A Just Energy Transition Starts with JUST Tariffs

A Cost to Serve (CTS) Study at eThekwini Municipality

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I. ABSTRACT

The paper highlights the cost to serve study within eThekwini Municipality and describes the overall process of carrying out such studies. In addition, the study elaborates on tariff structural reflectivity and its importance within tariff design for municipalities.

Introducing Distributed Energy Resources (DERs) and storage options are changing how customers traditionally use the grid. Traditional tariff structures (highly volumetric) as applied by eThekwini Municipality for the residential and business sector are becoming inefficient and will soon be obsolete. In the interest of municipal sustainability, there is a need to introduce tariff structures that are cost and structurally reflective. The tariff structures should also promote cost and price competitiveness compared to alternate generation and storage technologies to cater to changing conditions.

The paper evaluates the cost and structural reflectivity within the electricity tariffs of eThekwini Municipality per sector. The sectors include residential, business and industrial. The paper further proposes future tariff amendments to achieve structural reflectivity. Ensuring a high level of structural and cost reflectivity is key to the future sustainability of the distribution network.

Utilising a balanced budget, limited by annual tariff increases, indicates that eThekwini Municipality is 97% cost-reflective in its ability to recover the overall costs; however, tariff structural reflectivity for the residential sector is at 33%, the business sector at 40% and the Industrial sector met all the structural reflectivity criteria and resulted in 100% compliance based on the identified criteria. However, considering outstanding backlogs/projects, up to a further R3bn above the balanced budget, the overall cost reflectivity dropped to 87%.

II. KEYWORDS

Electricity pricing, cost-of-supply, distribution network, tariff restructure

1 BACKGROUND

1.1 The South African Cost to Serve Frameworks

Public utilities must provide their service at rates that are deemed reasonable and non-discriminatory [1]. Attempting to broadly uphold this criterion, the electricity supply industry (ESI) within South Africa is regulated by the National Energy Regulator of South Africa (NERSA). Cost to serve principles is guided by the NRS 058: Cost of supply methodology for application in the electrical distribution industry. The NRS project has issued the specification on behalf of the User group however is not a standard as contemplated in the standards act, 1993 (Act 29 of 1993) [2]. However, NERSA has included the specification for implementation at a municipal level via the grid codes. Compliance with the grid is a licence condition for Municipalities. NERSA has also published a cost of supply document to guide the industry further [3]. Both documents are comprehensive in their approach; however not prescriptive as the availability of data and the tariffing method differs per utility. The non-prescription allows flexibility in the composition of the study and the interpretation of the results thereof.

1.2 Understanding The Challenges of Carrying Out Cost to Serve Studies

The success of the cost to serve study is hinged on the availability and ringfencing of data. Municipalities with a high level of data and information at the granular level will be able to carry out a cost to serve study with high accuracy and confidence. However, as the quantity and quality of data degrade, the accuracy and confidence of the study decline. Therefore, there must be a balance between data availability and the quality of the cost to serve results. The data required for a cost to serve study within municipalities depend on the availability of various systems, which would provide the necessary technical and financial information. However, with the lack of systems, data availability is low. Therefore, many municipalities cannot carry out the detailed cost to serve studies.

1.3 Importance of Cost to Serve Studies for Municipalities

With the rapid introduction of renewable energy technologies, the role of the grid is inevitably changing, and the methods of tariffing have to change too. Therefore, recovering the costs imposed by renewable energy fairly and transparently is of great importance for the sustainability of utilities [4]. Furthermore, accurate cost allocation and tariff design incentivise appropriate customer response [5]. Therefore, innovative cost-reflective tariffs aligned with municipal and customer needs are critical.

Furthermore, the tariff structural reflectivity study provides the basis for understanding the complex relationships between customers, cost causation and cost recovery via the tariff structures. Their existence is therefore not only necessary but also essential for informing and preparing for future tariffs. However, it is also important to acknowledge that the benefit of the cost to serve study can only be harnessed should the outcomes be endorsed and implemented by the regulator.

A snapshot within Africa indicates that only Uganda and Seychelles have suitably designed tariffs to recover their total revenue requirement. Others have tariff structures that cannot adequately recover the costs of rendering their service. South Africa is included in the countries that cannot recover their total operating costs within the tariff structures.

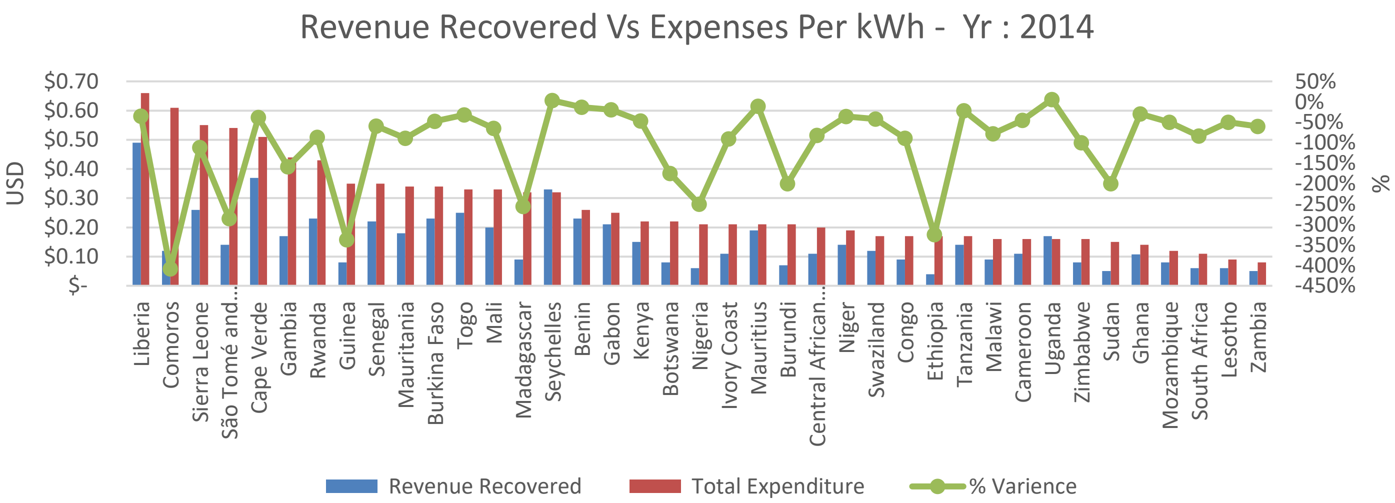


Figure 1 Level of cost recovery per country in Africa [6]

2 INTRODUCTION

The success of any business is underpinned by the ability to accurately and transparently recover the costs it incurs in providing a service. Municipalities are no different. Therefore, the electricity activities must be separated, i.e. ringfenced, from the remainder of the services the municipality renders. The basic principles of the cost to serve methodology are based on the ability to identify the costs, allocate the costs to customer categories and then utilise the costs to design the appropriate tariff (rate and structure) per customer category.

