity system, including network stability and the management of electrical loads to ensure the matching of electricity demand and supply. In the longer term, as alternative types of energy, such as hydrogen, become financially feasible, the City will explore the benefits and applicability of these alternatives and the role of different stakeholders in their supply and use.

In order to gain a deeper understanding of the possible electricity supply mix for City Supply Areas, a scenario development and analysis process was undertaken to inform decision-making; most notably the impact of load-shedding and scenarios for electricity supply. The results of this can be seen in Annexure B in the Addendum.

The key takeaways from the development of these scenarios for the development of this commitment include:

- Without intervention from the City of Cape Town, customers in City Supply Areas would experience greater frequency and severity of load-shedding;
- Cape Town will, in part, continue to source electricity from Eskom in the long term – but not return to the current state of 99% reliance on Eskom;
- The role of the City as a bulk reseller of electricity is reducing as there is an increasing range of supply options available to customers;
- There are a diversity of decision-makers who now influence the electricity supply in City supply areas;
- There is a critical decision-making point around 2030, where the City will need to think through the optimal supply programme up to 2050 and whether to rely on public or private-led interventions (or a combination of these) to further reduce reliance on Eskom as an electricity supplier, with this decision being made on the basis of the relative costs of the different supply options;

- Consideration of the energy mix on a daily basis is critical – there is a need to balance the time of supply of different generation sources with the demand profile of different electricity customers. Not planning appropriately for this can result in significant costs for grid upgrades and ancillary services.

This commitment unpacks the City programmes relating to the development of new city-owned generation and storage assets with the maintenance and refurbishment of existing assets, the procurement of additional electricity from private generators, the provision of electricity wheeling and trading service, and the enabling of SSEG.

Given the current electricity supply crisis and that the City of Cape Town plays a primary role in the supply of electricity as a distributor, it is justified that this commitment focuses on electricity supply in the short-to-medium term with an expanded focus on other energy sources in the medium-to-long term.

Outcome

Cape Town's energy demand is met by a reliable and cost-effective supply of increasingly carbon neutral energy from multiple energy suppliers, with new energy sources introduced to the benefit of residents and businesses.

In the short to medium term, the focus is on increasing the supply and storage of electricity from a range of public and private sources in response to the current scarcity of electricity supply due to load-shedding. In the longer term the focus is exploring the use of new energy sources whether for direct use or for power generation.

Applying this Commitment across the City Supply Area and Eskom Supply Area in Cape Town

As an electricity utility, the City is in a position to facilitate an optimal supply to its customers. This commitment therefore only applies to City Supply Area electricity customers in the short to medium term. It is important to note that any additional installed capacity initiated by the City of Cape Town does reduce reliance on the overburdened national generation fleet thereby also benefiting the broader energy system in South Africa and therefore Capetonians in Eskom Supply Areas too. Where new energy types are considered by the City, the decisions regarding distribution and supply of these may apply to the whole municipal area.

Goals to be achieved within the next 5 Years

Where an earlier date is targeted for these goals, this is stated.

- Facilitate increased access to electricity from alternative sources to meet up to 35% of maximum notified demand in City Supply Areas. This equates to approximately 650 MW of energy from small-scale embedded generation, city-owned generation, wheeling arrangements and purchases from IPPs.
- Develop an online registration form for Small-scale Energy Generation (SSEG) applications to streamline the process for customers by the end of 2024.

- Contribute to mitigating load-shedding across City Supply Areas by up to 4 stages through making available a range of dispatchable energy supply options by the end of 2026.
- Mitigate impact of load-shedding at critical city loads through the provision of on-site power generation and/or onsite energy storage.
- Implement wheeling through the establishment of the required systems and processes for these new City energy services.
- Implement systems and related technical requirements to make it easier for SSEG prosumers to feed electricity in to the grid by the end of 2024.
- Contracting and design of the refurbishment of Steenbras Hydro Pumped Storage Scheme.
- Decommission and plan for the repurposing of the Athlone Power Station Site.

4.1.1 Programme 1.1: City-initiated Energy Generation

The City of Cape Town is currently a bulk reseller of electricity to residents and businesses located within City Supply Areas. This programme considers how the City has a responsibility in this role to source a reliable and cost-effective supply of electricity to residents and businesses through buying and enabling alternative sources of supply other than from Eskom.

The City is initiating new dispatchable and non-dispatchable generation assets both connected to the distribution grid, known as embedded generation, as well as connected to the Eskom transmission or distribution grids to harness the energy resources available within the municipal boundary and neighbouring regions. This not only includes ground mounted, rooftop and floating solar and waste to energy projects, but also exploration into wind, biosolids and sludge beneficiation, and small hydropower turbines. Looking further into the future, there are opportunities for new types of fuel, such as hydrogen, which the City commits to investigating to understand the role of different actors in these new energy value chains and how these energy types can benefit the local energy system more broadly.

Importantly, while new generation projects may be initiated by the City, the best-suited contracting arrangements will be established per project based on the long term cost-benefit to residents and businesses over the full operational life of the asset. This raises the opportunity for the City to develop these projects internally using city resources, to appropriately partner with the private sector to deliver these generation projects and/or to consider purchasing power from independent power producers through a power purchase agreement.

Principles for Energy Supply

Due to the increasingly competitive and fast-changing nature of the energy generation sector, supply technologies cannot be pre-determined, but rather need to be considered based on a number of contextual factors and responses from the market within the parameters of the following principles:

- New supply must not undermine the reliability of supply to customers;
- Most cost-effective energy over the lifetime of supply;

- Fairly and transparently apportion the cost of new supply to customers over time (cost of new supply must as closely as possible align with the timeframe of the benefit received from the new supply);
- New supply must support price predictability and must not introduce increased price or supply volatility in to the energy market;
- New supply must not worsen the local grid emissions factor and/or decrease air quality in Cape Town.

Outcome

The City buys power from the private sector, develops its own generation plants and drives the adoption of innovative energy technologies to facilitate the bulk supply of lower carbon, cost-effective, and reliable energy.

City's Role

Deliver

Key City Action Areas

- Procure and manage energy supply contracts (Power Purchase Agreements) with IPPs to increase the number of suppliers that provide electricity to Cape Town.
- Identify and release appropriate City-owned land for generation plants directly connected to the municipal distribution grid.
- Maintain and optimise the use of existing generation assets to supply electricity for municipal service delivery and limit the impact of load-shedding - including the Coastal Park Landfill Waste-to-Energy Plant and pursue the development of waste to energy plants at other landfills.
- Develop generation projects on City land and facilities to increase Cape Town's renewable energy and dispatchable electricity supply, including:
    - Large-scale solar PV and wind projects on City land;
    - Small hydropower and Floating Solar PV at water treatment plants;
    - Electricity generation from landfill gas extraction at waste disposal facilities;
    - Expand the SSEG programme for municipal facilities;
    - Open-cycle gas turbines and associated value chains in the Western Cape.

Case Study: Floating Solar Pilot

The City of Cape Town has become the first municipality to install a floating solar photovoltaic (PV) system with partners Floating Solar (Pty) Ltd, the Water Research Commission (WADER accelerator) and the University of Cape Town. The floating solar PV pilot, which has been established at the City's Kraaifontein Wastewater Treatment Works, includes a 3.51kWp floating solar PV array as well as a same-sized ground-mounted PV system to determine evaporation savings and relative energy generation performance of floating solar PV technology. This is an innovative research study where data is being collected over a 12-month period to potentially inform the design of larger, utility-scale floating solar PV projects over the next few years through competitive bid processes.

4.1.2 Programme 1.2: Utility-scale Energy Storage

The City of City Town has successfully operated the Steenbras Hydro Pumped Storage Scheme (180MW) for over 40 years. This plant has ensured a cost-effective supply of electricity to Cape Town through generating electricity at peak time, thereby offsetting purchases from Eskom when the cost of electricity is at its highest; known as arbitrage. During the energy supply crisis, Steenbras Hydro Pumped Storage Scheme has been a primary tool to limit the number of stages of load-shedding experienced by customers in City Supply Areas.

Further to these current uses, energy storage is increasingly becoming a critical component of the energy system as the amount of energy sourced from renewables increases. Solar and Wind energy is variable and needs to be accompanied by energy storage to provide a consistent and balanced supply of energy to meet demand, especially at peak times. Diversifying the storage technologies available in Cape Town is an important step in adapting the city's energy system to climate change. Currently, the only storage system available relies on the plentiful availability of water and, with decreasing rainfall expected in Cape Town due to climate change, this system is at risk of not performing to its full capacity.

New utility-scale energy storage technologies, such as batteries, are decreasing in cost and are now being explored by the City for deployment to mitigate load-shedding at critical City services in the short term, and provide the necessary ancillary services in the medium to long term. Further to this, the City may explore opportunities for new regional pumped storage schemes in partnership with other municipalities and the private sector.

Outcome

The City mitigates the impact of load-shedding by optimising the use of the Steenbras Hydro Pumped Storage Scheme and installing new battery energy storage systems at critical City services. In the longer term, the City explores the development of new energy storage solutions that provide ancillary services to enhance distribution system functionality and manage distributed and embedded energy resources.

City's Role

Deliver

Key City Action Areas

- Continue to mitigate the impact of load-shedding by optimising the use of the Steenbras Hydro Pumped Storage Scheme.
- Install new battery energy storage systems at critical City services to protect these services from load-shedding.
- Investigate city-scale energy solutions to improve load management capabilities in response to greater variability in demand throughout the day.
- Investigate the feasibility of additional regional pumped storage schemes in partnership with other municipalities and the private sector.

4.1.3 Programme 1.3: Private Sector Embedded Generation

Private Sector-led embedded generation in Cape Town is a growing part of the energy system that provides residents and businesses with the opportunity to, in part, supply their electricity from on-site energy sources. These systems are typically up to 1 MVA, known as small-scale embedded generation (SSEG) and are directly connected to the distribution grid. These systems produce electricity to be primarily consumed on-site, with unutilised energy exported to the grid at the approved SSEG Feed-in Tariff. This follows the international trend of a growing base of 'prosumers' who both produce and consume energy.

With load-shedding an ongoing reality, there has been a rapid increase in the interest in the installation of photovoltaic (PV) systems with batteries to protect households and businesses from load-shedding. It is critical that all embedded generation systems installed are registered with the relevant Distribution Authority. For SSEG installations in City Supply Areas, read Requirements for Small-Scale Embedded Generation, to ensure the safe operation of the grid and the safety of staff who maintain it.

The number and overall capacity of SSEG systems is rapidly increasing. The total number of approved grid-tied SSEG installations in Cape Town in September 2022 was 2719 with a total capacity of 87.28 MVA, with the residential sector accounting for 13% of total capacity and the commercial and industrial sector accounting for 87% of total capacity. Almost all the systems installed were PV, but there is a growing interest in wind energy as the generation technologies improve. Since the start of 2023, there has been a marked increase in the number of SSEG application submitted to the City, with approximately 1000 applications received every 6 weeks.

While SSEG (<1 MVA) is most common at present, the City is expecting an increase in connection requests for larger scale systems due to the lifting of licensing requirements by the National Department of Mineral Resources and Energy. Therefore, the SSEG system and processes established will be the foundation upon which future systems will be developed for larger-scale embedded generation.

Outcome

Residents and businesses are empowered to generate their own electricity and sell their excess supply, with distributed energy resources integrated safely into the grid.

City's Role

Enable

Key City Action Areas

- Continue to develop and improve an easy-to-use and transparent connection registration system so that SSEG systems are safely integrated in to the distribution grid.
- Continue to improve the mechanisms to enable the City to purchase net energy generation from SSEG and ensure that SSEG customers are charged fairly for grid services provided by the City.
- Work with the SSEG industry and advocate for national standards and processes that promote SSEG and enable high quality installations.

4.1.4 Programme 1.4: Energy Wheeling and Trading

Wheeling is the financial transactions representing the transportation electrical energy (kWh) over the City's distribution network which allows for a third party supplier to sell electrical energy to a City customer directly. A benefit of wheeling is that it can facilitate the increased consumption and supply of renewable energy in Cape Town.

In 2022, the City of Cape Town implemented a Wheeling Pilot involving 25 generators, 40 customers and over 350 MW of electricity to be wheeled over the City's network. The lessons learned from this pilot are being used to optimise the process and tariff structure, and then roll-out a larger programme. It is however important to note the City is currently undertaking this work in the context of limited national regulations to govern wheeling.

