Long term financial modelling to inform electricity utility reform in the City of Cape Town Municipality

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Disclaimer: The research presented in this paper is for information purposes only and is in no way representative of any official policy position of the City of Cape Town Municipality.

1. Introduction

The energy system in South Africa is undergoing a fundamental transition. There are changes taking place in the demand for electricity, including rising energy efficiency, increased uptake of embedded generation, the emergence of wheeling, and increased uptake of electric vehicles in future. There are also shifts on the supply side, with Eskom unbundling into separate Generation, Transmission and Distribution businesses and the tariff restructuring that is expected to be associated with this. Additionally, a reform of the wholesale electricity sector is underway.

The City of Cape Town's Energy Strategy for 2050: *Our Shared Energy Future* holds that, as a central point of departure, there are changes taking place within the global and local energy system at present that have both known and unknown trajectories and impacts. Furthermore, the Energy Strategy acknowledges that the City of Cape Town must respond appropriately and timeously to cushion the negative impacts on citizens and the economy as far as possible, while taking full advantage of opportunities available during this energy transition.

Where these changes have a particularly high degree of uncertainty and have a high anticipated impact on the energy system in Cape Town, these are termed as 'critical uncertainties'. These critical uncertainties are noted for energy demand, energy supply, energy governance, and the energy system more broadly. Running concurrent to these changes, there are key actions that the City must undertake to transform in to a future-fit energy utility (Enabler A in the Energy Strategy). However, making long term decisions in a context with a high degree of uncertainty can be difficult and requires a specialised approach for decision-making.

Keeping electricity costs affordable through the energy transition is a critical priority, whilst at the same time, safeguarding the financial sustainability of the City's electricity utility, and the City as a whole, to ensure ongoing service delivery. T this end, tThe City of Cape Town Municipality commissioned a research project to further deepen the understanding of these uncertainties and their impacts, especially on the current financial model of the electricity utility. With this developed as a more substantial problem statement, it was then possible to outline a range of financial and tariff reforms that could provide meaningful benefits to customers and support the long term financial sustainability of the City's electricity utility.

The research addressed the uncertainties and future transitions in the energy system, providing the City with a decision support tool for strategic planning and policy-making. Importantly, this research did not result in any specific policy decisions or statements yet. The ultimate goal was to guide the City in navigating the energy transition, ensuring optimised and effective infrastructure investments, financial resilience, and a sustainable municipal electricity utility. The deliverables included a comprehensive decision support tool, impact analysis, and training for City staff, ensuring the practical application of the research outcomes. This paper provides a summary of the results of this research and a reflection on the value of such research for municipal utility reform processes more broadly.

2. Overview and Results of the Long Term Financial Modelling Research

This paper outlines the research project initiated by the City of Cape Town Municipality entitled "Long Term Electricity Scenarios for Cape Town and their Implications for Financial Sustainability of the Municipal Electricity Utility." This research has quantified the possible impacts of the energy transition on the finances of the City's electricity utility and explored options for financial and tariff reform to respond to these impacts. The project was structured into three phases and was conducted from July 2023 – June 2024.

Table 1: Summary of the three phases of research

	Key question answered	What was done
Phase 1	What is likely to happen to the demand and supply of electricity via the municipal grid between now and 2040?	Quantitative modelling and analysis was undertaken assuming different scenarios about the drivers of change within the Energy system. These scenarios focussed on shifts relevant to the financial model of the municipal electricity utility.
Phase 2	What will be the financial impact be if the municipal financial model remains the same?	The implications of the quantitative scenarios were assessed for the City electricity utility's financial sustainability under the current financial model. In other words, if CCT's electricity utility uses the same business model, what is the impact of the scenarios modelled in phase one. A long-term view (20 years) of the revenue and expenditure trajectory of the municipal energy business was generated assuming the existing financial model and tariff structure held constant.
Phase 3	What financial and tariff reform options can the City want to consider to mitigate this impact?	The risks and implications of the different scenarios were analysed in terms of the financial and tariff reform programme (CT draft Energy strategy) and how the nature, scale and pace of these activities would need to change in order to achieve the programme outcome.