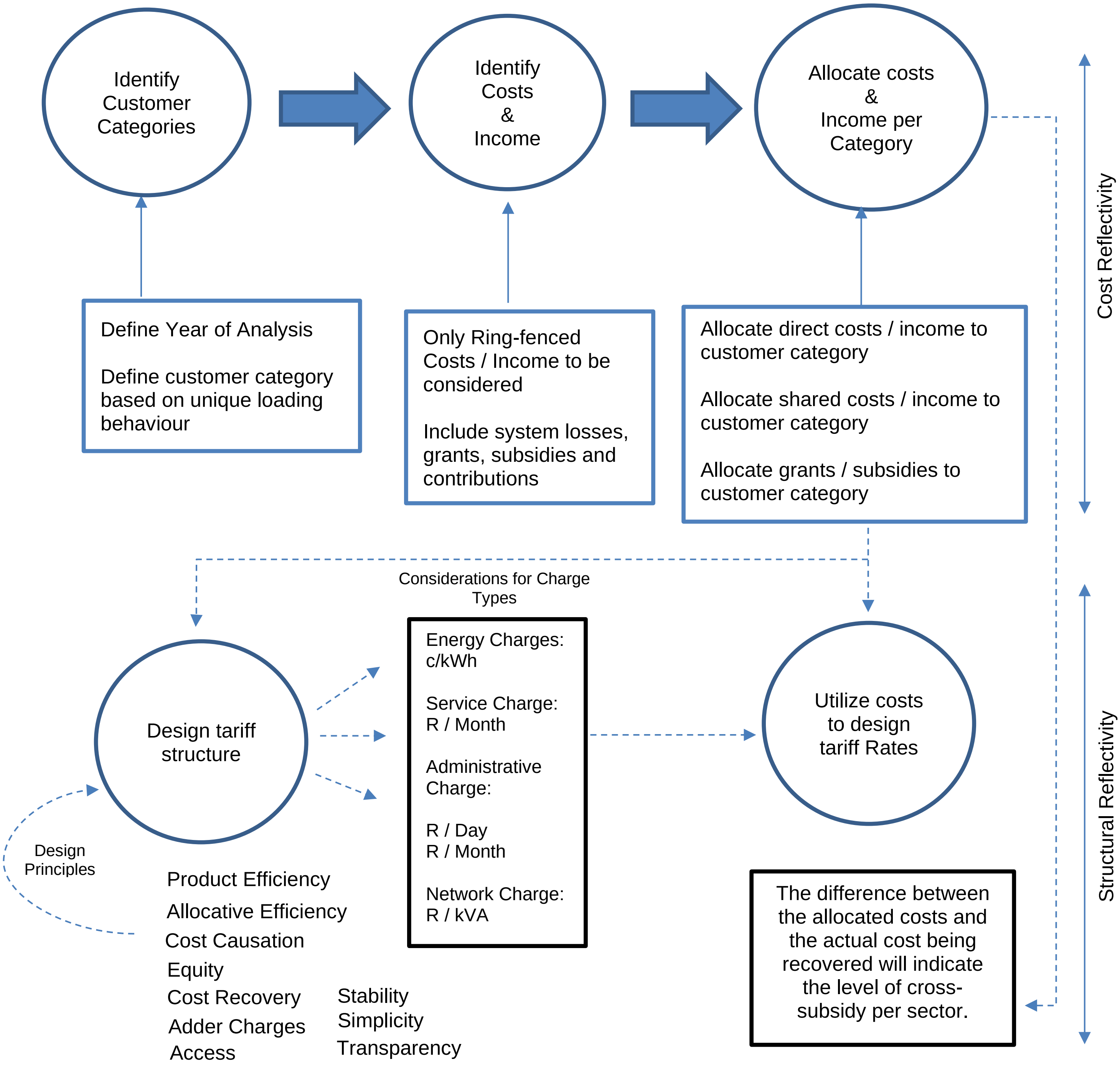
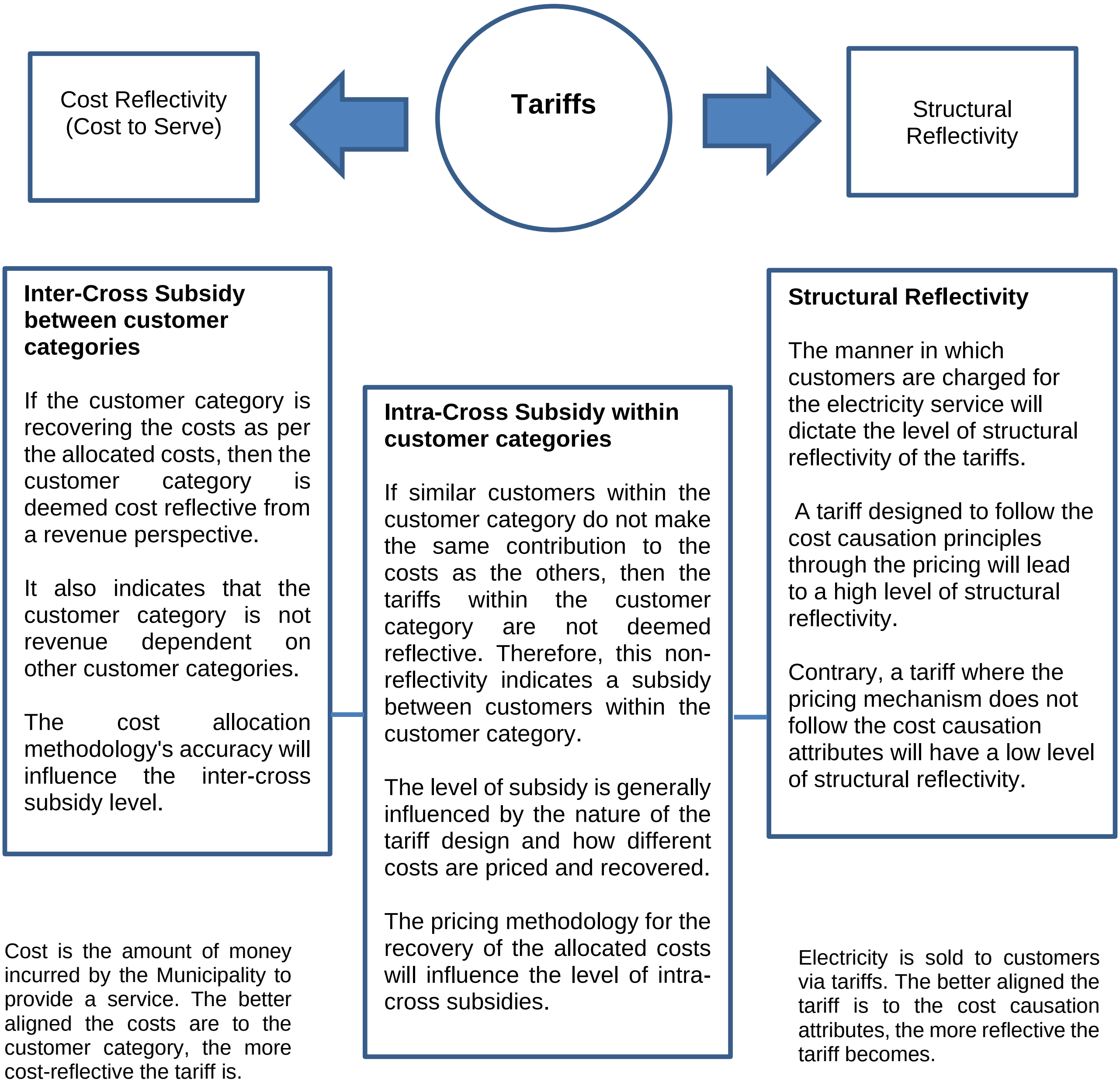


Figure 2 EThekwini Municipality revenue recovery model – Own elaboration based on [2], [3]

The variance between the actual cost recovered and the allocated costs will indicate the level of subsidisation. The customer category is subsidised if the allocated cost exceeds the recovered cost. Conversely, when the actual cost recovered is greater than the allocated cost, the customer category provides a subsidy. The accuracy of the cost identification and cost allocation process is key in correctly establishing the level of subsidisation that the customer category is providing or receiving.

2.1 Understanding Cost Reflectivity and Structural Reflectivity

In the context of this paper, tariffs are evaluated from two perspectives. These perspectives are illustrated below.



Poor cost and structural reflectivity do not provide the correct signals for customers to respond. Moreover, traditional tariff structures do not represent the customer's true network impact as expenses are generally socialised [5]. The migration to cost and price reflectivity is therefore imperative for the future sustainability of municipalities.

Figure 3 Tariff relationship with costs reflectivity and structural reflectivity

3 IDENTIFICATION OF COSTS

The more granular the level of identifying costs, the more accurate the methodology. However, there needs to be a balance between the number of cost items to use verse the time and effort it takes to identify and synthesise such costs. Municipal budgets consist of many itemised costs. Understanding the cost allocation of all items is a time-consuming process. Further, many of the cost items cannot be easily and directly attributed to a customer category. There is also an element of cost-sharing among customer categories.

In the spirit of simplification, reference is made to the National Energy Regulator of South Africa (NERSA) tariff guideline and benchmark document [7]. This document guides the industry in terms of the average yearly tariff increases. In addition, the document refers to 5 major cost items within municipalities that are representative of the total budget.