In the medium to long term, the City is using the wheeling processes to better understand how an energy trading market may be established and the most appropriate role and processes for the City. With energy trading, there is significant opportunity for private third-party service providers to sell electricity directly to a pool of customers, while the City focuses on the retail services for the use of the distribution grid infrastructure. This is a necessary distinction due to the need for high levels of agility and flexibility, as well as rapid or real-time response in the energy market that the City is currently not geared to undertake within municipal financial regulations.

Outcome

Customers and aggregators are able to wheel and trade electricity across the City's distribution network as made possible through the adoption of the necessary contractual and technological arrangements, and the application of cost-reflective use-of-system charges.

City's Role

Enable

Key City Action Areas

- Establish a wheeling contract management system, associated tariff, regulatory approvals and the necessary internal staff capacity.
- Research and develop appropriate mechanisms for an energy trading platform and market demand for such a service.
- Explore opportunities to facilitate third-party retail pool aggregation services and implement if feasible.

4.2 Commitment 2: Alleviate Energy Poverty

Where We Were	Where We are Going
From indigent households and informal settlements experiencing energy poverty on a regular basis, with some having limited access to grid-connected	…To a wider range of interim energy service offerings and enhanced access to energy subsidies in indigent households and informal settlements to alleviate energy poverty.

electricity services and related subsidies available…	

Energy poverty refers to a lack of access to clean, safe and affordable energy and has severe social and economic consequences. Energy security across all socio-economic brackets in the city is critical to ensuring equitable support for economic growth, poverty alleviation and improved well-being in Cape Town. Energy poverty is a critical challenge that limits the achievement of the vision of this Energy Strategy for energy security in Cape Town. As indigent households and those located in informal settlements and backyard dwellings are the most vulnerable to experiencing energy poverty, it is necessary to implement a specific set of programmes targeting this category of households.

This section unpacks the ways in which the City seeks to enable energy poverty alleviation across the municipal area. This is with the City not only as an agent of service delivery, but also as a partner and enabler of access to energy services. The subsidy and electrification programmes captured in this commitment focus on residents in City Supply Areas, with strong partnerships with Eskom required to see a radical shift towards alleviating energy poverty across all of Cape Town.

Understanding Energy Poverty

Energy poverty takes different forms - accessibility, reliability, and affordability and not just a lack of service or choice, need to be taken into account. The impacts of energy poverty include adverse health outcomes associated with exposure to cold and heat, respiratory and pulmonary diseases from exposure to air pollution, limits to hours of study for children in education, limits to current and future economic productivity, and malnutrition due to not enough energy to cook nutritious food. The lack of access to clean, safe, and affordable energy is associated with gender inequality as women are typically responsible for managing household activities, like cooking, that are dependent on energy.

In Cape Town, energy poverty can be classified as not having access to grid electricity (the highest level of energy service offered) and therefore also not having access to any form of subsidised energy services, as well as the inability to pay for sufficient safe and clean energy to meet your needs throughout the month, even if the household is connected to grid electricity. Energy poverty is therefore experienced in a variety of ways by different types of households:

- Households in informal settlements that are grid connected;
- Households in informal settlements that do not yet or cannot be connected to the electricity grid;
- Formal households who qualify as indigent and have a grid connection;
- Informal additional dwellings located in the backyards of formal housing properties, whether on public or private land, that do not have a direct connection to the electricity grid and the related individual meter.

Access to energy is an essential component of contemporary urban life. However, due to a range of socio-economic conditions, not all residents have access to the energy required to

meet their daily needs and therefore experience energy poverty. More broadly, the financial sustainability of the City's electricity utility must be preserved to ensure its continued ability to provide a range of subsidised energy services to those who need it most.

The Social Support Package for Electricity:

In City Supply Areas, the City of Cape Town automatically allocates monthly free basic electricity (FBE) to about 189 000 qualifying households who are also on the subsidised Lifeline Tariff. This package is made available through the City's Indigent Relief Measures contained in the Credit Control and Debt Collection policy (2022/2023) and National Free Basic Electricity Policy (2003). The Lifeline Tariff is a special, highly subsidised tariff intended to provide relief to prepaid customers with limited means. In addition to the Lifeline Tariff, the City also subsidises the network costs for the operation and maintenance of each household connection.

In Eskom Supply Areas, the City provides the financial allocation for Free Basic Electricity to Eskom who then disburses it to registered indigent households on their distribution grid. A subsidised Homelight Tariff is available to households whose supply is limited to a maximum of 20A connection without any further qualifications. Approximately 40% of households that receive the FBE subsidy are located in Eskom Supply Areas. This figure has been increasing over the past few years, from about 24% in 2012 to about 40% in 2018.

Outcome

Indigent households and communities in informal settlements are supported to access a range of safe and cost-effective energy services to meet their daily needs for improved well-being and increase economic participation.

Goals to be achieved within the next 5 Years

- Continue to uphold high electrification rate of informal settlements, where permissible.
- Establish robust datasets to inform targeting of grid enhancements and subsidy reform.
- Free Basic Alternative Energy Policy and Implementation Design.
- Pilot alternative public lighting solutions for unelectrified informal settlements.

4.2.1 Programme 2.1: Energy Subsidy Reform

Many indigent households and those located in informal settlements remain largely in a position of energy poverty. This is despite high household electrification rates in the City and most of these households receiving the above mentioned energy social package. While energy poverty is often a symptom of greater economic hardships faced by households, the City is committed to leveraging existing and new mechanisms within the energy sector to reduce the experience of energy poverty in Cape Town over time.

The City provides an energy social package to qualifying households, whether directly or via Eskom depending on the supply area. The package consists of subsidised grid connections and electricity available at a subsidised tariff, which is combined with a free basic electricity (FBE) allocation. The National FBE allocation has been stagnant at 50 kWh/month since its introduction in 2003, despite growing energy demand in indigent households. This, combined with Lifeline

and Homelight Tariffs including a VAT tax charge, reduces the impact of the energy social package in terms of alleviating energy poverty.

The funding for this energy social package is sourced from the National Equitable Share Grant and a cross-subsidy collected through the sale of electricity in other tariff categories. These sources of funding are increasingly being constrained due to a reduction in electricity sales, the pressure of population growth, and other basic service requirements on the equitable share grant.

Currently, the City of Cape Town has no mechanism which allows for the delivery of interim and alternative basic modern energy services in informal settlements that cannot be electrified or that are awaiting electrification. The waiting list for electrification is growing due to the pace of informal settlement growth being greater than the pace that electrification can be provided. These circumstances impose a costly burden on the households, communities and on the City in terms of high energy costs, health, fire, crime, marginalisation and discontent. The lack of access to grid electricity means that they are unable to benefit from subsidised electricity tariffs and access free basic electricity. It is therefore necessary to explore mechanisms available to disburse a subsidy for non-grid connected energy sources, such as gas, home solar systems, and/or micro-grids to contribute to alleviating energy poverty in unelectrified settlements.

Outcome

An optimised and diversified energy subsidy regime that has a sustainable source of funding and allows unelectrified households to access a range of safe and clean energy sources.

City's Role

Deliver

Key City Action Areas

- Continuously build a deeper understanding of the impact of subsidised electricity provision on energy poverty and the degree of improvement to the life chances of households receiving this subsidy.
- Optimise how the energy social package is disbursed, including the value of the subsidy, eligibility criteria, the inclining block tariff, and the time of the month where the free electricity is allocated.
- Advocate for the National Government to increase the funding available and quantum of the Free Basic Energy allocation that is disbursed to indigent households, and explore alternative funding streams for the energy social package to compensate for both the uncertain long term trajectory of grant funding and the decreasing electricity sales.
- Advocate for excluding VAT Tax from Lifeline and Homelight Tariff customer categories to maximise the amount of energy received by indigent households when purchasing electricity.
- Establish a service model, funding source and vending system for the provision of a Free Basic Alternative Energy Subsidy to qualifying households who are not connected to the electricity grid.

4.2.2 Programme 2.2: Informal Settlement Electrification

When considering household access to electricity for lighting, the City of Cape Town achieved an electrification rate of 98% in 2018. The City is one of four metropolitan councils to achieve this rate in the country. The percentage of formal households using electricity for lighting stood at 100%, while informal households stood at 91%.

The City is committed to increasing access to grid electricity for residents living in informal settlements located in City Supply Areas, and will work with Eskom to address electrical connection backlogs in informal settlements located in Eskom Supply Areas. Trends in housing provision over time suggest that the City could see the majority of housing being of the informal type by 2030.

Investments in the provision of electricity within informal settlements form part of a suite of basic services provided by the City to enable the sustainable development of neighbourhoods over time. Within their respective areas of supply, the City and Eskom are responsible for providing a subsidised and/or free electrical grid connection to informal dwellings where site and land ownership conditions allow for this. Once access to grid electricity has been provided, there is no distinction between the quality of supply and service levels to informal and formal residential areas in City Supply Areas.

Case Study: City Electrification Programme Successes

The City of Cape Town is committed to ensuring that all residents have access to energy services. In July 2022, the City's Electricity Generation and Distribution Department completed more than 400 connections to the City's electricity grid in Masiphumelele. This R2.6 million project will immediately improve the living conditions of residents in the area and it will open the doors of learning for students who no longer need to study by candle or lamp light.

Outcome

In line with informal settlement upgrading processes, eligible unelectrified settlements across Cape Town have access to grid-supplied electricity to promote sustainable settlement development.

City's Role

Deliver and Partner

Key City Action Areas

- Where electrification is possible, households in informal settlements are provided with a metered electricity connection.
- Identify blockages to electrification and work with relevant stakeholders and departments to address these.
- Work with Eskom to ensure coordination and equality of service provision between electrification programmes in City and Eskom Supply Areas.
- Explore new ways to provide electricity at community scale through the exploration of feasibility of micro-grids.

4.2.3 Programme 2.3 Informal Settlement Public Lighting

Public area lighting is one of the most effective interventions to prevent crime and improve community safety, as well as enabling increased economic activity after dark. This is particularly important in improving the safety of women and girls in accessing communal facilities in informal settlements at night.

The City's Energy Directorate is responsible for public lighting in both the City and Eskom Supply Areas. Public lighting in informal areas is usually provided through the use of high-mast lighting, with a total of 650 high mast lights installed in informal settlements across the city. However, high mast lighting in informal settlements can create shadows with these systems not being able to adequately light walkways between structures.

High mast lighting systems have also become an increasing target for theft and vandalism, which is undermining the sustainability of the service due to the increased cost of protecting, repairing, and replacing this infrastructure. This is diverting scarce resources away from the expansion of public lighting services in informal settlements. Innovative approaches and community partnerships are a key priority in high incident areas to ensure service continuity of public lighting for public safety.

There are a number of informal settlements that are unelectrifiable and therefore also cannot have high-mast public lighting installed. These settlements cannot benefit from the improved public safety and other socio-economic benefits of public lighting. It is therefore necessary to explore options for alternative public lighting service delivery models to ensure increased coverage of public lighting throughout Cape Town.

Outcome

Sufficient and cost-effective public area lighting is provided in both electrified and unelectrified informal settlements to improve safety and security.

City's Role

Deliver

Key City Action Areas

- Design and install lighting in grid-connected informal settlements that is less vulnerable to theft and vandalism and provides improved quality of lighting provision.
- In collaboration with the City's informal settlements department, support the design of community layout to support safe walking routes enabled by lighting.
- Explore and pilot service delivery models for the installation of non-grid-connected public lighting systems in unelectrified informal settlements.

4.2.4 Programme 2.4: Energy Service Provision for Backyarders

Formal and informal additional dwellings, also known as backyard dwellings, are being developed at a rapid rate on private properties throughout Cape Town. In its Human Settlements Strategy (2021), the City recognises the value of this type of development in

providing much needed affordable housing opportunities at scale. However, these dwellings are reliant on obtaining services via the occupier of the main dwelling, which can exacerbate energy poverty. Also, this in-situ densification of formal neighbourhoods without an accompanying extension of metered electrical connections results in increased illegal connections and electrical outages and enhanced risk of fire.

Where backyard dwellings are built on publicly owned land, such as at City Rental Properties, the City of Cape Town has embarked on a programme to electrify these backyard dwellings and provide them with individual and metered grid electricity connections.