2.1. Phase 1: Quantitative Scenario Modelling

This phase involved developing a range of projections for each critical uncertainty and then combining these in to plausible scenarios that can be used in Phase 2 to 'stress test' the current financial model of the electricity utility. The full list of the critical uncertainties interrogated in this phase is below:

Energy Supply:

- National electricity unavailability (i.e. load-shedding frequency)
- Eskom wholesale tariff increase
- Eskom wholesale tariff restructure (i.e. pace of implementation of higher share of fixed costs)
- Cost of alternative supply options

Energy Demand

- Growth in number of customers
- Growth in number of customers receiving free basic electricity
- Uptake of electricity efficiency measures
- Uptake of embedded generation and behind-the-meter storage
- Uptake of wheeling across City grid
- Uptake of electric vehicles
- Losses (technical & non-technical)
- System energy: sales (incl. departmental) & losses (GWh)

The tool developed provides a set of plausible projections, ranging from very low to very high, for each of the uncertainties listed. These were predominantly based on existing datasets and engagements with key individuals where data was not readily available. An example of this is shown below for the City Utility System Energy (Sales & Losses). For each of these uncertainties, the tool differentiates between actual data and projected data, and provides functionality to update these graphs with new actual data that can be compared to the projections. This allows for the tool to be used on a regular basis by the City to more deeply understand the changing energy landscape. These projections were then grouped in to three scenarios as shown in Table 1.

Table 2: Summary of the projection for each critical uncertainty and the grouping of these in to the three scenarios

Energy system driver	Research Scenarios		
	Scenario 1	Scenario 2	Scenario 3
Scenario name>	**System in Shock**	**System constrained**	**System functional**
SUPPLY			
National electricity unavailability (i.e. load-shedding frequency)	Very high	High	Very low
Eskom wholesale tariff increase	Very high	High	Medium
Eskom wholesale tariff restructure (i.e. pace of implementation of higher share of fixed costs)	Low	Medium	Very high
Cost of alternative supply options	High	Low	Medium
DEMAND			
Growth in number of domestic customers	Very high	High	Medium
Growth in number of small power user & large power user customers	Very low	Low	Medium
Growth in number of domestic customers receiving free basic electricity	Very high	High	Medium
Uptake of electricity efficiency measures	Low	High	Very high
Uptake of embedded generation	Low	Very high	High
Uptake of behind-the-meter storage	Very low	Very high	Very low
Uptake of wheeling of electricity across City grid	Very low	Medium	High
Uptake of electric vehicles	Very low	Low	Very high
Electricity losses	Very high	Medium	Low
City utility system energy (sales & losses)	Low	Very low	Very low

The Phase 1 scenarios present a picture of significant change in the demand for energy. There are four key drivers of this change:

1. **Energy efficiency**, much of it related to building regulations and not behaviour change, will drive the overall demand for electricity down.
2. Increased uptake of **embedded generation** will mean that households and businesses are generating their own power and using this rather than buying power from the City or others.

3. Large industries and eventually smaller industry and commercial customers will be purchasing power directly from IPPs and **wheeling** it through the City's grid rather than buying it from the City.
4. **Electric vehicles** will boost the demand for energy, but uptake will be slow, and impacts will only be felt strongly in the medium to long term.

The energy scenarios also present a picture of significant change in the composition of customers in the long term. The energy scenarios developed for Cape Town indicate a declining share of sales to industrial customers in the long-term as they increasingly invest in on site energy generation and choose to wheel electricity from IPPs.

The composition of customers is highly relevant to the future financial sustainability of the utility. The City currently cross-subsidizes Lifeline, Domestic and Small Power User customers from sales to Home Users and Large Power Users (LPUs). The modelled declining sales to LPUs threatens the City's cross-subsidization model.

There are also significant changes anticipated on the supply side. By 2040:

1. **Eskom will have unbundled** into separate Generation, Transmission and Distribution businesses.
2. Tariff restructuring will be associated with this unbundling, and **Eskom will be recovering a far larger portion of its expenditure through fixed charges.**
3. There will have been some reform of the wholesale electricity market, with multiple generators, but **Eskom will still be dominant**.

Changes in Eskom's tariff structure towards fixed charges will have major implications for the electricity utility financial model of municipalities, as bulk purchases of electricity from Eskom are currently the largest driver of operating costs. If municipal utilities cannot recover this cost from customers appropriately and effectively, the financial sustainability of the utility is at risk.