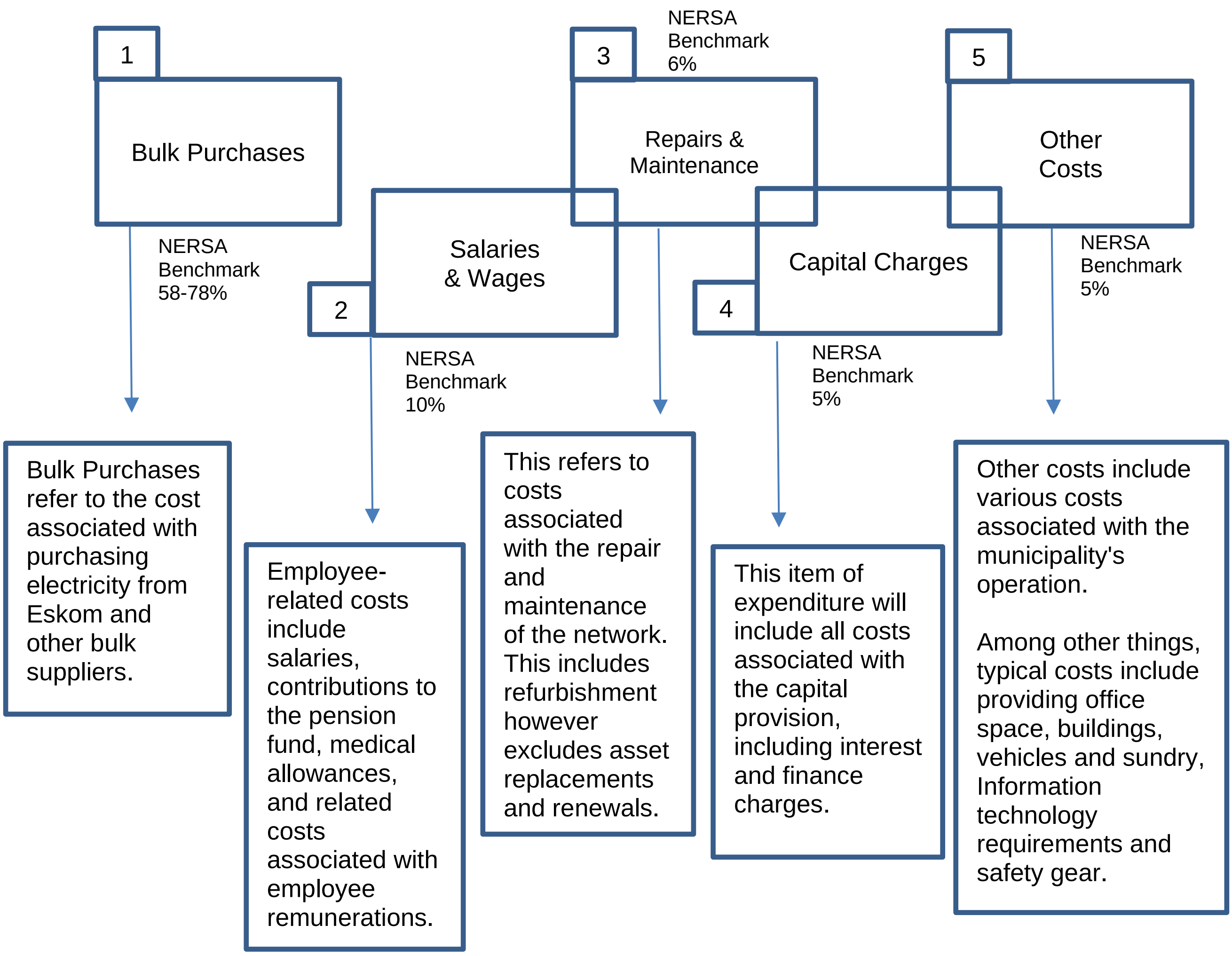


Figure 4 Typical costs within municipalities – Own elaboration based on [7]

The benchmark document indicates the contribution of each cost item to the total budget. Based on this, it is evident that the accuracy with which each cost item is allocated to each customer will influence the accuracy of the cost reflectiveness in that proportion. It will therefore make sense to pay particular attention to how the high expenditure items are allocated to the tariff categories.

The dominating expense item is Bulk Purchases accounting for 62% of the total expenditure in the case of eThekwini. Salary & wages (10%) and repairs & maintenance (6%) in addition account for a further 16%. These three expenditure items represent over 90% of the overall expenditure. Efforts should therefore be placed on rationalising these expenditure items per the identification of costs and the allocation per customer category. Accurate identification and allocation would allow for a high accuracy within the study.

3.1 Other Costs for Consideration within the Budget

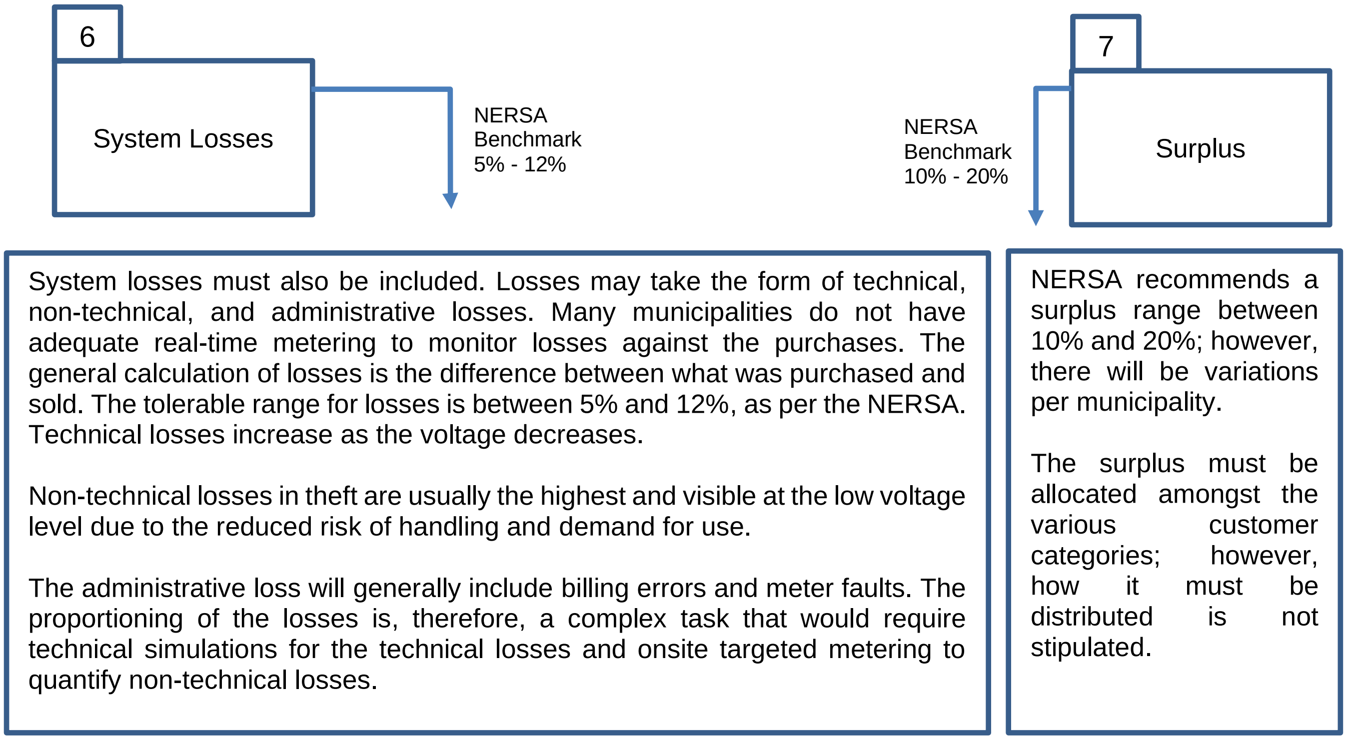


Figure 5 Other relevant costs within Municipalities – Own elaboration based on [7]

3.2 Identification of Income

It is also essential to understand the income per customer category. The comparison of the allocated costs with the actual income will give clarity on the level of subsidisation. The majority of income for municipalities will be from the sale of electricity. Other income will include insurance income and connection charges. In the case of eThekwini, income is also received from the rental of facilities and equipment. However, the other income is usually small compared to the income from the sale of electricity.