All customers are subject to an inclining block tariff, as is required by the National Energy Regulator. However, in the case where unmetered backyard dwellings access electricity from a metered dwelling and/or the household has a higher than average number of occupants, the impact of this inclining block tariff can cause a significant increase in the cost of electricity for all dwellings on a property. This is understood to both dampen electricity demand as well as push households to utilise other, unsafe, energy fuels.

It is important that all households who are eligible for Free Basic Electricity and subsidised services receive access to the energy social package to improve their ability to participate in the economy and to enhance the quality of their lives. As the FBE subsidy is currently allocated through a metered electricity connection, the electrification and metering of all households is essential to further alleviating energy poverty in Cape Town.

Outcome

Opportunities for improved energy access in informal backyard dwellings, on both public and private land, across Cape Town are explored and harnessed, contributing towards improved quality and safety of affordable rental accommodation in Cape Town.

City's Role

Partner

Key City Action Areas

- Prioritise the provision of a subsidised and metered electrical grid connection to backyard dwellings on City rental stock properties.
- In partnership with will private landowners, actively encourage the formalisation of electrical connections and sub-metering for backyard dwellings in support of an increased supply of safe and affordable housing and the sustainable densification of neighbourhoods.
- Explore opportunities for an alternative electricity tariff structure to accommodate properties with backyard dwellings.
- Design and install lighting in grid-connected informal settlements that is less vulnerable to theft and vandalism and provides improved quality of lighting provision.

4.3 Commitment 3: Optimise Energy Use

Where We Were	Where We are Going
From passive customers who use inefficient energy practices with high peak electricity demand and carbon-intensive energy sources…	…To customers being empowered to participate in the energy system, energy being used efficiently and improved energy management practices to allow carbon neutral energy to be the dominant source of energy for Cape Town.

How energy is used and what kind of energy is used are a critical part of the equation to ensure a more resilient energy system in Cape Town. The demand for energy is determined by the investments and behaviours of the City, residents, and businesses in Cape Town. The overall energy demand of Cape Town is made up of the liquid fuels, gas, and electricity used in the transport sector, buildings, municipal service delivery, industry, and aviation.

Globally, electricity's share of final energy consumption is expected to grow due to the electrification of a range of end use sectors that could ultimately make electricity the most significant energy source over time. This is considered a critical component to the transition to a carbon neutral energy system where the electricity provided is generated from renewable sources.

Customers are increasingly using smarter energy technologies in their homes and businesses, and taking a more active role in generating electricity and managing their electricity use behind the meter. The City is committed to supporting and enabling businesses, residents and municipal services to use energy efficiently, take action for smart load management, and to switch to fossil fuel alternatives in the transport sector, such as electricity from renewable energy.

It is important to note that many factors affect the energy efficiency and overall energy demand of Cape Town, especially the transport sector; including spatial layout, urban density, modal split, amongst others. To avoid duplication of efforts, this commitment specifically limits the focus on transport to electric vehicles as these other critical factors are addressed in the Comprehensive Integrated Transport Plan (CITP) and the Municipal Spatial Development Framework (MSDF).

This commitment focuses on four programmes of action that address energy use in municipal operations and service delivery, energy used in buildings by businesses and residents, and the energy used in the transport sector. Through the municipal energy demand management programme, the City has direct control over the pace and scale of investments, and has the ability to engage employees on good energy behaviours. However, as the other programmes primarily involve action taken by other stakeholders, the main levers available to the City are through engaging with customers to support decision-making, alongside ensuring that the infrastructure provided offers a menu of good energy options and that the tariffs are also supportive of good energy practices.

This commitment is applicable to energy users across the municipality, with certain demand-side response programmes only available to City customers. This section unpacks the ways in which

the City is seeking to support optimised energy use by residents, businesses and municipal departments.

Outcome

Businesses, households, and municipal services use energy efficiently and are supported to manage the demand for electricity to allow for greater use of renewable energy and contribute to balancing the electricity distribution grid.

Goals to be achieved within the next 5 Years

Where an earlier date is targeted for these goals, this is stated for the specific goal.

- Residential demand response programme contracted by 2024.
- Rapidly expand the municipal services energy efficiency programme in buildings and industrial facilities.
- Increase the amount of interruptible supply derived from the existing commercial demand response programme.
- Establish energy performance baseline per occupancy class for all privately owned buildings in Cape Town.
- Energy training material and related communications for micro-developers to build energy efficient, affordable rental accommodation.

4.3.1 Programme 3.1: Energy Efficient City Services

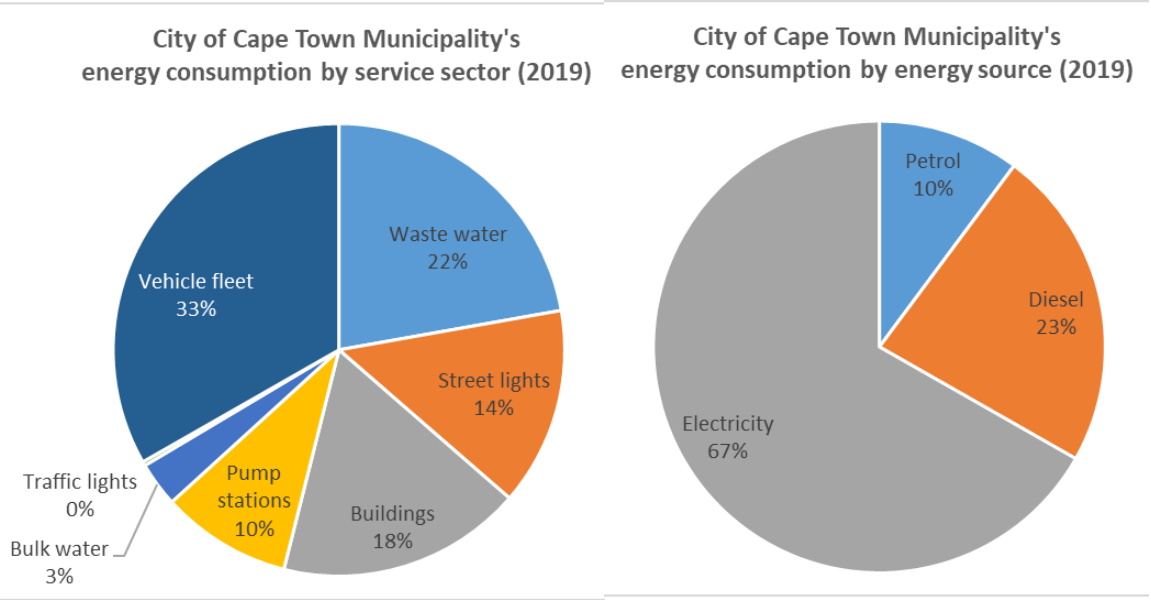


Figure 9 (right): A graph depicting the types and share of energy used in City of Cape Town's municipal operations for service delivery.

Figure 10 (left): A graph depicting the major users of energy within the City of Cape Town's municipal operations for service delivery.

In delivering on its core functions, the City accounts for the largest share of demand for energy overall (1%) and electricity (3%) by any one entity in Cape Town. In 2019, the energy required to deliver services cost the City close to 3% of the City's operating budget, with the functions of

wastewater treatment, public lighting and buildings being the major energy users of primarily electricity, as seen in Figures 8 and 9.

Rising electricity costs and the targets in the City of Cape Town's Climate Change Strategy (2021) to decarbonise city services have driven a programme of energy efficiency and renewable energy in City operations, which has been ongoing since 2009. The City has invested in systems to monitor the energy usage of the City's infrastructure and public facilities, as well as quantify the energy performance of projects and the anticipated savings of planned energy efficiency interventions. It is therefore important for the City to build on the success of these initiatives and expand them for greater impact through this programme.

Case Study: Municipal Energy Efficiency Programme

In the context of the current national energy crisis, the City of Cape Town is leading by example to reduce the electricity consumption of its municipal buildings. The Municipal Energy Efficiency Programme began in 2018 with the intention to reduce total building consumption through conducting internal energy audits and determining buildings' baseline consumptions. After having identified targeted buildings with the potential for optimised savings, the City undertook energy efficiency interventions such as LED retrofitting of existing light fixtures, the installation of occupancy sensors, and retrofitting of Heating, Ventilation and Air-conditioning (HVAC) systems. The Energy Efficiency Programme has consistently exceeded its targets: in the 2021/22 period, the project saved the City 1 625 270 kWh, surpassing its target of 1 600 000 kWh, amounting to savings of over R2.8 million. As a key component of the City's Climate Action Plan for carbon neutrality and climate-resilience by 2050 and its commitments to achieve net-zero carbon emissions in city-owned buildings by 2030, the Municipal Energy Efficiency Programme will also help the City achieve energy resilience within its own operations.

Case Study: Becoming ISO 50001 Compliant

The City's Bellville Wastewater Treatment Plant (WWTP) received ISO 50001 certification, which recognises this facility for its leading efforts in energy efficiency. Bellville WWTP is the first municipal wastewater treatment plant in South Africa to achieve this global energy management standard which reaps positive benefits for Cape Town and climate change mitigation. The energy-efficiency improvement at Bellville WWTP has resulted in some key benefits, with more than R1 million in savings a year for electricity costs, equivalent to more than one million kWh savings a year. This will reduce carbon dioxide emissions by around 1000 tonnes a year. This recognition highlights the City's commitment to improving the quality of treated effluent, adopting energy-efficient operations, and reducing the impact of climate change by lowering carbon dioxide emissions. In the face of constant load-shedding, energy efficiency in City operations is particularly important. A third of the City of Cape Town's municipal electricity consumption is from running wastewater treatment plants. If this could be reduced by 10%, it would result in emission reductions equivalent to 13 000 tons of CO_2 a year. The Water and Sanitation directorate will continue to invest and enhance energy efficiency and treatment processes of our other plants at Macassar, Wesfleur, Cape Flats, Kraaifontein and Potsdam WWTPs.

Outcome

Municipal service continuity and cost-effectiveness is enhanced through investments in energy efficiency and energy demand reduction in buildings and facilities.

City's Role

Deliver

Key City Action Areas

- Invest in energy efficiency in municipal buildings and facilities in order to mitigate the impact of electricity costs on the cost-effectiveness of public services.
- Empower City staff with information and skills needed to manage buildings and facilities to be more energy efficient and to encourage energy efficient behaviours.

4.3.2 Programme 3.2: Optimised Building Energy Performance

This programme is closely aligned with and builds on Strategic Focus Area 8 of the Climate Change Strategy and Action Plan (2021).

In Cape Town, buildings and the neighbourhoods in which they are located are the primary places where most residents and businesses use energy. Residential and commercial buildings account for approximately 24% of energy consumption in Cape Town and contribute to the largest proportion of carbon emissions of any sector (approximately 42%) due to the high carbon intensity of South African electricity.

The size of Cape Town's formal and regulated building stock is expected to grow and it is therefore important that buildings are designed and constructed to be highly energy efficient to prevent the lock-in effect of inefficient design and to negate the need for expensive retrofitting in the future.

Optimising building energy performance requires the City of Cape Town to actively engage, collaborate and build strong partnerships with various stakeholders. This includes other spheres of government, the private sector in particular, unions, civil society, communities and academia. Communication and transparency are also critical, and the City will need to convey the scientific, economic and social rationale to promote enhanced building energy management practices.

To achieve this, the City will focus on advancing the following set of practices amongst building designers, developers and owners when designing a new building or undertaking a major refurbishment:

- Reduce the need for energy and thereby reduce overall energy demand;
- Where energy is still needed, increase energy efficiency;
- Optimise load management to match renewable energy supply through practices such as peak shifting;
- Tracking and measuring energy use (in real time).

Case Study: EWW Forum

The Energy Water Waste Forum was established by the City of Cape Town to promote resource efficiency and operations for in the commercial sector. The commercial sector is a key sector with regard to resource efficiency, already using about 11.1% of the electricity supply in the Cape Town area and is responsible for 22% of Cape Town's total carbon emissions. The Forum's objective is to provide owners and managers of offices, shopping centres, hotels and other commercial and public buildings with practical knowledge and support to promote resource efficiency, as well as minimise the amount of landfill waste. The Forum is aimed at large and small property owners, managing agents, facility managers and other related service providers.

Outcome

Property owners and developers are supported and enabled to optimise their building's energy performance through energy efficiency and enhanced building energy management systems.