2.2. Phase 2: Financial Implications Assessment

The second phase evaluates the financial sustainability of the City's electricity utility under the scenarios developed in Phase 1, considering revenue streams, legal and institutional frameworks, and expenditure requirements. In Phase 2, a financial model of the electricity utility was developed to provide a high degree of detail to understand the implications of these scenarios between 2023 and 2040. Importantly, the model was designed to ultimately indicate the required tariff parameter increases required if the electricity service is to remain tariff funded.

The Phase 2 modelling found that the GWh of electricity sold by the City will decline under all three of the Phase 1 scenarios.

The decline is driven by *increased energy efficiency* (greater increases under Shock and System Constrained compared to System Functional) and *uptake of embedded generation* (the same under all three scenarios).

- System Constrained has the highest uptake of *wheeling*, and as a result the lowest projected kWh sold.
- Higher growth of industrial and commercial customers plus lower efficiency uptake and lower wheeling uptake mean that sales are significantly higher under System Functional than under System Constrained.
- Sales start to pick up again after 2036 for System Functional and (to a lesser extent) for Shock, due to *uptake of electric vehicles*.

GWh sales are the current revenue base for electricity, including the base for funding all cross-subsidies and surcharges. This revenue base has been reliable for decades but is now declining.

The Phase 2 analysis also found that the composition of the customer base is expected to change significantly. By 2040, the share of sales to non-residential customers (LPUs and SPUs) will likely have decreased under all scenarios

- Under System Constrained, the research projects very low to no sales to large industrial customers by 2040 and sales to small industrial and commercial customers will be significantly lower than current, due to high proportions of wheeling and market participation by these customers
- Under Shock and System Functional, there may still be some sales to large industrial customers, although less, and sales to small industrial and commercial customers will be a larger share.
- The share of sales that are to Lifeline customers is higher by 2040 under all three scenarios, with the increase in share larger under System Constrained and System in Shock than under System Functional.

Declining energy sales to large industrial customers threatens the City's cross-subsidisation model and places more demands for cross-subsidisation on Home Users.

Eskom has long noted that its tariff structure is not cost-reflective and has signalled that it wants to transition to recovering a larger portion of its revenues through fixed charges. This is likely to be associated with its unbundling, as the different businesses (Generation, Transmission and Distribution) have different fixed/variable compositions of cost. The three scenarios also made different assumptions about the extent of Eskom bulk tariff price increases, with System Functional assuming that these would decline from current levels steadily and increase only by inflation from 2031 onward; while System Constrained assumed that they would remain at approximately 4% above inflation from 2031 onward; and Shock assumed that they would remain at approximately 7% above inflation from 2031 onward. Together, these assumptions mean that the Phase 2 analysis found that bulk purchases expenditure continues to rise, even as GWh of electricity sold by the City declines.

The tariff restructure means that bulk purchases cost will be driven largely by Notified Maximum Demand (NMD) and not GWh purchased from Eskom. As bulk purchases are the largest share of total expenditure, total operating expenditure also continues to increase under all three scenarios. A far smaller share of expenditure will be due to energy costs in future, with the share of expenditure that is driven by demand, administrative and capacity costs share projected to rise from current levels.

Electricity tariffs increased by 3.5 times the level of inflation between 2006 and 2023. Without any changes to tariff structures or the funding mix, if kWh sales decline in future but expenditures continue to rise, large tariff increases (above CPI) may be necessary to ensure that sufficient revenue is generated to cover costs. However, sustained increases of this level are be affordable to customers. Phase 3 of the study therefore looks to what financial and tariff reforms the City might implement to mitigate the need for increases of this magnitude or at least ensure that they are borne in an equitable manner.

2.3. Phase 3: Developing a menu of plausible reforms

The final phase involved identifying a wide range of possible reforms to address the problem statement of an unsustainable financial model established by the work in Phases 1 & 2. This Phase of the research did not intend to determine what the City should do in terms of tariff reform, but rather identify the full range of options for what it could choose to do. These reforms were then evaluated against four key characteristics of a good revenue source: equity, feasibility, revenue adequacy, and economic efficiency; as found widely in literature and public finance theory and defined in Table 2 below.