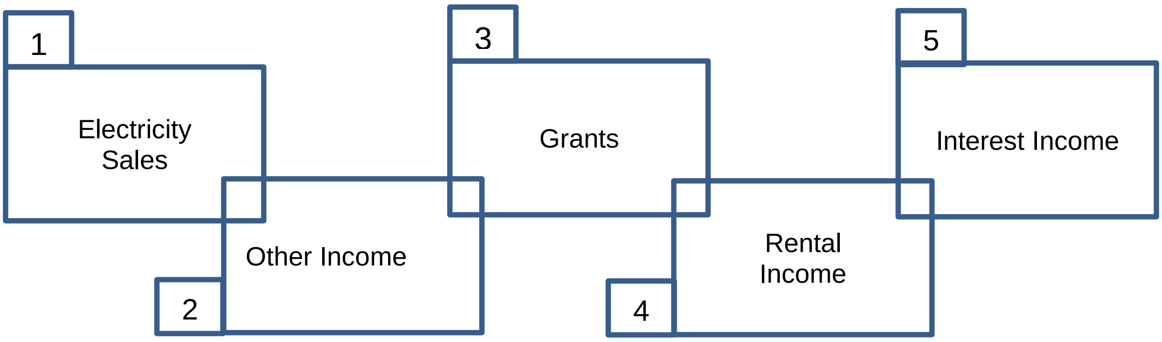


Figure 6 Typical income source within municipalities – Own elaboration based on [8]

The bulk of the municipality's income is generated via the sale of electricity (92.45%). However, other forms of income include grants (2.59%), interest (0.45%), rental income (0.0004%) and other income (4.51%). Comparatively, these forms of income are small and account for less than 10% of the total. Other income could also include disaster funding which may be received in instances of network damage in extreme weather conditions.

3.3 Allocation Mechanism for Costs & Income

Another essential aspect in determining the accuracy of the cost to serve study is allocating the cost fairly and accurately amongst customer categories. Some costs can be directly allocated, while others must be allocated based on a rational and practical approach. The following five allocation methods have been utilised in creating a standardised and simplified approach to the cost allocation methodology.

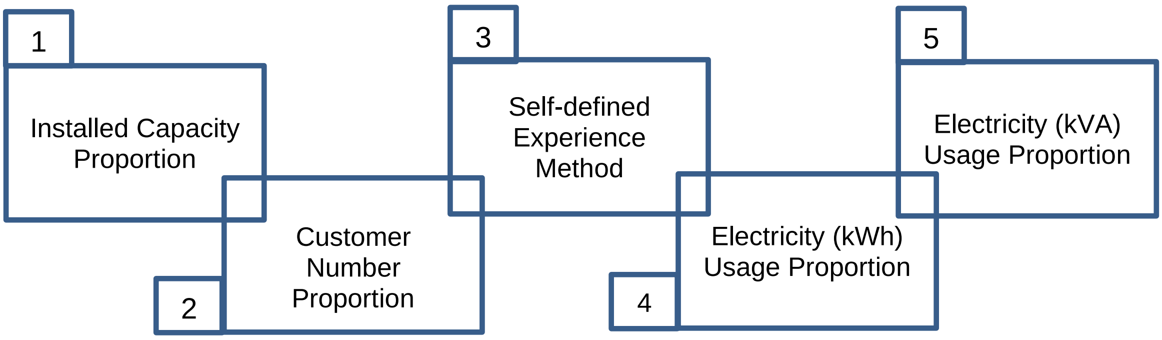


Figure 7 Allocation mechanisms for costs and income

The information to create the above cost-sharing methods is based on basic information that should be available to most municipalities or could be easily developed with basic customer information, simplified network information and segmented income and expenditure data. This data from the D-form can also be used to define the cost-sharing allocations. The five allocation methodologies should sufficiently allocate costs fairly amongst each tariff category. In the case where accurate information is available for the allocation of costs, it should be used; however, with the lack of information, a best-fit cost allocation method based on the above should be considered.

3.4 Installed Capacity Proportion

It is not feasible or practical to allocate costs on an individual customer basis. The cost allocation methodology is therefore based on a cost pooling method based on the voltage level of operation. Customers taking supply at different voltage levels would therefore experience costs based on the voltage level of operation they connected at and shared upstream costs. Therefore, it is valuable to understand the installed capacity per customer per voltage level and the shared assets within the network.

3.5 Self-Defined: Data Synthesis and Experience Method

In many instances, cost allocations do not fit predetermined criteria. Cost allocations in these cases must be based on synthesising available data with known methods and long-standing experience.

3.6 Customer Number Proportion

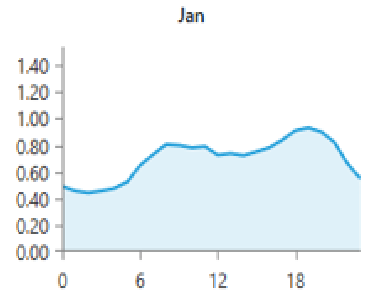
The customer number proportion can be a valuable allocation method as it relates directly to the proportion of customers connected to the grid. However, caution must be exercised when using this method as it is usually not representative of the number of kWh consumed nor the accurate reflection of the usage of the grid.

3.7 Electricity Usage Proportion – kWh & kVA

Electricity is predominantly purchased from Eskom at either 275kV or 132kV. On average, eThekwini reaches a maximum demand of 1650MW. Megaflex is a time-of-use based tariff with price variations depending on the hour, day, and season of use. Because of the complexity of the tariff in terms of price variations, the most accurate way to carry out the cost allocation per customer category for bulk purchases is to understand how each customer category consumes electricity. Therefore, customer consumption was understood via the load profile analysis per sector.

The load profiles (hourly) have been attained utilising yearly actual onsite measurements of substations that predominately supply electricity to each sector. The yearly profile was then modelled against the purchasing tariff to calculate the costs and the subsequent contribution to the bulk electricity costs per sector.

Residential

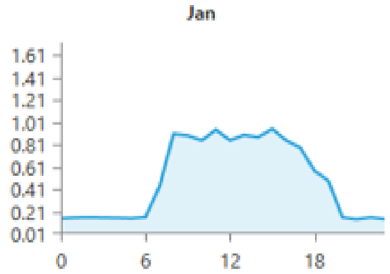


The load profile for the residential sector shows two distinct peaks, one in the morning and one in the afternoon. The usage of appliances mainly drives this during these periods based on household activities.

The usage profile will be influenced by numerous factors, including the household's income level, number of appliances and circuit breaker size.

The profile will also be affected based on temperature and rainfall.

Business

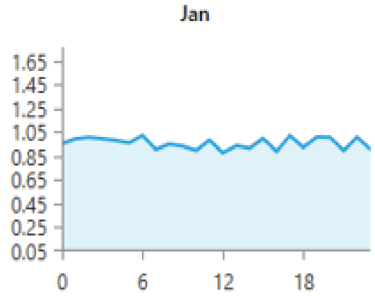


The load profile for the business sector shows a ramp up in the morning, a constant loading during the day and a ramp down towards the afternoon.

The usage profile will be influenced by numerous factors, including the business's size, type of business, and hours of operation.

The profile generally reflects the sector's operating pattern despite the influencing factors.

Industrial



The load profile for the Industrial sector shows a consistent loading profile over the 24 hours.

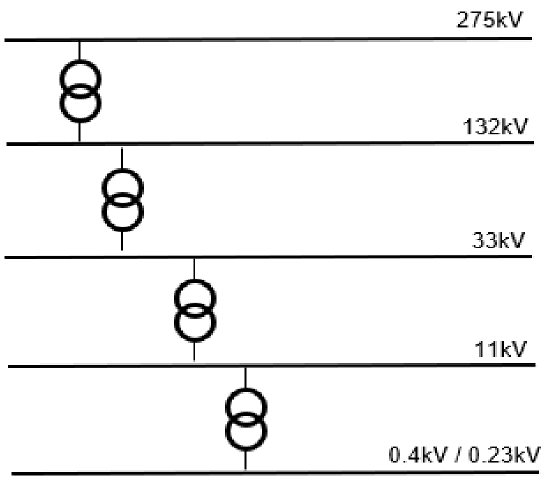
The usage profile will be influenced by numerous factors, including the operation's size, type, and hours of operation.

The profile generally reflects the sector's operating pattern despite the influencing factors.

Figure 8 Typical load profiles for allocation of bulk purchases and sales

Each sector was represented by its respective loading profiles for allocating costs. It is acknowledged that different customers within the individual customer category may deviate from the normalised profile. A detailed analysis of the loading profile will increase the accuracy. However, it does warrant extensive data and manipulation, which is not always readily available. However, the generalised profiles are deemed reflective and fit for purpose in terms of this exercise [9].