City's Role

Enable

Key City Action Areas

- Empower residents, business owners and employees with the information needed to:
    - Implement energy efficient behaviours at home and at work, invest in energy management systems, and to reduce and/or shift peak energy demand;
    - Ensure that homes are built, retrofitted and refurbished to be energy efficient, and to explore opportunities for onsite energy generation.
- Facilitate the communication of the operational energy use of homes during design, occupation and at point of sale, providing an incentive for property developers and homeowners to invest in energy efficiency.
- Engage micro-developers on how to increase energy efficiency and thermal performance of affordable rental accommodation that is developed.
- Engage government departments to increase energy efficiency and thermal performance of state-subsidised housing and City rental stock;
- The City's design of new and upgraded precincts and neighbourhoods promotes energy efficient lifestyles that provide safe non-motorised transport options, access to public transport, energy efficient service delivery and opportunities for the deployment of larger-scale renewable energy.

4.3.3 Programme 3.3: Enhanced Demand Response

Demand response is the act of rapidly reducing electricity demand, known as curtailment, and/or shifting electricity demand to another time in order to provide system operators flexibility when balancing and managing the grid. Demand response is generally a contracted arrangement between the system operator and customers directly, or through a service provider that acts as an aggregator for demand response. These contractual arrangements are based on financial and non-financial incentives.

Demand Response is a growing component of the energy system in Cape Town. This is both in response to load-shedding in the short term, where a voluntarily interruptible power supply allows specific energy users to be load shed, instead of the current practice of whole zones in the grid experiencing interrupted power supply. In the longer term, demand response enables the system operator to balance energy demand and supply, which is a required functionality in order to integrate a greater proportion of renewable energy resources into Cape Town's energy supply mix. Critically, demand response requires agreement and participation from customers and is undertaken voluntarily.

Case Study: Demand Response Programme: Power Heroes

In another move to protect its customers from some of the impacts of load-shedding, the City has initiated the Power Heroes programme, which will see customers rewarded for reducing their power usage at a given time so that City Supply Area customers can be protected from the impacts of load-shedding. These Cape Town Power Heroes will be key in the City's load-shedding protection efforts. A tender has been issued to appoint third party aggregators who will sign up Power Heroes on a voluntary basis, comprising residential and small-scale commercial customers. When usage needs to be cut, the Aggregators switch off agreed-to non-essential electrical equipment of the Power Heroes, which could be done remotely via installed smart devices. This new initiative is part of the City's demand response plan to mitigate load-shedding while we work on getting new sources on board to end load-shedding over time.

Outcome

Effective commercial and residential demand response programmes are implemented so that the City can efficiently balance electricity supply and demand through the distribution network and mitigate load-shedding.

City's Role

Partner

Key City Action Areas

- Continue to utilise and expand the Large Power User Demand Response and Curtailment Programme to decrease demand when electricity availability is constrained to protect more residents and small businesses from the effects of load-shedding.
- Procure service providers to act as aggregators of demand response in the residential and small power use customer base to establish an interruptible supply of up to 60 MW, which equates to one stage of load-shedding. This programme targets high energy uses that can tolerate a disruption in their electricity supply, such as geysers and pool pumps.
- Work with residential customers to directly manage the demand for electricity in order to maintain network stability, enable the spread of demand for electricity over time and protect more residents from the effects of load-shedding.

4.3.4 Programme 3.4: Support Uptake of Electric Vehicles

Road transport in Cape Town accounts for 54.4% of total energy use through the use of liquid fuels (diesel and petrol) for commuting in public and private vehicles, freight and deliveries.

Mobility worldwide is rapidly moving towards an electrified transport system, and in order to remain competitive in the vehicle manufacturing market and achieve its carbon emissions goals, South Africa will need to embrace electric vehicle (EV) technology. Cape Town aims to be at the forefront of this shift, which will help the City reach its commitment to be carbon neutral by 2050, as outlined in the Climate Change Action Plan. However, in both public and private road transport, the uptake of EVs has been slow so far. While there are a number of EVs available in the market and there have been a few demonstration projects in the public transport sector and municipal fleet, this uptake is suppressed due to the high import tariffs, limited charging infrastructure, limited EV options and few local manufacturers. However, with the global ramp down in production of internal combustion engines, it is expected that there will be a greater infiltration of EVs in the next 10 years. EV charging is likely to be a major driver of electricity demand for residential properties in future, and a significant driver of demand for commercial buildings. As such, the installation of EV chargers will need to be properly managed to ensure that risks of concentrated electricity demand on the stability of the electricity grid are mitigated, especially in already constrained areas and during peak demand periods.

Outcome

Cape Town is a leading Electric Vehicle-friendly city in South Africa, with the City proactively introducing EVs in the public sector over time and enabling EV charging infrastructure to develop in support of the industry.

City's Role

Partner

Key City Action Areas

- City Fleets: Building on the recent pilot project, the City is considering options to convert City-owned Fleets to low-emission vehicles, including electric vehicles, over time in order to contribute to lower air pollution, greenhouse gas emissions and noise pollution in the transport sector, together with decreased refuelling and maintenance costs
- Policies & Regulation: Work with stakeholders to advocate for and contribute to develop a proactive policy framework that will ensure the growth of this sector is for the benefit of all South Africans. Continually assess where the City can provide policies, standards and tariff changes that will result in greater policy certainty for the EV industry.
- Charging Infrastructure: Anticipate and manage the increase in demand due to EV charging points effectively to ensure the safety and integrity of the City's electricity grid.

Case Study: The City's first public EV chargers

The City of Cape Town is supporting the uptake of eMobility for all, and is developing initiatives to drive the growth of this technology in Cape Town, so that it can become more accessible and rolled out in the future to benefit all Capetonians. To catalyse a shift towards the use of EVs and support the City's environmental strategy, the City installed two electric vehicle charging stations, located in Bellville Civic Centre and Somerset West Civic Centre at the end of 2020 and start 2021. These were donated by the United Nations Industrial Development Organisation (UNIDO), and are free for the public to use as part of a two year pilot project to

encourage awareness of EV technology and support the City's commitment to the reduction of greenhouse gas emissions. The vast majority of liquid fuels for transport is comprised of imported fossil fuels, with transport-related GHG emissions currently account for about 34% of the carbon emissions in the city, so reducing tailpipe emissions will contribute significantly to our climate change targets and energy security goals. The charging stations are fitted with rooftop solar PV panels which feed excess energy into the grid, which offsets any emissions produced through the chargers.

4.4 Enabler A: Operate a Future-fit Utility

Where We Were	Where We are Going
From an electricity utility that operates optimally only within a monopoly business model and relies only on the sale of electricity for cost recovery, with limited customer choice and underpinned by a repair-focused reactive maintenance regime…	…To an electricity utility that is financially sustainable and that operates optimally within an increasingly competitive regional energy market that offers customers greater choice and that integrates a greater share of distributed renewable energy, underpinned by a reliability-focused proactive maintenance regime.

Traditionally, electricity utilities have been established to perform optimally in a monopoly, where there is one dominant supplier of electricity that services a captive market, where customers have limited choice as to where they purchase electricity. Electricity supply is now, however, shifting to decentralised renewable energy sources, thereby disrupting the business model of utilities and introducing engineering challenges on electricity grids. Nationally, the electricity industry has experienced severe difficulties, with a debt crisis at the vertically integrated national utility Eskom, steep price increases and increasing severity of load-shedding. Historically, the financial model for local governments in South Africa has been built on the assumption that municipalities can gain revenue from the sale of electricity to customers to pay for a range of municipal services. However, decreasing demand for electricity due to low economic growth, the uptake of energy efficient technologies, and the increase in embedded generation also makes the energy transition an issue of financial sustainability at the local government level.

Explainer box: Institutional arrangements with Eskom

The City has 17 supply accounts with Eskom, each with its own electricity supply agreement (ESA) and specific Notified Maximum Demand (NMD). Within each account there may be several points of delivery (POD) with their own respective NMDs. There are agreed processes and co-developed documents stipulating the rules and responsibilities between the City and Eskom in terms of electrical infrastructure. The City and Eskom engage in conversation on matters of interest to both parties on various platforms, such as monthly outage planning meetings, quarterly transmission and distribution planning and project meetings, and the regular Electrification Management meetings, to name a few.

The City recognises that a reform of its current electricity utility business model is needed to enable multiple actors to operate effectively within the energy market, while distributing the cost

of upgrading and maintaining the grid fairly across customers**.** This reform needs to consider the full suite of businesses within the electricity utility; namely generation, distribution and retail. There are, however, a number of functions required of the municipal electricity utility that must be retained through this process of reform:

- Ensuring equitable access to energy through the provision of affordable energy services to indigent households;
- Ensuring the continued functionality of the electrical grid infrastructure to distribute electricity safely and efficiently throughout the city, both the physical infrastructure and the systems for its operation;
- Retaining the ability to be an electricity supplier of last resort, even in a fully competitive and liberalised generation and retail market.

It is essential that the City continues to perform its constitutional responsibility to distribute electricity to Cape Town, through investing in an administratively efficient government that is financially sustainable. The Energy Strategy focuses on cost-effectiveness, making use of digital technologies to maintain and improve service delivery, and enhancing data collection and analysis capabilities to ensure public resources are used in such a way so as to achieve maximum public benefit.

However, the City of Cape Town cannot operate in isolation to address the current energy crisis and navigate the energy transition, but rather operates within a system of energy actors. Working with a network of partners in government and the private sector is critical for the City to govern and provide energy services effectively and sustainably.

The following section outlines the business model and short and medium term priorities of the three business units making up the municipal electricity utility (Generation | Distribution | Retail).

The Generation Business

- Business Model: utilising city-owned generation assets to operate within a growing competitive energy market.
- Short term: The City will look to optimise the existing and already planned fleet of generation and storage assets to provide cos- effective energy for municipal service delivery and ancillary services.
- Medium to long term:
    - Beyond this threshold, the generation business will explore opportunities to leverage city resources, such as available roof space, land, skilled staff, and the City's balance sheet to provide cost-effective energy supply to residents and businesses.
    - All decisions relating to the City's generation business must be cognisant of operating within an increasingly cost-competitive environment where there is significant private sector participation, along with a push to see the generation business operating in a financially self-sustainable manner.

The Grid Services Business

- Business Model: Regulated operation and maintenance of the City's distribution grid as a monopoly in City Supply Areas, while allowing for private mini-grids.
- Short Term:
    - In City Supply Areas, the City will continue to be the sole provider of distribution grid services and manage and maintain the electrical grid as a platform for the safe and cost-effective transportation and storage of electricity from multiple sources to customers, alongside private mini-grid operators.
    - The distribution business will include an enhanced Distribution System Operator function to operate the grid and effectively balance energy demand and supply from increasingly diverse and variable energy sources and users.
- Medium to long term: The City intends to remain a grid services provider in the long term, operating largely within a monopoly in City Supply Areas. This is to ensure equitable access to a safe and well-maintained electrical distribution grid.

The Retail Business

- Business Model: Regulated monopoly supplier of electricity to customers in City Supply Areas delivered via the wires business.
- Short to medium term: The City's electricity utility will remain responsible for sourcing bulk electricity from the City generation department as well as other sources to meet the demand for grid electricity by Cape Town customers.
- Medium to long term:
    - The City will continue to be the supplier to the vast majority of customers in CSA. As competitive markets develop in the generation space, this will open opportunities to source more cost-effective electricity.
    - The City recognises that customers will have greater choice to range of suppliers operating within the City Supply Area.

Applying this commitment across the City Supply Area and Eskom Supply Area in Cape Town

This commitment only applies to areas supplied by the City of Cape Town. The City's long term objective is to ensure effective and efficient provision of electricity services to all residents and businesses, with the City seeking to distribute electricity directly to all customers in Cape Town. Any adjustments to supply areas will be investigated and considered where it is financially and technically feasible and undertaken in a manner that ensures the affordability and quality of service for both Cape Town and Eskom Supply Area customers.

Outcome

A municipal electricity utility with enhanced asset management of energy infrastructure and that adapts its business model and systems to provide financially sustainable energy services in an increasingly competitive and distributed energy system.

Goals to be achieved within the next 5 years

Where an earlier date is targeted for these goals, this is stated.