Table 3: Characteristics of a good revenue source

Criterion	Explanation
Revenue adequacy	A good revenue base is as **broad** as possible. It is **elastic**, meaning that it grows as much or more as the expenditures that it needs to fund. It is **certain** and **stable**.
Economic efficiency	Taxes and charges should be levied in such a way that they **result in optimal use of a service**. They should not discourage use by being set too high, nor encourage over-use by being set too low. Economic efficiency is therefore linked to the price signals that a tax or charge sends and the financial incentives that these price signals create. Efficiency is typically achieved if a volumetric tariff is set at the marginal cost of an additional unit consumed. It is also achieved if the base for levying a tax or charge is linked to the cost driver for the expenditure funded. For example, if the cost of supplying a service is linked to the kWh supplied, then a charge levied per kWh will give the customer an accurate price signal of how much cost is saved if they reduce their consumption by a kWh.
Equity	Tariffs and taxes should be fair in their allocation of burdens. 'Fairness' is a complex principle and means different things to different people. In economics, it typically incorporates some combination of **ability to pay** (people with greater income or wealth should pay more), **benefit** (people who benefit more should pay more) and **responsibility** (those who create the need for a good should pay more for it).
Feasibility	Tariffs and taxes should respect **administrative** and **legal** implications. It should be possible to implement those using existing systems and data, or it should be feasible to upgrade systems and gather the required data. It should be possible to implement them within existing legal frameworks, or it should be within the power of the entity to amend the legal frameworks to allow them to be implemented. *Regarding feasibility, it is important to note that this report was prepared while the Electricity Pricing Policy was under review. Proposed amendments to this policy were published for comment in 2022 but a final version had not yet been published by the time of writing (in mid-2024). The report has included consideration of the published proposed amendments to the Electricity Pricing Policy when evaluating feasibility. It is possible that these may change in the final version of the policy.*

The tariff reform options considered in Phase 3 are organised as responses to the five key trends shown in Table 3. Once again, please note that this table is not indicative of any policy or related decisions.

Table 4: Groupings of options for change in response to anticipated future shifts in the electricity supply system

Key future shift	Implication for electricity pricing	Responses
The City will have more choice about supply mix	This means that *there is a need for a clear basis for comparing the prices of different supply options,* including City own Generation, IPPs and Embedded Generation exports.	*Ensure accurate pricing of Own Generation and Embedded Generation exports*

The City's business will shift away from retail and towards grid services	The City needs to *cost new services, including wheeling and acting as a back-up source of supply for customers. Ancillary services* required to keep the grid stable will become more important.	*Ensure that costs are accurately allocated* to those that create the need for them *and increase transparency around different components of electricity utility bill.*
Customers will have more choice about how to supply their electricity needs	Customers *need clear price signals to allow them to make investment decisions* (including embedded generation systems, batteries, inverters, heat pumps etc.) as well as the decisions about how much electricity to use and when.	*Match charges to costs more closely*. This will require *managing impacts on ability to pay* and *on Embedded Generation* and may necessitate *offering choice*.
kWh of energy sold will no longer be a reliable base for surcharges and subsidies	Wheeling and EG mean that *the City no longer has a monopoly on supplying electricity*. kWh sales are declining and may do so more in future.	The source of current *surcharges and subsidies* needs to be reviewed to ensure sustainability. Improve the *equity and efficiency of cross-subsidies*
There will be a greater need to manage load on the system plus a greater ability for some customers to do so	Increased use of batteries, inverters, heat pumps and electric vehicles will give *some customers more ability to shift the timing of their electricity demand*. *Rising Eskom network access and/or demand charges* will mean that reducing Notified Maximum Demand or chargeable demand will be the biggest lever that the City has to reduce its costs.	Customers need *clear financial incentives to encourage them to shift their load* and participate in providing grid services, if available. Expand *incentives to encourage load shifting and the provision of other ancillary services.*

Each responses was then further unpacked to identify the specific tariff reform options available. In total, twenty-six options were identified. In some cases, options can be evaluated in isolation of each other. In other cases, there is a choice between options or choosing an option will result in additional options emerging. This is represented in the decision tree below. An example of this is, when considering the introduction more cost reflective tariffs, it is important to implement measures that manage the ability of certain customer groups to pay for these.