3.8 Reduced Network Diagram (RND)



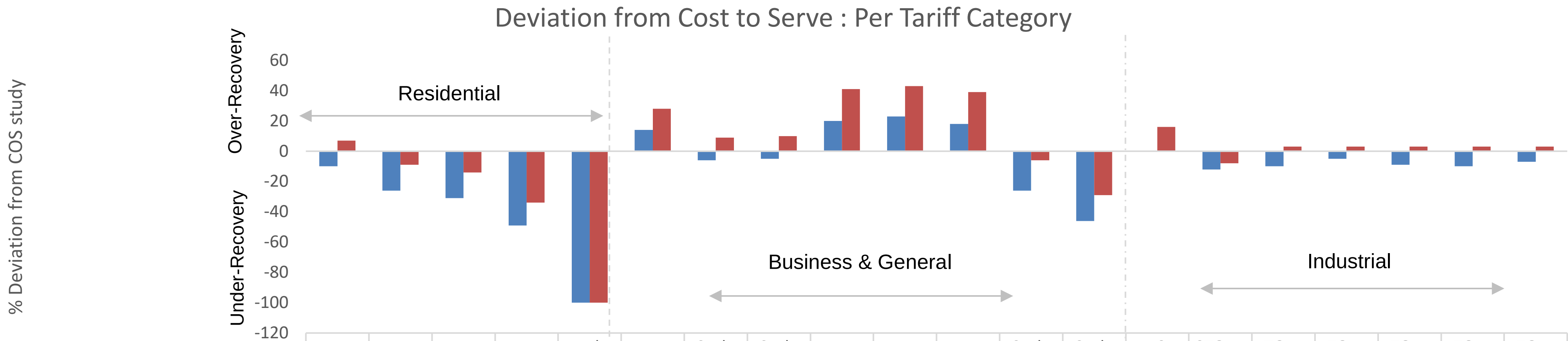
The RND is a helpful visualisation of the network and the customer category connection topology. By having this high-level view of the connectivity within the network, the allocation of costs per category follows a more rational and methodological approach.

The RND could be further classified to cater for distinct geographical variances, including urban and rural areas, as their cost structures could differ significantly.

It is vital to pool costs appropriately in order to minimise cross-subsidisation. Customers who use higher voltage levels do not affect the capacity needed at lower voltage levels. Customers should not be charged for an asset that they do not use. Not charging for assets, not in use is accomplished by calculating unit costs for each asset in the RND and only including assets relevant to the customer class in the cost pooling exercise.

Figure 9 The reduced network diagram – own elaboration referencing [2]

4 THE COST TO SERVE RESULTS: COST REFLECTIVITY [10]

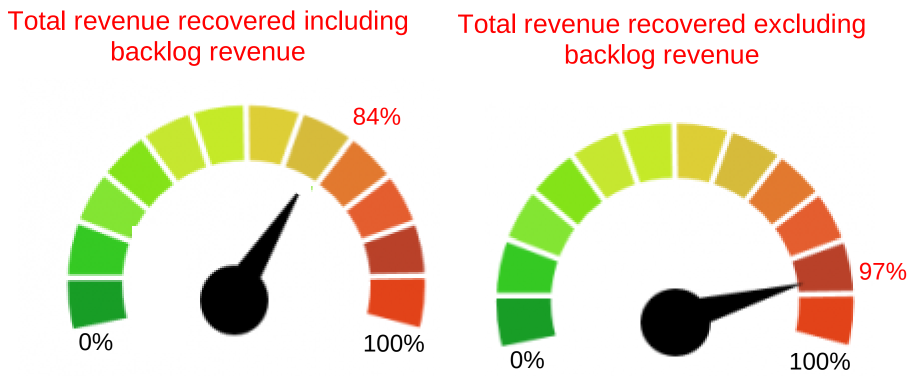


	Scale 3	Scale 4	Scale 8	Scale 9	scale 12	Scale 1	Scale 021	Scale 002	Scale 5	Scale 6	Scale 7	Scale 10	Scale 11	LV3 - 400V	CTOU - 400V	ITOU - 400V	ITOU - 6.6kV	ITOU - 11kV	ITOU - 33kV	ITOU - 132kV
% Deviation from COS incl Backlogs	-10	-26	-31	-49	-100	14	-6	-5	20	23	18	-26	-46	0	-12	-10	-5	-9	-10	-7
% Deviation from COS	7	-9	-14	-34	-100	28	9	10	41	43	39	-6	-29	16	-8	3	3	3	3	3

Figure 10 Deviation from COS: per tariff category

Considering a balanced budget per the NERSA guidelines, the municipality is recovering 97% of its revenue; however, revenue recovery is not reflective. Hence some tariff categories are paying more, and some are paying less.

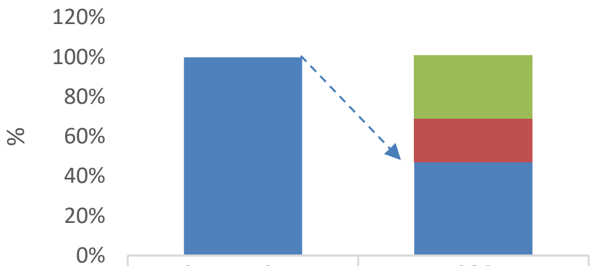
However, the reality is that the municipality has backlogs that must be completed. Therefore, the cost of backlogs must be included in the cost to serve revenue requirements. With an estimate of R3bn for backlogs, the tariff categories further deviate from the initially calculated cost to serve. Including the backlogs, the total revenue recovered is only 84%. The 16% revenue shortfall requires a tariff increase of 27.7% to reach cost reflectivity.



5 THE COST TO SERVE RESULTS: STRUCTURAL REFLECTIVITY [10]

Table 1 CTS results: Structural Reflectivity

Residential Category – Scale 3,4,8,9



	Current Case	COS
Fixed	0%	32%
Demand	0%	22%
Energy	100%	47%

*Rounded Off

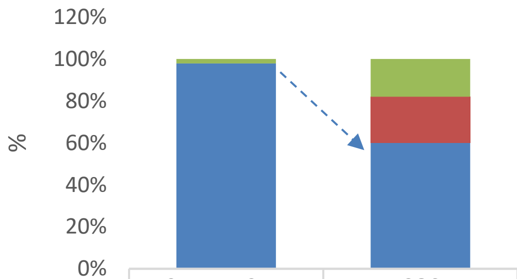
Figure 11 Residential tariff structure: Current vs CTS

The current residential tariffs are single-rate energy tariffs only; therefore, the energy rates reflect 100% of the current cost recovery. However, in the CTS study, the energy rate should be recovering 47% of the revenue, a demand charge should recover 22% of the revenue, and a fixed charge should recover 32% of the revenue.

With the current tariff structure, the municipality is at significant risk of an under-recovery should the customer reduce energy consumption through adopting energy efficiency measures or alternate generation [11].

Many of the prepaid customers are procuring electricity via prepaid meters. Therefore, implementing fixed and demand charges would significantly complicate the purchasing mechanism.

Business Category – Scale 1



	Current Case	COS
Fixed	2%	18%
Demand	0%	22%
Energy	98%	60%

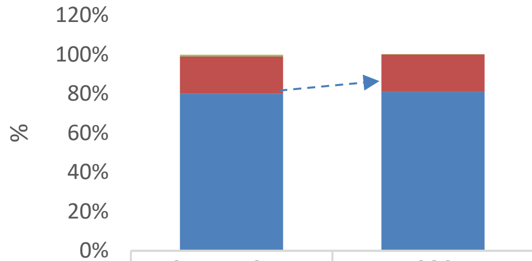
Figure 12 Business tariff structure: Current vs CTS

The business tariffs (Scale 1) are single-rate energy tariffs and a service charge. Currently, 98% of the costs are recovered via the energy charges, whilst the CTS indicates an optimum recovery of 60% through energy charges.

While a fixed charge is present, it only caters for 2% of the allocated revenue, while the CTS indicates an optimum recovery level of 18%. A demand charge should be priced to recover 22% of the costs; however, currently, there are no demand charges within the tariff structure.

With the current tariff structure, the municipality is at significant risk of an under-recovery should the customer reduce energy consumption by adopting energy efficiency measures or alternate generation [11].

Industrial Category – ITOU



	Current Case	COS
Fixed	0.80%	0.14%
Demand	19%	19%
Energy	80%	81%

*Rounded Off

Figure 13 Industrial tariff structure: Current vs CTS

The Industrial tariff structure is well balanced and aligns with the CTS study. The optimum energy recovery ratio, as per the study, is 80%, and in reality, it is 81%. The optimum demand is 19%, and the current tariff meets that requirement. The fixed component currently recovers 0.8% of the total costs; however, as per the CTS calculations, the optimum indicates a level of 0.14%.

With the current tariff structure, the municipality's risk of an under-recovery should the customer reduce energy demand through adopted energy efficiency measures or alternate generation is limited.