- By 2026, operate the distribution system so as to harness dispatchable energy supply and curtailment programmes to allow the City of Cape Town to mitigate up to 4 stages of load-shedding in City Supply Areas between 06:00 - 22:00 on weekdays.
- Implement systems and process to improve access to the grid to enable the connection, operation and management of distributed energy resources.
- Design of electricity tariff restructure to enable improved cost recovery for fixed distribution system costs.
- Design of enhanced distribution grid communications network and increased functionality for distribution system operator.
- Implement required institutional and financial reforms to enhance the separation of the electricity generation business unit and the electricity distribution business unit.
- Investigate avenues for retaining and growing revenue streams for utility, including wheeling, EV charging and hydrogen, to name a few, and mechanisms for growing the customer base.

4.4.1 Programme A.1: Institutional and Workforce Reform

Electricity utilities have traditionally been vertically integrated across the electricity value chain, from generation to transmission and distribution to retail functions. Over the past few decades, utilities the world over have unbundled their operations in order to enhance financial sustainability, increase transparency and accountability, reduce risk exposure, and increase agility to respond to the changing energy landscape; with the National Utility, Eskom, now undergoing a similar process. For these same reasons, the City is now also seeking to unbundle its three functions of generation, distribution and retail within an appropriate institutional structure.

Furthermore, City staff working in the Energy Directorate must have the skills to address current and new demands being placed on the utility with regard to increased digitalisation and more engagement with customers as active participants in the energy system, to name a few. This requires enhanced and new skill sets within the utility.

Outcome

A restructured and capacitated electricity utility department that is agile and viable within a changing energy system and has the skills to respond to the changing needs of customers and the energy system more broadly.

City's Role

Deliver

Key City Action Areas

- Institutional Redesign: Restructure the electricity utility to meet the demands of a changing energy market and enhance cost-effectiveness and transparency.
- Workforce development: Develop a workforce with the skills and expertise required to operate optimally and innovatively in support of a more diverse and competitive electricity market – through both recruitment and upskilling of current staff.

4.4.2 Programme A.2: Tariff and Financial Reform

The financial sustainability of the utility is a prerequisite for optimal functionality. The structural and technological changes in the utility business model need to adjust to a changing energy system require a commensurate change in financial arrangements to ensure appropriate revenue collection and management. Furthermore, it is critical that the evolution of the electricity utility in response to the transitioning energy system is managed in a way that reduces the risk exposure of the financial sustainability of the City. This programme therefore focuses on three critical areas of financial reform; namely

- Tariff model reform;
- Modernising billing and collections;
- City financial model reform.

Reform across these areas is governed by the following principles:

- **Fairness and Transparency:** The cost of transitioning the energy system in Cape Town is appropriately and fairly apportioned across customers and is transparent to all stakeholders involved. Pricing is used as a tool to transparently communicate and encourage the sustainable use of energy, including energy efficiency and time of use.
- **Cost Reflectiveness:** The level and structure of electricity tariffs will, in the long term, reflect as closely as possible the underlying costs (variable and fixed) of supply for the majority of consumers.
- **Household Affordability:** Changes in the energy tariff structure must be cognisant of how the City leverages costs for municipal infrastructure and services; where the total costs levied on the household are understood. The affordability of municipal services at the household level will form a key departure point for the restructuring of energy service tariffs and their impact on property-based charges.
- **Enabling cross-subsidisation of the poor:** Electricity supply to substantially low-income households will need to be held below full cost-reflective levels in the medium to long term, for social-development reasons.

Outcome

A financially sustainable electricity utility that encourages private sector participation in energy supply, safeguards the provision of subsidised energy access to indigent households, and ensures that the cost of providing and maintaining electricity infrastructure is fairly distributed across customers.

City's Role

Deliver

Key City Action Areas

Tariff Model Reform

Tariffs are the mechanism through which utilities recoup revenue to cover the costs of services rendered and resources provided. These costs include fixed costs to provide network service connection and the ongoing operations and maintenance of the electricity grid; as well as variable costs of the actual electricity provided. While the municipal utility has a certain level of control over the fixed costs, the variable costs are derived directly from buying electricity, which at present is predominantly from Eskom.

Traditionally, municipal utilities have used tariffs that have combined fixed and variable costs with current electricity tariffs available online on the City's Website. However, this is no longer viable in a context of decreasing energy demand as the revenue recouped in this manner no longer covers the cost of critical operations, maintenance and investment needed for the distribution grid. This restructuring of the tariff is important for the long term financial sustainability of and continued investment in the electricity distribution network, which all residents and businesses will continue to rely upon in new ways as the sources of energy and the flow of electricity across the grid becomes more complex.

What is paid for through electricity consumption tariffs and once-off charges?

The City's electricity tariff includes the following costs which are currently bundled together. In future these costs will be charged separately.

- Use-of-system charge: monthly fixed fee for maintenance and operation of existing infrastructure and investment in required upgrades of infrastructure.
- Energy charge: Variable charge based on the volume of electricity utilised, with the price determined by the retailer, which would be the City or Eskom depending on which distribution area the customer resides.
- Contribution to the subsidisation of energy access for indigent households.
- Contribution to the investment in to City public services, such as libraries, parks, clinics, public lighting and street lighting for the development, maintenance and operation of these services across the City.

Once-off charges related to establishing new or enhanced electrical connection and capacity include:

- Connection fee: The connection fee refers to the direct costs of the material, labour and transport to provide the dedicated assets needed to connect a property. Material costs would include cables, meters and breakers required to connect the property to the upstream network;
- Shared-Network Charge: This charge pays for the authorized electrical capacity in kVA (kilovolt-ampere) which is assigned to the property, which is a certain kVA of electricity in the network reserved for use by the owner.

The City will restructure electricity tariffs with the aim of:

- Accurately representing the fixed costs of providing and maintaining this grid and distribute these costs appropriately, fairly and transparently across customers;
- Sending pricing signals to customers to promote peak-shifting to limit the need to commit resources for upgrading network infrastructure and generation capacity solely in response to a peak in demand at certain times of day or times of year;
- Enabling increased installed capacity in response to the current context of severe electricity supply constraints.

Modernising billing and collections

With the rise of new energy services and stakeholders comes a more complex billing and collections environment, where retail transactions will take place more frequently and involve more parties per transaction. This requires a shift in billing and collection processes to accommodate incremental, bi-directional, and market-responsive and near real-time transactions that are supported by smarter meters and responsive retail software.

The City will:

- Explore ways to use electricity metering and billing mechanisms to enhance the collection of rates and electricity tariffs;
- Address the technical constraints to applying Time of Use tariffs due to capabilities of the current metering fleet, through exploring options for smarter residential metering options which allow for communication of electricity usage over time;
- Invest in billing software that can handle the increasingly complex nature of retail transitions in the energy system.

Financing the capital budget

The 'Harness New Energy Commitment' will require a higher level of investment than previously undertaken by the City of Cape Town. Financial modelling shows that this budget can be financed by the City cost effectively, based on its balance sheet and from its sources of rates and tariff income. Capital grants will be used to prioritise access to basic services. The City is able to achieve efficient financing of capex through a pooled City financing strategy. Grants from the National government, such as the Urban Settlement Development Grant and Equitable Share partially cover the costs of providing services, such as distribution infrastructure, connections and Free Basic Electricity, to indigent households.

City financial model reform

The sale of electricity is currently a valuable source of revenue for the City of Cape Town along with property rates and other service charges. The sale of electricity not only cross-subsidises the provision of energy services to indigent households and the provision of street and public lighting, but also provides for a contribution from electricity sales to the cost of other municipal services provided by the City, such as clinics, libraries, parks, etc. These additions to the cost of network services and the cost of energy require a review to ensure the ongoing affordability of energy costs for customers and to ensure that the City utility remains relevant as customers gain increasing choice in the energy market. Furthermore, the funding for these cross-subsidies is at risk as long as they are currently linked to a variable charge in a declining sales environment.

The City will undertake the following actions to ensure the financial sustainability of the services provided by the municipal electricity utility and the City:

- Explore how the City's financial model may transition to reduce reliance on electricity sales revenue to fund municipal services beyond the provision of electricity services;
- Identify sustainable sources of funding for capital projects and non-network-based electricity services;
- Review of subsidies within the electricity tariff for services outside of electricity distribution and identify opportunities to find alternative sources of funding for these subsidies;

- Package a long-term electricity infrastructure investment pipeline to engage with financiers to source sustainable financing for capital projects.

4.4.3 Programme A.3: Infrastructure and Technology Reform

The distribution network is a significantly valuable asset that the City owns and operates. Electricity networks form the backbone of reliable and affordable electricity systems and also support the uptake of new renewable generation. The ongoing maintenance and refurbishment of current infrastructure is essential to protect historical investments and ensure maximum benefit to all who use the distribution grid. Beyond this, there is a need to evolve the functionality of the grid to accommodate an increase in distributed and embedded energy resources across City Supply Areas. This is mainly considered feasible through investment in enhanced and new digital systems that will support real-time decision-making for operations and maintenance.

A severe threat to the functionality and cost-effectiveness of the distribution grid is theft and vandalism of infrastructure. The City must work collaboratively with a range of stakeholders across law enforcement agencies, communities, and others to develop innovative mechanisms to help curb the continuation of this threat.

Outcome

Enhance utility operations through modernising and maintaining infrastructure and leveraging digital technologies to ensure a safe and cost-effective distribution grid services, enhanced system operator functionality, and support the integration of more distributed energy resources.

City's Role

Deliver

Key City Action Areas

Modernising grid infrastructure for improved operations and maintenance

Improving the frequency and accuracy of information about the performance and condition of electrical infrastructure enables the electricity utility to enhance network reliability by reducing the number and duration of customer interruptions, ultimately improving customer satisfaction. Furthermore, the use of intelligent devices in electricity grids has aided utilities in more accurate tracking of reliability metrics like SAIDI and SAIFI during unplanned outages.

- Leverage technology for more targeted and efficient maintenance of electrical infrastructure, including self-monitoring infrastructure systems, in order to increase the cost-effectiveness of network service.
- Delivery of capital investment pipeline to maintain and upgrade distribution network infrastructure to ensure the ongoing high quality of service to customers.
- Replace ageing infrastructure with modern, smarter devices for faster turnaround time when responding to faults and to proactively maintain network infrastructure.
- Increased protection of critical infrastructure and prevent service disruptions due to vandalism and theft.

Case Study: Paardevlei Switching Station

A new switching station with a capacity of 300 MVA has been completed at Paardevlei in Somerset West. This is equivalent to the energy consumed by 25 million lightbulbs, or 74 000 households. The R142 million project is aimed at cutting monthly operational costs for the City and enabling area growth and will benefit housing, commercial and industrial developments in the area. It will also provide a grid connection point for future independent power producers, which is in line with the City's drive to diversify its energy mix to include renewable energy. The substation is designed to be fully automated, and incorporates indoor SF6 gas insulation switchgear (GIS) which distributes the electricity flows. The GIS takes up less space than traditional, outdoor switchgear, and, being indoors, is aesthetically more pleasing and significantly more reliable.

Enabling embedded generation and new energy services

The City is also committed to maximising the value of the distributed energy resources to the customers, while meeting its mandate to provide a stable electricity network. The electricity distribution grid has primarily been designed for the flow of electricity from a generator located outside of the network to a customer within the network. However, with the increase in embedded generators and the increase in bi-directional flows of electricity, the distribution grid needs to be appropriately upgraded and maintained to ensure system stability and functionality. This will allow the distribution grid to more effectively accommodate distributed energy resources and enable new energy service offerings and an enhanced customer interface of the utility.

- Enhance the electrical grid operating platform to provide the technology, protocols and structure to allow users to interact within a competitive energy market – including providing Distributed Energy Resource providers with the access and information they require to operate effectively and identify investment opportunities.
- Partner with National government to co-develop the necessary standards, specifications and practices for grid readiness to operate a grid with a high variable renewable electricity share of supply (including high penetration of SSEG) and a higher level of decentralisation.
- Invest in more accurate measurement and metering of energy flows in order to support the more sophisticated pricing and load management necessary.

Protection of critical infrastructure

Network infrastructure is at risk from technical issues, such as the stresses caused by frequent load-shedding, as well as socio-economic issues of theft and vandalism. Theft and vandalism are considerable risks to network infrastructure delivery and maintenance, with its prevalence increasing in response to concerns regarding energy affordability. This is a risk due to the impact on the financial sustainability of the utility where infrastructure needs to be replaced earlier than expected and due to the need to more frequently remove illegal connections that overburden electricity infrastructure and become safety hazards in communities. The City alone cannot combat theft and vandalism and requires the support and partnership of communities and law enforcement.