Options for change identified under this study were assessed based on their performance against the characteristics of a good revenue source shown previously in Table 3. A simple traffic light system was used to evaluate the options as shown in Table 4. These tables provide a high-level summary of the detailed analysis that was undertaken for each of these tariff reform options. Where there are areas of concern highlighted, it does not mean that the tariff reform option should not be pursued. Rather, it means that further investigation and work is required to address these concerns when considering that option for implementation.

Figure 1: Key to 'traffic light' system applied in evaluating options – not indicative of policy

Category	*Name*	*Revenue adequacy*	*Economic efficiency*	*Equity*	*Feasibility*
Ensure accurate pricing of Own Gen and EG exports	**Introduce Own Generation tariff**				
	Ensure that FITs are efficient				

Allocate costs accurately	Accurate cost allocation to Generators				
	Cost ancillary services				
Match charges to costs more closely	Expand administrative charges				
	Expand Network Access Charges (NACs)				
	Eliminate IBTs for all Residential Customers				
	Recover all admin and capacity costs through property rates				
Manage impact on ability to pay	Lobby National Treasury to remove VAT on Lifeline tariffs				
	Link fixed charges to income				
	Link fixed charges to property value				
Manage impact on EG	Discontinue subsidies for EG				
	Provide transparent, time bound incentives for EG				
	Remunerate EG customers for ancillary services				

Category	Name	Revenue adequacy	Economic efficiency	Equity	Feasibility
Improve equity and efficiency of cross-subsidies and surcharges	Reduce Contribution to Rates (CtR)				
	Calculate CtR based on actual sales, not budget				
	Phase out electricity funding of public lighting				
	Introduce separate public lighting charges in all supply areas				
	Fund electricity cross-subsidies and surcharges through rates				
	Fund electricity cross-subsidies and surcharges through visible charges				
	Lobby NT for adjustments to Local Government Equitable Share (LGES) formula				
	Lower property value thresholds for Lifeline and Domestic customers				
Expand incentives to encourage load shifting	Expand demand charges				
	Expand TOU pricing				
	Introduce Critical Peak Pricing (CPP)				
	Offer choice				

Table 5: Summary of the evaluation of each tariff reform option against the four characteristics of a good revenue source

Going forward, the City will use this research to develop proposals for tariff restructuring over the short and medium term, highlighting where certain more disruptive reforms may require more investigation before a decision can be made about their implementation. From the literature review, along with international case studies, a key lesson for implementation is to start small and early and scale up over time, rather than delaying implementation and then being forced to institute large shifts in the tariff that will cause significant disruption for customers and the economy.

3. The Value of this Research for Municipal Electricity Utilities

The value of this year-long research endeavour is evidenced in the current use of these outputs:

- Supporting decision-making in the City with a strong business case for tariff reform,
- Sharing the results more broadly so that a common understanding of the challenges of financial sustainability of the municipal utility can be developed, and
- Supporting advocacy and intergovernmental collaboration where the mandate for implementing necessary change lies beyond the City of Cape Town and where collaboration on implementation is required or would be beneficial.

This is further strengthened by the collaborative process by which this research was undertaken in partnership between the City's Finance, Energy, and Future Planning and Resilience Directorates, along with senior City leadership that included the City Manager and Executive Mayor. This collaboration was formally established as the Energy Finance Task Team. This structure has provided input, guidance, and a space to digest and reflect on the results of this research in a holistic and collaborative manner, from the perspective of the broader municipality, not only the electricity utility. This has been a critical factor in making this research a valuable exercise, where it became a vehicle for developing a common understanding and shared ownership of these long-term financial implications for the electricity utility and municipality. This broad-based approach to project development has created a strong foundation of understanding and collaboration to take forward into the next phase of design and implementation for tariff and financial reform.

The Energy Strategy's implementation has benefited significantly from this research too through establishing a more quantitative basis for scenario planning and the implementation of priority reform programmes. While it may not be appropriate for all municipalities to undertake research of a similar scale and depth with support from external service providers, it is suggested that municipalities chart out a collaborative exercise to understand the range of plausible scenarios of change in their municipal energy system, the financial state of their utility under the stress of each of these scenarios, and determine a menu of options of how to proactively respond. This will contribute to a more financially sustainable and future-proof municipal utility, while at the same time supporting customers and local economies to navigate the energy transition in a way that creates the greatest benefit possible.

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