6 UNDERSTANDING STRUCTURAL REFLECTIVITY: RECOVER THE COST AS IT IS EXPERIENCED

6.1 Reflection of Input Costs

There are a variety of input costs that are responsible for the successful operation of the municipality. Designing a tariff with all input costs as tariff components would be unreasonable. Therefore, there is a need to balance simplicity and reflect the costs as experienced. Due to the core of the business being electricity sales, it is evident that energy will have to be a tariff component. The organisational structure of the Electricity Unit further dictates the design of the non-energy tariff components

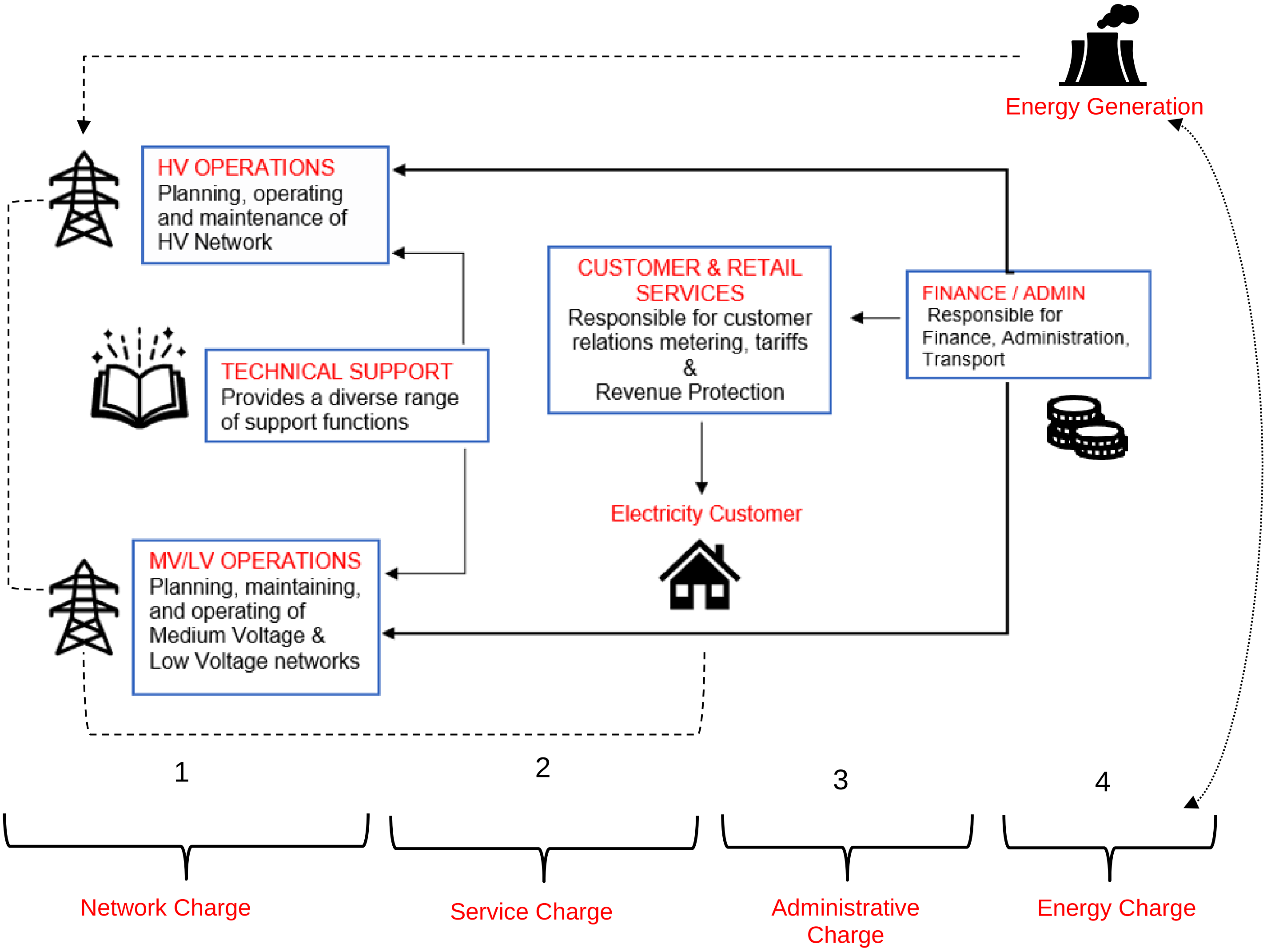
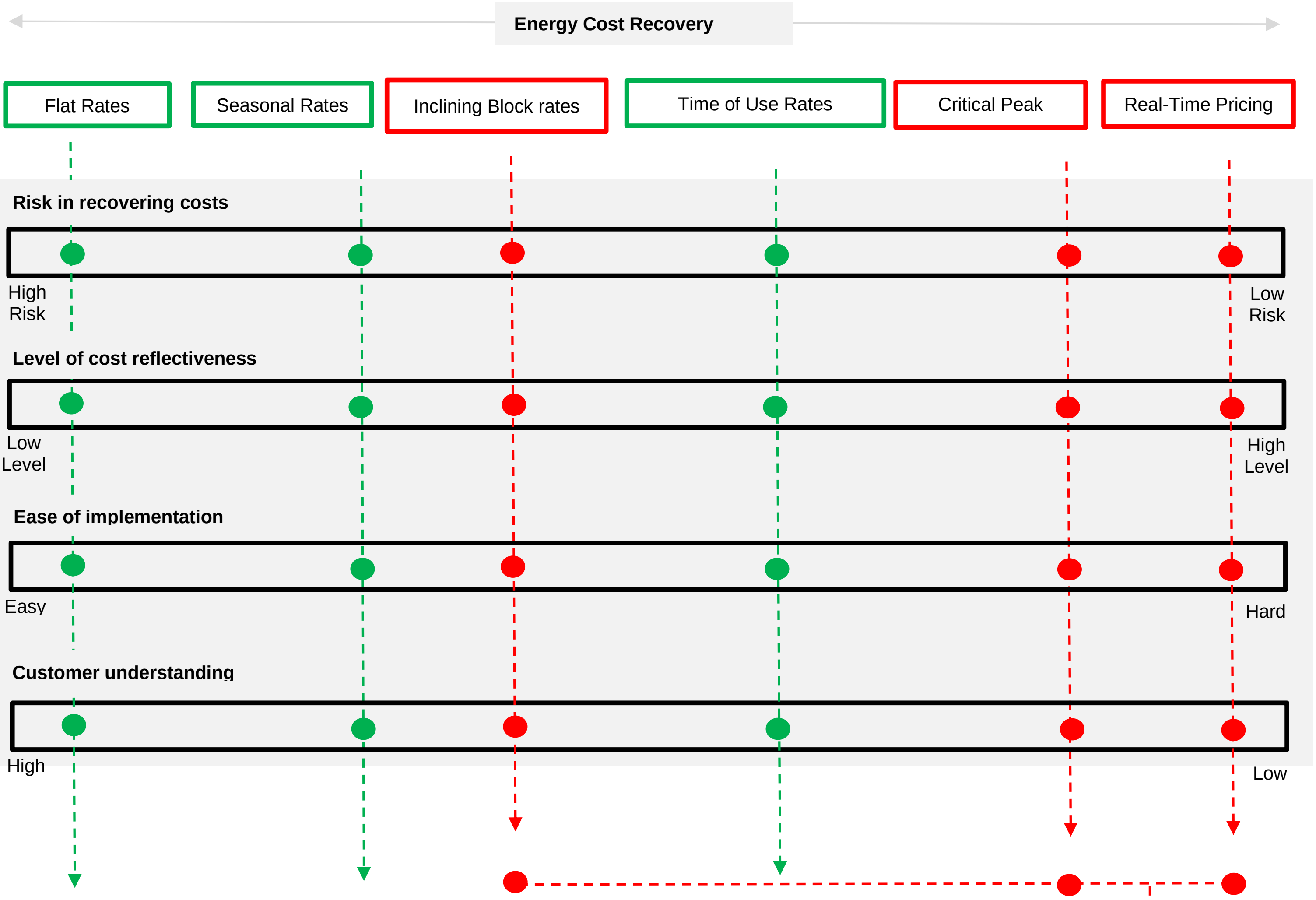


Figure 14 EThekwini Electricity Unit: departmental structure - Own elaboration based on [8]

A well-balanced tariff for eThekwini should therefore be made up of at least the following four tariff components: Energy Charge, Network Charge, Service Charge and Administrative Charge. The nature of the service and administration charges are similar and may be combined to simplify the overall tariff structure [12]. The charges should be administered depending on the type of customer served and the desired simplicity or complexity the municipality aims to achieve within the tariff structure for that customer category. The failure to include all of the above tariff components will dilute the reflectivity of the tariff. On the other hand, the dilution of tariff components with a lower cost weighting will have a negligible impact on the tariff and vice versa. Designing electricity tariff components based on cost causation promotes economic efficiency [4], [9]. Including fixed and network-based charges to recover costs is vital as capital investments and many other utility costs are unrelated to the amount of electricity utilised and, therefore, should be fixed [12].