Using digital technologies for improved network control

Utilities can make use of digital technologies to optimise operations, network control, and the customer interface, while providing the opportunity for a step-change in transforming utility operations and management. To effectively support a more decentralised energy market, there will be a need for increasingly real-time and highly granular data, alongside an increase in the skills and capabilities to process and use this data to the benefit of the energy system overall.

The City of Cape Town's Network Control currently implements real-time control and monitoring of the network infrastructure to maintain network stability, matching of electricity supply and demand and prevent service disruptions. In particular, self-monitoring and self-correcting systems will be a priority. With more and more distributed generation, particularly renewable energy sources, network stability issues at local level will become more prominent and will require more frequent and responsive network adjustments that could be automated.

Going forward investments in network control will result in the increased automation of these systems and processes with digital technologies and artificial intelligence integrated into control systems to a greater degree. The need to forecast demand and supply will increase significantly as the City takes on greater functionality as a system operator. Critical to this is ensuring that the investments and improvements made are fit-for-purpose and provide an appropriate and necessary level of digital maturity, while better securing these systems against the cyber threats to which they may be increasingly vulnerable.

- Invest in the software and systems for enhanced network control and operations in order to effect better load management and maintain network stability in response to more variable electricity supply from renewable generation.
- Enhance retail functions by optimising the current communication systems for real-time management and metering of the flow of electricity control and allow for increased bi-directional communication with customers over time.

4.4.4 Programme A.4: City-level Energy Planning

The City utility has primarily focused on network planning for investment in the expansion and maintenance of the distribution grid. However, with the increased desire to achieve greater self-determination in bringing about increased energy security, the City will need to invest in enhancing localised planning related to energy supply, demand forecasting and infrastructure capacity assessments over the long term to inform decisions.

City-level energy planning capabilities enable the City to identify the implications of critical energy decisions before significant capital and operational investments are made, thereby improving the decision-making ability of the City and other stakeholders. The City will also engage inter-governmental partners around the potential benefits of linking adjacent municipal grids in order to link the load centre of Cape Town with potential energy services in neighbouring municipalities.

Outcome

The utility makes use of detailed and accurate data sets in system-wide planning and modelling to optimise the functioning and investment in the local electricity system, as supported by the digital and spatial representation of electricity infrastructure systems.

City's Role

Deliver

Key City Action Areas

Electricity Supply Planning

Local energy supply planning consists of collecting and analysing high quality data relating to the local energy system, and using this data to model energy pathways and scenarios to inform the evolution of Cape Town's electricity supply mix to be more reliable, affordable and carbon neutral going forward. It is important to note that the electricity supply mix is realised through decisions made by a range of actors, not only the City. However, the City can play an enabling role in the local energy system by offering up data and analysis for decision-making and providing direction and coordination across suppliers, off takers and third-party aggregators. Planning for increasingly variable loads will become more important, whether due to renewable energy penetration or energy storage. Grid stability investments or contracted services (ancillary services) will be required to balance the increasingly variable generation that renewable energy creates, and it is essential to ensure these costs are fairly, transparently and equitably assigned in the tariffs.

- Develop pathways for achieving an optimal local energy supply mix within the principles of reliability, affordability, and carbon neutrality, including a load allocation model to inform the balancing of supply and demand for electricity to guarantee a secure supply, particularly as renewable energy makes up a greater proportion of the base load electricity supply.

Electricity Network Planning

The City is committed to leveraging its spending on electrical infrastructure for maximum economic and social benefits. Decisions on where and what infrastructure is expanded and upgraded need to be informed by accurate data to ensure that the city's electricity network meets the needs of the economy and residents. Planning for the necessary network infrastructure upgrades and expansion is a critical function of the City's electricity utility to ensure that the electrical network can support Cape Town's spatial vision and the growth in electricity demand across the economy and neighbourhoods over time. Going forward, the intention is to centre GIS as a core business tool and database for network planning and other operations, along with greater alignment of network planning with the long term spatial vision of the City of Cape Town, with energy as a key enabler.

- Enhance network data collection and modelling to proactively plan for customer electricity needs in line with long term spatial priorities.
- Invest in the skills and software required to undertake and regularly update energy and network models developed and related data analysis to inform decision-making.

4.5 Enabler B: Action by Residents, Businesses and Partners

Where We Were	Where We are Going
Residents, businesses and partners have some, but at times still limited, access to information and resources to inform the action they take…	…To increasingly well-informed residents, businesses and partners that are empowered to take action that will benefit the energy system overall.

A more resilient energy system is not possible without the action of a broad range of empowered and well-informed stakeholders. The City is committed to being a better partner in resolving our energy crisis and realising the long term energy vision together.

Key to implementing this Energy Strategy is ensuring that decision-making is fair and transparent to all stakeholders and provides greater policy certainty so that they can participate effectively in the energy system. Many of the actions of this strategy are complimented by actions to provide greater communication and information-sharing with customers so that they are able to make good energy decisions.

Case Study: Engaging Citizens: Cape Town Future Energy Festival

The Cape Town Future Energy Festival was a fun, family-friendly virtual event experience which ran throughout 2020 and into 2021. Organised by the Sustainable Energy Markets Department, the Festival was designed to include all residents in shaping an energy future for Cape Town that is sustainable and equitable. It showcased innovative and cost-effective household solutions for more efficient resource use through a number of events targeted at different audiences. The line-up of activities educated residents on how to make sustainable choices in their day-to-day lives, and included events such as a smart cooking competition, an edutainment series for kids to introduce concepts such as energy, water and waste, and culminating in the design and building of Cape Town's first net zero home exhibit.

The City of Cape Town has developed a home for all energy-related resources online which can be found here: https://www.capetown.gov.za/Energy.

Outcome

All stakeholders in the energy system have the knowledge needed and are supported to take action that contributes to the achievement of energy security in Cape Town.

Goals to be achieved in the next 5 Years

- Annual publication of updated energy data on City Open Data Portal
- Revised State of Energy and Carbon Report published
- Energy Festival to engage citizens on energy innovations
- Energy services support database developed

4.5.1 Programme B.1: Awareness and Engagement

In order for residents, businesses and other partners to make informed energy decisions that will benefit the energy system as a whole in Cape Town, it is imperative that they are first aware of critical energy issues and the need to take action. Building on this awareness, the next step is for all stakeholders to have accurate information that can be used to help make sound decisions related to a range of actions. These actions can include changing behaviour related to energy use and making investments in energy technologies.

With the pace and scale of the energy transition and the current electricity supply crisis, there are numerous sources of information and resources that residents, businesses and other stakeholders rely on to inform the decisions they take regarding energy security. The City aims to be a trusted partner and source of energy information to the public by regularly sharing relevant, helpful and up-to-date information packaged so that all energy users can easily understand this information and take action.

Outcome

Residents and businesses are capacitated to make informed energy decisions which support the achievement of key energy priorities in Cape Town

City's Role

Deliver

Key City Action Areas

- Publish resources on energy issues that appropriately package information in accessible and easy-to-use ways
- Develop campaigns that make use of key channels of communication with the public (social media, City website, print media, radio, etc) to effectively share the latest resources and information on energy-related issues and the type of actions that residents and business can take
- Facilitate and partner with relevant energy events to share information and engage key stakeholders on priority energy issues and innovations
- Provide relevant training on City processes to energy service providers that support residents and businesses to take action and implement their investment decisions, such as installers of small-scale embedded generation systems.

4.5.2 Programme B.2 Energy Data Access

The City of Cape Town is the custodian of a wealth of energy-related data, whether related to energy demand, supply, and energy system behaviour. The quality of this data however varies with the experience of a time lag in the availability of some datasets. Additionally, other energy system stakeholders hold critical data, such as Eskom and National and Provincial Government Departments, which would be valuable to share so that a comprehensive picture of the energy system can be obtained from more complete datasets.

Where this data is appropriately anonymised and analysed, it can be a valuable resource for businesses, households and academia to use to support energy-related decision-making across the city. In particular, making up to date and relevant data publicly available, the City of Cape Town can leverage this resource to better support private participation in the energy system so that independent power procedures and other energy service providers can make evidence-based decisions.

Energy data can also be a valuable resource for internal City processes and decision-making related to capital and operational expenditure and to deliver insight into customer and market trends that influence critical focus areas such as energy supply, demand and utility reform. Energy data should therefore be made available to the officials and applications that can appropriately make use of this data to support evidence-based decision-making.

The City therefore acknowledges the role it can play as an enabler and partner for navigating the energy system transition through enhancing the quality and availability of its energy data for use by a range of stakeholders and applications, whether within the City or external to the City.

Case Study: The State of Energy & Carbon Report

In May 2022, the City of Cape Town launched its 4th Cape Town State of Energy and Carbon 2021 Report. It highlights the key transitions already under way and still required in an energy sector that continues to be in turmoil and where greater public-private partnerships are increasingly emerging as tangible beacons for a more sustainable and secure future. The report aims to provide a data-rich evidence base for decision makers, support for researchers and planners as well as operational transparency in the energy sector. It looks at aspects of electricity, transport and waste and how these can transition to more sustainable operations. Coal-fired electricity remains the largest source of greenhouse gas emissions, while load-shedding across South Africa continues to limit economic growth, and electricity price increases add an unnecessary burden to households already under financial pressure The expansion of the scope of this publication to a 'State of Energy and Carbon' reflects the critical role of energy supply in climate action. For the first time, the full data set of the State of Energy and Carbon is available digitally on the City's Open Data Platform.

Outcome

Up-to-date and comprehensive energy datasets and related analysis are made available to applications and accessible by all energy system stakeholders to enable evidence-based decision-making.

City's Role

Deliver

Key City Action Areas

- Collect, prepare and keep up to date relevant energy datasets for public release on the City's Open Data Portal.
- Advocate for energy data sharing and access across energy system stakeholders.

- Make data available in formats that can be used by City applications to support decision-making.

4.5.3 Programme B.3 Energy Services Industry Support

There is an expectation that, as a larger variety and number of energy services are delivered to households and businesses, there will be an increase in the number of workers needed to provide these services; i.e. opportunities for entrepreneurship and job creation. Taking a more holistic approach to the achievement of energy security in Cape Town therefore requires consideration of how energy services are delivered too. In particular, the impact of energy poverty alleviation interventions can be further magnified through the targeted inclusion of energy service providers from the communities in which these services are being provided.

The City of Cape Town already has a number programmes that seek to support those looking for employment, entrepreneurs and micro-enterprises more broadly. These include the Entrepreneurship Academy, Jobs Connect and the Cape Skills and Entrepreneurship Accelerator, the Business Hub, to name a few. This programme would seek to build on the foundation these have already established and further expand them to include energy specific information, training and course materials.

Furthermore, the City will support the development of skills to meet this energy service demand through partnering with non-governmental organisations, civil society organisations and other relevant entities, such as SAREBI, to understand the type of skills needed to meet the demand for energy services and to develop appropriate training and entrepreneurial support programmes.

Outcome

Leveraging existing support programmes in the City, empower entrepreneurs, youth, and job seekers to take hold of opportunities offered by a growing energy services sector to increase economic participation and support a thriving energy market in Cape Town.

City's Role

Partner

Key City Action Areas

- Resource sharing: Share relevant City resources with existing programmes to provide the additional information on the energy system and related opportunities.
- Support training initiatives: Support the design and implementation of energy-specific training activities by other City departments and external partners.
- Industry engagement: Engage with the energy service industry to understand opportunities to link existing support programmes to industry work areas.

Addendum

Annexure A: Alignment of Energy Strategy with other City Strategies

The Energy Strategy is informed by and aligns with existing City Strategies, such as the Integrated Development Plan 2022 - 2027, the Climate Change Strategy, the Water Strategy, the Human Settlements Strategy, amongst a number of others. A summarised analysis of this alignment is represented in the table below.

	Strategy Description	**Commitment 1: Harness New Energy Supply**	**Commitment 2: Alleviate Energy Poverty**	**Commitment 3: Optimise Energy Use**	**Enabler A: Operate a Future-fit Utility**	**Enabler B: Action by all Capetonians**
IDP 2022-2027	The Integrated Development Plan (IDP) is the central strategy of the City of Cape Town (the City). The IDP communicates to residents, businesses and investors the City's long-term vision, and how the City plans to achieve it.	Obj. 3: End load-shedding in Cape Town over time - 3.1 Diversified energy supply programme	2. Improved access to quality and reliable basic services - 2.1 Mainstreaming basic service delivery to informal settlements and backyard dwellings programme - 2.1.B: Energy Access 8. Safer, better-quality homes in informal settlements and backyards over time - 8.1 Micro-developer and additional dwelling improvement programme	Obj. 3: End load-shedding in Cape Town over time - 3.2 Energy Demand response programme 8. Safer, better-quality homes in informal settlements and backyards over time - 8.1 Micro-developer and additional dwelling improvement programme 16. A capable and collaborative city government - 16.5 City facilities and property optimisation programme	4. Well-managed and modernised infrastructure to support economic growth - 4.1 Utility business model reform programme and 4.8 Excellence in energy service delivery programme	16. A capable and collaborative city government - 16.3 Evidence-based decision-making programme and 16.7 Community engagement and partnership programme
Inclusive Economic Growth Strategy	This strategy rests on six core principles: inclusivity, competitiveness, accessibility, resilience, sustainability and collaboration. These principles encourage inclusive, sustainable and resilient development, and will contribute	Quality Service Provision: Higher quality and extent of service delivery	Quality Service Provision: Higher quality and extent of service delivery	Quality Service Provision: Stimulating sustainable construction	Quality Service Provision: Higher quality and extent of service delivery	Quality Service Provision: Leveraging City Data as an economic Asset

	significantly to reducing vulnerability for those that are most at risk from climate hazards.					
Climate Change Strategy	The purpose of this strategy is to provide high-level strategic guidance for decision making, planning, and programme and project development and implementation in respect of climate change.	SFA 7: Carbon-neutral energy for work creation and economic development - Goal 12 & 14 CCWA 2: Economic impacts and green economy opportunities - Goal 28 & 29 SFA 2: Water Security and drought-readiness - Goal 3	SFA 6: Spatial and resource inclusivity - Goal 11 SFA 5: Managing fire risk and responsiveness - Goal 9	SFA 7: Carbon-neutral energy for work creation and economic development - Goal 14 SFA 8: Zero-emissions buildings and precincts - Goals, 15, 16, 17 SFA 9: Mobility for Quality of Life and Livelihoods - Goal 20 CCWA 2: Economic impacts and green economy opportunities - Goal 29	SFA 7: Carbon-neutral energy for work creation and economic development - Goal 13 CCWA 3: Business models, revenue and financing climate change response - Goal 31	CCWA 1: Mainstreaming, Governance, Research and knowledge management - Goal 27 CCWA 4: Communication, Collaboration and skills development - Goal 32
Water Strategy	This strategy sets out the City's high-level vision and plan for transitioning Cape Town to become "a water-sensitive city that optimises and integrates the management of water resources to improve resilience, competitiveness, and liveability for the prosperity of its people". Addressing the impacts of climate change, specifically drought, is a core concern of the strategy.	Commitment 3: Sufficient, reliable water from diverse sources		Translating the strategy into Action: Financing capital costs and setting tariffs		
Resilience Strategy	This strategy aims to put in place programmes and projects to address a set of prioritised chronic	Pillar 3: Capable, job-creating city - Goal 3.1: Foster	Pillar 2: Connected, climate-adaptive city - Goal 2.4: Innovate for improved	Pillar 4: Collectively, shock-ready city - Goal 4.3: Encourage responsible investment in	Pillar 5: Collaborative, forward-looking City - Goal 5.2:	Pillar 3: Capable, job-creating city - Goal 3.3: Connect

	stresses and acute shocks, including climate change and related climate shocks and stresses, and to increase Cape Town's resilience and reduce vulnerability into the future.	green economic growth Pillar 4: Collectively, shock-ready city - Goal 4.1: Future-proof urban system	conditions, service delivery, and well-being in informal settlements	household and business resilience	Mainstream resilience in city decision-making	the workforce with a changing economy Pillar 5: Collaborative, forward-looking City - Goal 5.3: Enhance knowledge management and data use
Human Settlements Strategy	The Strategy unpacks how the City will also leverage its roles and functions to enable and incentivise the formal property market to develop affordable housing that is safe, diverse and well-located. It aims to support the development of housing opportunities by all actors in the housing market – from the public sector to large scale property development companies to households seeking to develop an additional dwelling on their property.		The City as a provider of human settlements - informal settlements upgrading City as a regulator of human settlement - Backyarders	The City as a provider of human settlements - Breaking New Ground & Public Housing City as an enabler of human settlements - Urban design in human settlements		
Environmental Strategy	The City of Cape Town Environmental Strategy recognises the risks posed by climate change and natural hazards, and therefore commits the City to the following principle: "In taking decisions, implementing service delivery, operating, and planning for the future, the City will ensure a focus on	City purchasing of green and renewable energy is optimised, and household renewable energy and energy efficiency technologies (e.g. solar water heaters) are widely used;	The City actively drives and supports a green economy that results in expanded economic opportunities and more efficient production of goods and services, through improving resource efficiency, enhancing environmental resilience, and	All City operations, businesses and residents use energy and water optimally; a safe, clean, efficient, affordable and integrated public transport system servicing all parts of Cape Town is in place, safe bicycle and pedestrian paths and crossings are		All citizens know how to live in a more sustainable way, and make environmentally and socially responsible choices.

	resilience, enabling the city to withstand and mitigate the negative impacts of environmental hazards, proactively reduce Cape Town's vulnerability, and protect the city's economy."		optimising the use of natural assets, while promoting social inclusivity;	provided, and transport fuel use and emissions are dramatically reduced; City purchasing of green and renewable energy is optimised, and household renewable energy and energy efficiency technologies (e.g. solar water heaters) are widely used;		
Municipal Spatial Develop-ment Framework	This framework sets out the spatial vision and development priorities to achieve a reconfigured, inclusive spatial form for Cape Town. Fundamental to the framework is ensuring spatial transformation via dense and transit-oriented growth and development, anchored by an efficient transport system.	Strategy 2: Manage urban growth, and create a balance between urban development, food security and environmental protection - Facilitate land development to enhance the city's energy independence and efficiency by investing in renewable energy.	Strategy 3: Building an inclusive, integrated, vibrant and healthy city - Encourage integrated settlement patterns.	Strategy 2: Manage urban growth, and create a balance between urban development, food security and environmental protection - Ensuring ecological service provision is acknowledged, protected and enhanced to ensure a resilient urban form that can act as a buffer against the increasing climate risk and ensure that low carbon and green infrastructure are considered to meet ecosystem service provision.		

Annexure B: Energy Supply Scenarios

To frame the strategy, a series of scenarios were developed that incorporate a plausible range of outcomes from the critical uncertainties listed in the Context Chapter. These scenarios were then simplified to focus on the primary uncertainties that threaten energy security in the short term, that is:

1. The severity of the constraints on the national electricity supply system to meet electricity demand in Cape Town;
2. The time that these constraints will last.

Pairing these uncertainties against one another, the matrix in Figure 11 identifies six possible scenarios, with the most likely assumed to be those identified in blue. These are that the national electricity supply system will be highly constrained in the short to medium term and will move to a status of moderately constrained in the medium to long term. This translates to an estimated average of Stage 4 load-shedding experienced until 2032 and then Stage 2 until 2037. It was not considered plausible that there would be little to no constraint in the short, medium or long term. These scenarios are considered to be prudent for the City's energy planning purposes.

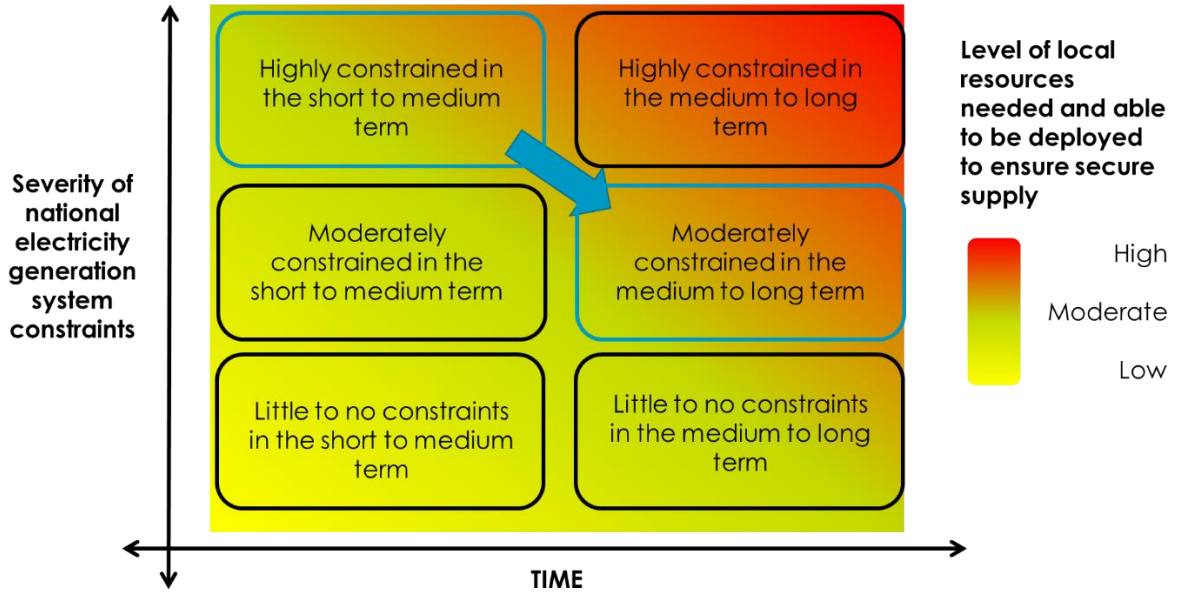


Figure 11: Overlaying the level of resource investment required to address national electricity system constraint scenarios.

To start unpacking how the City and other stakeholders may then intervene within this range of scenarios, a heat map is overlaid on to this matrix, as seen in Figure 11. This heat map speaks to the level of resources that the City of Cape Town and other energy system actors in Cape Town should reasonably expect to apply in order to remedy this threat to energy security. Resources include, but are not limited to, projects, money, and people. This is represented in the heat map where the higher the constraint over a longer period of time requires a higher level of resource invested; as represented by the following colour code:

- Yellow-green: A low level of resource required
- Green-orange: A moderate level of resource required

- Orange-red: A high level of resource required

This heat map is then matched to three proposed strategies that can be implemented, in Figure 12:

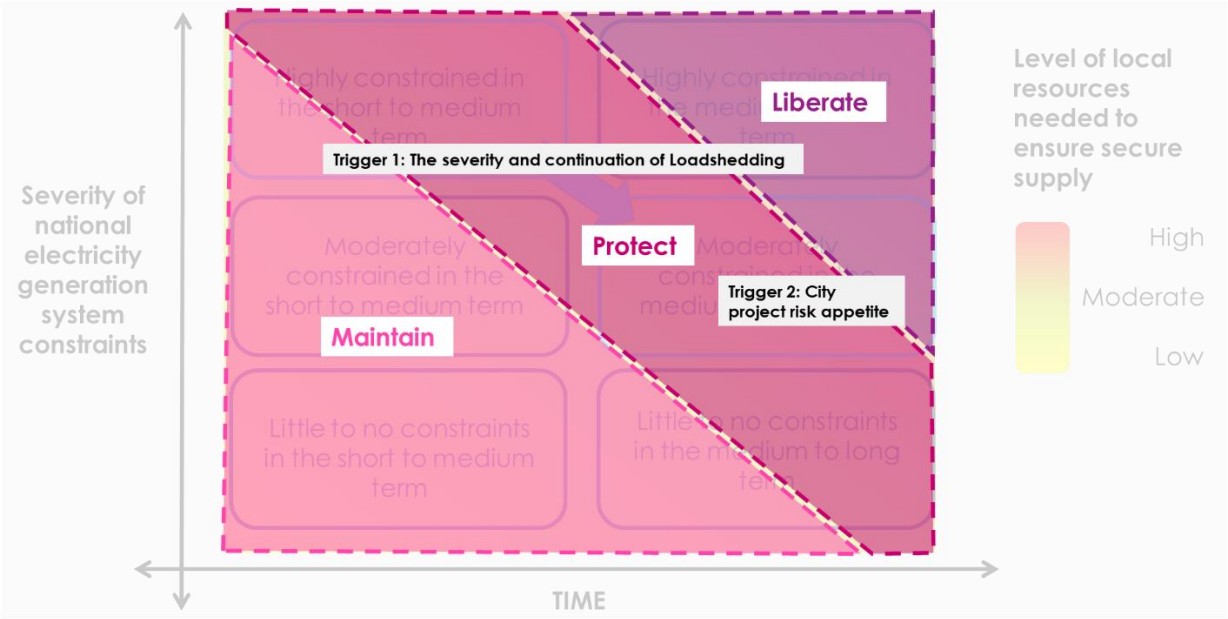


Figure 12: Identifying three strategies to map out intervention in the energy system for improved energy security.