6.2 Method of Recovering Energy Costs

Numerous tariff components can be used to recover energy costs. However, the adoption of a tariff structure by a municipality will depend on the level of significance placed on the following factors: risk in recovering costs, customer understanding, level of cost reflectiveness and ease of implementation.



The flat rate tariff is a simple tariff structure. It is famous as it is easy for customers to understand and easy for municipalities to implement. In addition, single register meters could be used in conjunction with simple billing systems. However, the flat rate tariff is not cost reflective, as it cannot pass on signals of price variations due to time and seasonality. Not passing through time and seasonality signals increase the risk to the utility in terms of cost recovery.
Within eThekwini, 100% of residential and 96% of business costs are recovered via flat rate charges. However, no industrial customers purchase electricity on a flat rate tariff.

Seasonal tariffs can vary the prices due to a change in season. Therefore, seasonality pricing is advantageous in areas with significant discrepancies in the generation of energy costs between seasons.

The tariff is simple to implement and can be done with simple metering and billing systems. Customer understanding is deemed high.
The seasonal tariff cannot pass on price variations due to time differences and is considered a high utility risk with low levels of cost reflectivity, albeit better than flat rate tariffs.
Within eThekwini, only industrial/commercial tariffs are designed around seasonality.

The Time of Use tariff can vary the energy prices based on the time of usage. There are generally three distinct time periods. In the case of eThekwini, they are categorised as Peak, Standard and Off-Peak.

Due to the time-based charging, the metering infrastructure is more complex, and the bill is more complicated as there are more energy charges with varying energy rates. Therefore, a high level of customer understanding is required.
Due to its ability to vary prices on time, it can better pass on the varying generation prices to the end customer, making the tariff highly cost reflective. It also lowers the utilities cost recovery risk.
Within eThekwini, only industrial /and commercial tariffs are designed around the time of use rates.

Currently not implemented in eThekwini

Figure 15 Tariff method of recovering energy costs – Own elaboration referencing:[13], [14], [15], [16], [17]

6.3 Tariff Method of Recovering Network Costs

Network costs can be recovered in a variety of ways from customers. As the recovery method becomes progressively reflective, it becomes more complex to implement. It also poses a high risk of customers not understanding it. However, it does lower the municipal risk in terms of recovering costs. Each municipality would have to analyse their circumstances and set its method of recovering grid costs accordingly.

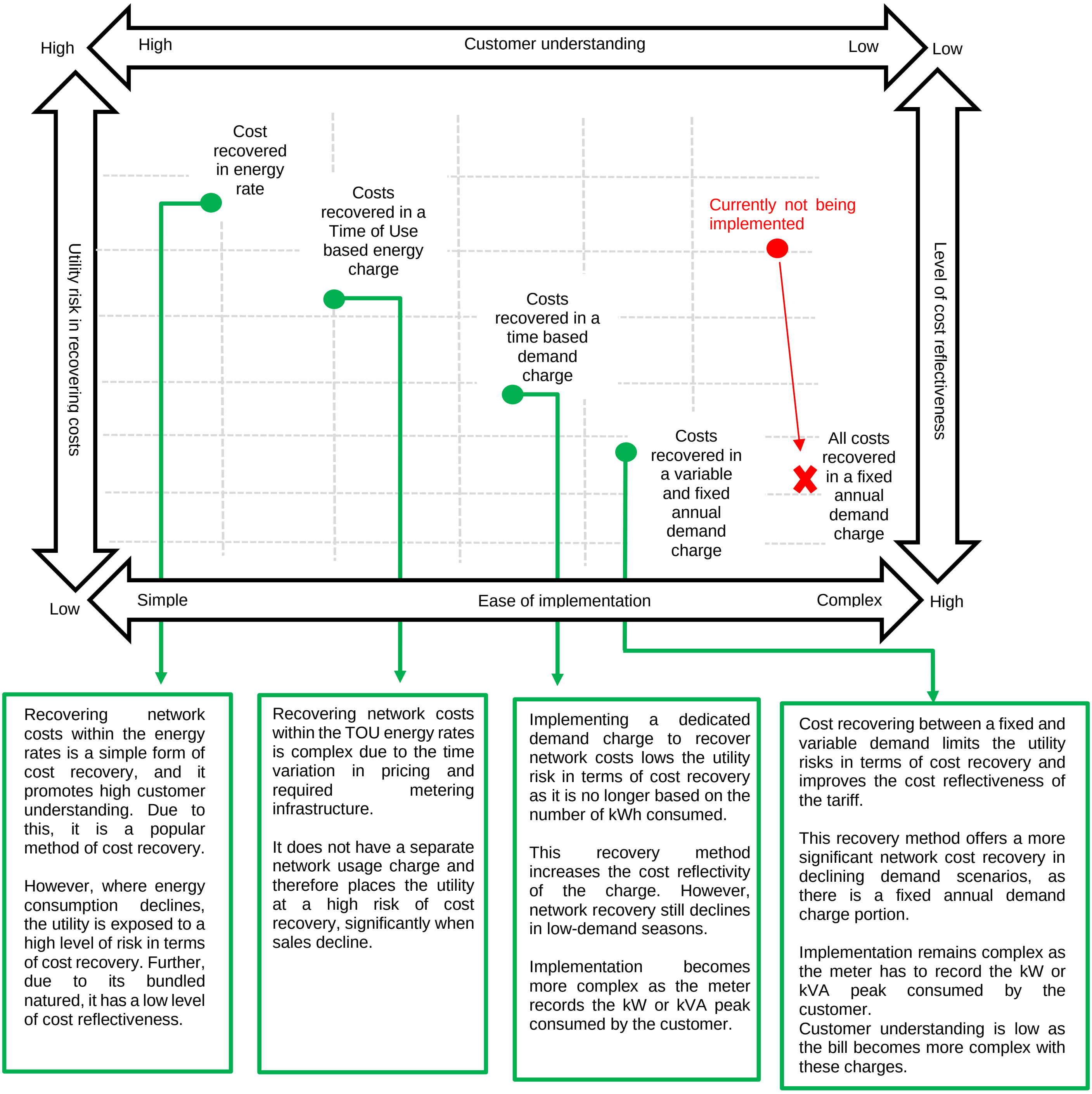


Figure 16 Tariff method of recovering network costs – Own elaboration referencing: [18],[19], [20], [21],[22]

Recovering all network-related costs in a fixed network charge offers the utility the lowest risk in cost recovery and promotes the highest level of cost reflectivity. Therefore, it is the preferred method of recovery.

6.4 Emulating the Input Cost Method of Charging Within the Tariff Structures

The tariff structure's charging method must mirror the input costs to promote structural reflectivity. The failure to do so will result in the deviation of price reflectivity introducing unjust financial recovery amongst customers. Unjust recovery leads to the creation of intra-subsidies within customer categories. Standard methods of charging per cost item are highlighted below. Further, compliance of each customer sector tariff within eThekwini Municipality with the charging methodology is also highlighted below.