These three strategies are described as and summarised in Figure 13:

1. A low level of intervention required translates to the strategy to **Maintain**: This strategy acknowledges that the City and other local energy system stakeholders are limited in their ability to significantly ramp up investment in to new assets and systems in the short term, nor is a high level of intervention required as this threat to energy security will dissipate without significant local investment. Therefore, it requires that the City and partners maximise the value and optimise the use of existing assets and resources, while focusing efforts on demand-side management measures to limit the impact of a constrained national electricity supply system. It is however expected that a portion of the market would invest a greater level of resources in order to diversify energy sources at a faster rate than this strategy. It is this trend that will determine the pace of utility reform. This strategy does not require the City to source additional electricity supply, but rather leaves that to the market to determine.
2. A moderate level of intervention required translates to the strategy to **Protect**: This strategy acknowledges that the City and other local energy system stakeholders can ramp up investment into new assets and systems in the medium term in order to mitigate load-shedding over a longer time period. Therefore, it requires that the City and partners prioritise investment in or procurement of energy from new generation & storage assets and increase demand response efforts to mitigate load-shedding up to 4 stages. All new assets invested in should have multiple use cases (dispatchability is a priority use case for initial investments and willing to pay a premium only in the short to medium term – but limit investment where this is the only use case). New energy generation sources that are

connected to the City's distribution grid are prioritised in the short to medium term, with generation sources attached to national transmission grid possible in the medium to long term. A steady and moderate pace of utility reform required to ensure cost recovery in a limited kWh sales market. Key principle is to provide policy certainty and support and encourage diversification by a range of actors.

3. A high level of resources required translates to the strategy to **Liberate**: This strategy acknowledges that the City and other local energy system stakeholders can significantly ramp up investment into new assets and systems in the medium to long term in order to mitigate load-shedding over a longer time period. City of Cape Town to significantly diversify electricity supply by rapidly investing in all new generation and storage assets – on our own grid, maximise net generation from embedded generators, and increase demand response efforts. Dispatchability as a sole use case for investment in an asset is permissible and the City and customers are willing to pay a premium in the long term for this. Only new generation sources connected directly to the City's distribution grid will be considered. Rapid pace of utility reform required to ensure cost recovery in a highly limited kWh sales market.

Considering the choice of these three strategies, the City has implemented the Maintain Strategy and has now moved on to implementing the Protect Strategy in the medium term. This shift was made due to the increased severity and frequency of load-shedding (Trigger 1). Although it is assumed that the national electricity supply system will continue to be at least moderately constrained in the medium to long term, the City will evaluate the need to implement the Liberate Strategy or continue with the Protect Strategy based on the energy outlook scenario within the next 10 years.

In the context of these three strategies, an energy supply model was developed to offer high-level insight into the implications of their implementation. This is shown through graphs that represent the four plausible scenarios of both short term energy security through load-shedding mitigation and longer term energy security through seeking out alternative sources of supply.

The four supply scenarios are summarised below:

- Scenario 1 - Maintain Strategy:
    - Load-shedding mitigation: Utilising Steenbras Hydro Pumped Storage and the enhancement of demand response programmes with large power users and residential customers.
    - Enhanced energy supply: Limited City intervention with market-led wheeling and SSEG would continue.
- Scenario 2 - Protect Strategy:
    - Load-shedding mitigation: Utilising Steenbras Hydro Pumped Storage in combination with 500 MW of dispatchable power supply for 10 years, and the enhancement of demand response programmes with large power users and residential customers.
    - Enhanced energy supply: Moderate City intervention up to 2030, then return to Eskom thereafter with market-led wheeling and SSEG.
- Scenario 3A – Liberate through city-initiated power:

    - Load-shedding mitigation: Utilising Steenbras Hydro Pumped Storage in combination with 500 MW of dispatchable power supply for 20 years, and the enhancement of demand response programmes with large power users and residential customers.
    - Enhanced energy supply: Moderate City intervention up to 2030, then an expansion of city-initiated generation programmes over time.
- Scenario 3B - Liberate through private power:
    - Load-shedding mitigation: Utilising Steenbras Hydro Pumped Storage in combination with 500 MW of dispatchable power supply for 20 years, and the enhancement of demand response programmes with large power users and residential customers.
    - Enhanced energy supply: Moderate City intervention up to 2030, then no expansion of city-initiated solar or wind generation programmes, the remaining supply is rather provided by an increase in private generation through wheeling, trading & SSEG.

	Maintain	Protect	Liberate	
Scenario	**Scenario 1:** limited city intervention:	**Scenario 2:** moderate City intervention in the medium term with a return to majority Eskom supply after 2032	**Scenario 3A:** moderate City intervention in the medium term with a ramp up in **public** sector investment in the longer term	**Scenario 3B:** moderate City intervention in the long term with a ramp up in **private** sector investment in the longer term
Benefits	Limited capital investment required	Level of investment does not limit investment in other city priority areas CT shielded from worsening load-shedding to a moderate degree	High degree of energy supply autonomy CT shielded from worsening load-shedding to a high degree	
Risks	Economic and social fall out from limited action if load-shedding continues and/or worsens	Some potential stranded assets (physical or contractual) Increased electricity costs	Potential for high number of stranded assets (physical or contractual) if situation changes rapidly Significantly increased electricity costs Level of investment may hamper investment in other City priorities Revenue decline under current financial model	

Figure 13: A summary of how the strategies are implemented across four key areas: energy supply, energy demand, network upgrades and utility reform, and outlines the benefits and risks of each.

The graphs below represent these four supply scenarios at a high level in two ways. Figure 14 takes a multi-year view and Figure 15 zooms in on a summer's day in 2030 for each of the scenarios to give a more detailed snapshot of the daily supply profile.

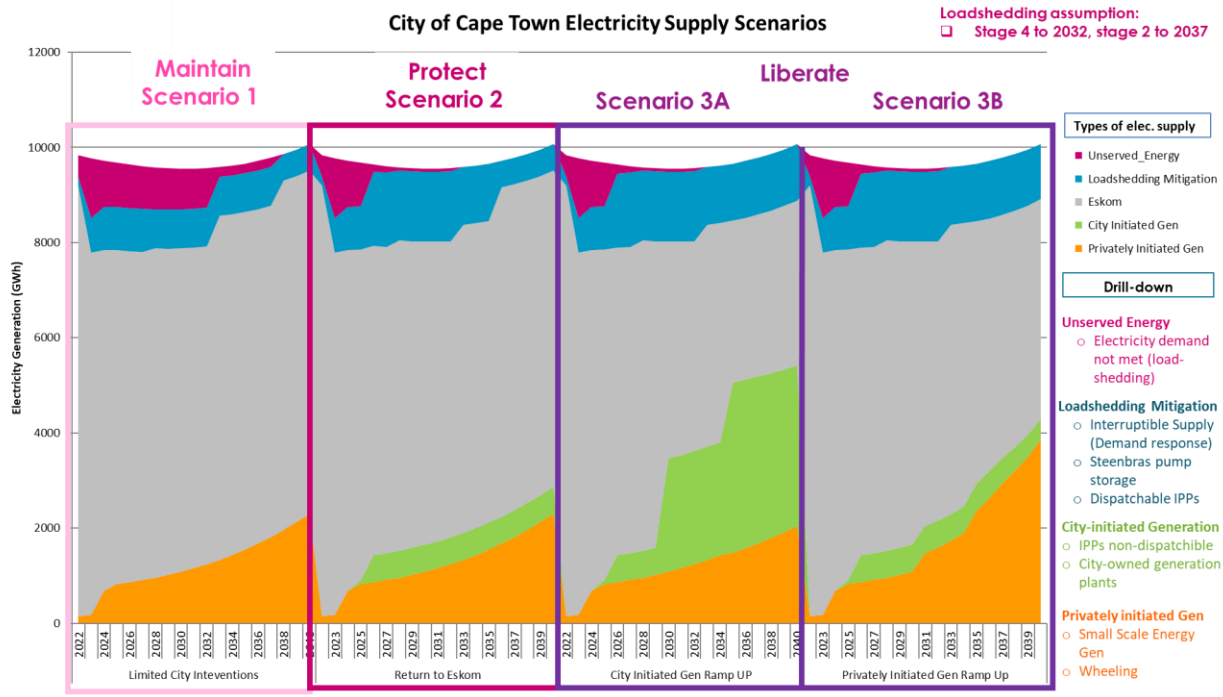


Figure 14: A graph showing a multi-year view of each of the energy supply scenarios from 2022 - 2040.

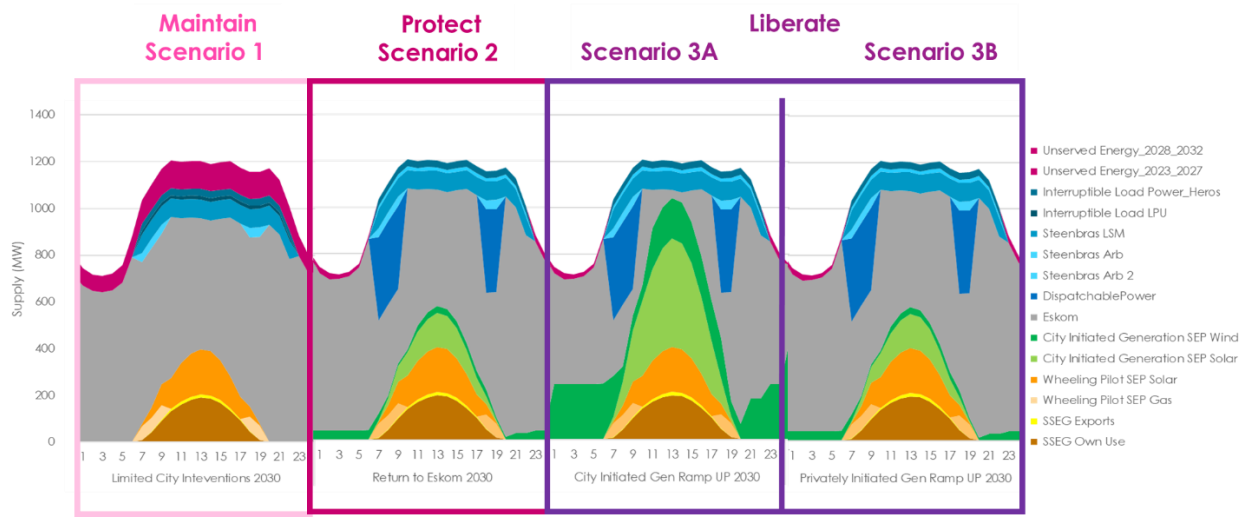


Figure 154: A graph showing a representative summer's day in 2030 from each of the energy supply scenarios to demonstrate the impact of different energy supply technologies on the daily energy balance.

The key takeaways from this high-level modelling that inform the Energy Strategy are:

- Without intervention from the City of Cape Town, customers in City Supply Areas would experience greater frequency and severity of load-shedding;
- Cape Town will, in part, continue to source electricity from Eskom in the long term – but not return to the current state of 99% reliance on Eskom;

- The role of the City as a bulk reseller of electricity is reducing as there is an increasing range of supply options available to customers;
- There are a diversity of decision-makers who now influence the electricity supply in City supply areas;
- There is a critical decision-making point around 2030, where the City will need to think through the optimal supply programme up to 2050 and whether to rely on public or private-led interventions (or a combination of these) to further reduce reliance on Eskom as an electricity supplier, with this decision being made on the basis of the relative costs of the different supply options;
- Consideration of the energy mix on a daily basis is critical – there is a need to balance the time of supply of different generation sources with the demand profile of different electricity customers. Not planning appropriately for this can result in significant costs for grid upgrades and ancillary services.