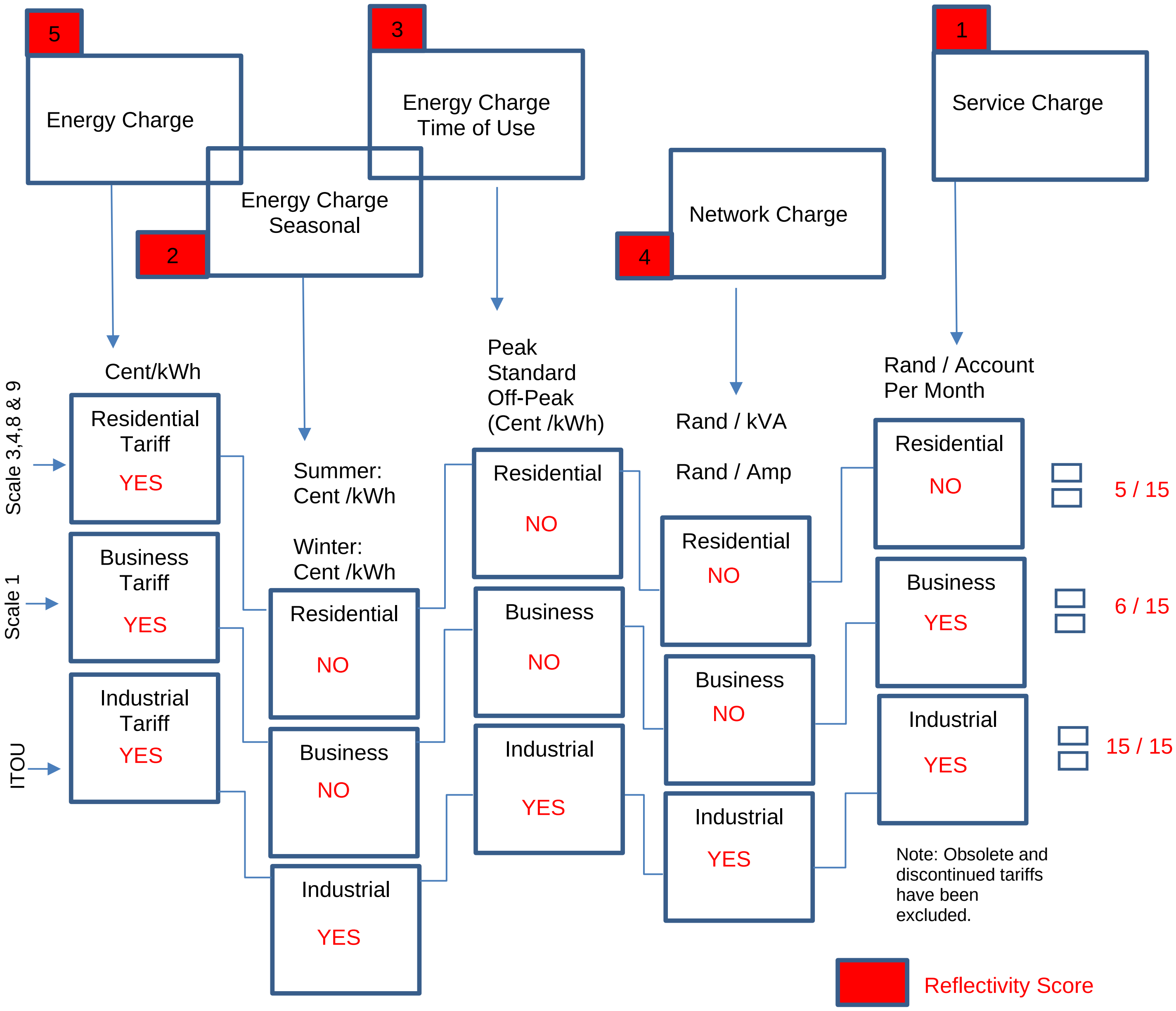
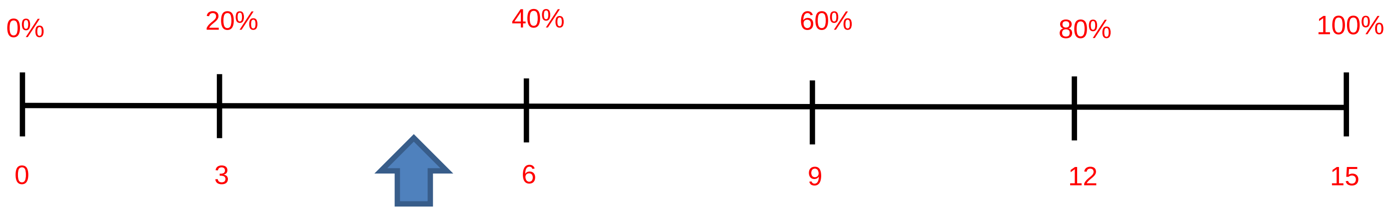


Figure 17 Evaluation of tariff structure reflectivity

To properly understand the level of structural reflectivity, each tariff component was weighted with a level of importance ranging from 1 to 5, with 1 indicating a low level of importance and 5 indicating a high level of importance. In an instance where the tariff structure included that tariff component, it was awarded the relevant score; otherwise, it scored zero. Finally, the percentage reflectivity was calculated based on the total score of 15.

6.5 Results of Structural Reflectivity Analysis & Recommendations for Improvement

6.5.1 Tariff Structural Reflectivity – Customer Category: Residential



Currently, the residential sector is only 33% structurally reflective. The low reflectiveness is not ideal or sustainable. As electricity consumption drops, revenue will also decline.

Introducing seasonality tariffs for the residential sector will improve price reflectivity and allow for passing on the higher winter pricing signal.

The Introduction of time-based tariffs will significantly enhance price reflectivity. However, specialised metering and communication will be required.

Introducing a network charge, service charge, and administration charge will significantly improve the structural reflectivity of the residential tariff.

Making the transition to introduce fixed charges will start to place a burden on low-consumption customers. Invariably this would interfere with the subsidisation mechanism within the tariff.

Before implementing fixed charges, careful consideration must be given to social, economic, political and affordability whilst balancing the need to move to price reflectivity.

Table 2 Impact of COS tariffs on residential customer bills

The existing tariff is a flat rate tariff of 209 c/kWh.

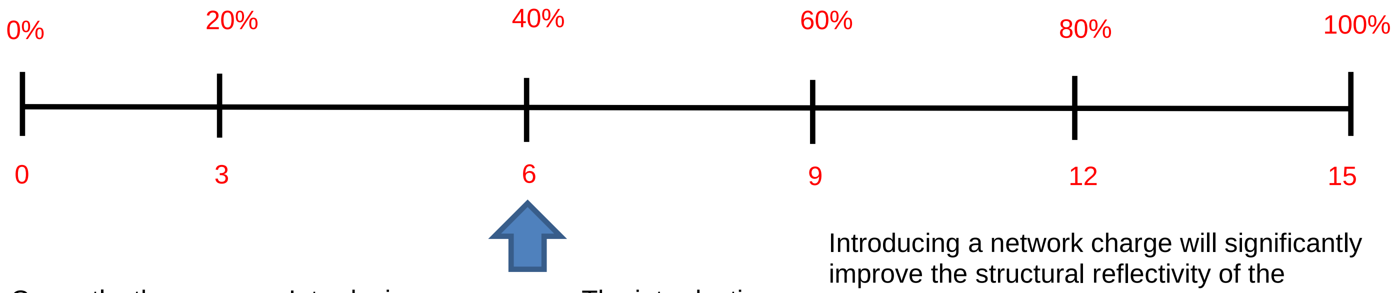
The reflective tariff is calculated with a fixed charge of R 363 p/m, a network charge of R 237/ kVA / pm and a reduced energy charge of 105 c/kWh.

Low-consumption users will be severely impacted during the move to cost-reflective tariffs. Moving to CTS tariffs results in low-consumption customers not enjoying the subsidies provided by the higher-consumption customers.

Unless there is an alternate form of subsidisation, low-consumption customers will bear the brunt of migrating to CTS-aligned tariffs.

kWh Use	Existing Bill	Bill after implementing cost to serve	Increase	% of customers
100	R 224	R 1,653	638%	62%
200	R 448	R 1,758	292%	
300	R 672	R 1,863	177%	
400	R 896	R 1,968	120%	
500	R 1,120	R 2,073	85%	24%
600	R 1,344	R 2,178	62%	
700	R 1,568	R 2,283	46%	
800	R 1,792	R 2,388	33%	
900	R 2,016	R 2,493	24%	Customers consuming greater than 800kWh per month account for only 14 %
1000	R 2,240	R 2,598	16%	
1200	R 2,688	R 2,808	4%	
1400	R 3,136	R 3,018	-4%	
1600	R 3,584	R 3,228	-10%	
1800	R 4,032	R 3,438	-15%	

6.5.2 Tariff Structural Reflectivity – Customer Category: Business



Currently, the business sector is only 40% structurally reflective. The low reflectiveness is not ideal or sustainable. As electricity consumption drops, revenue will

Introducing seasonality tariffs for the business sector will improve structural reflectivity and allow for passing on the higher winter pricing signal.

The introduction of time-based tariffs will significantly enhance structural reflectivity. However, specialised metering and communication will be required.

Introducing a network charge will significantly improve the structural reflectivity of the residential tariff.

Making the transition to introduce fixed charges will start to place a burden on low-consumption customers. Invariably this will interfere with the subsidisation mechanism within the tariff.

Before implementation, careful consideration must be given to protect indigent consumers.

Table 3 Impact of CTS tariffs on business customer bills

The existing tariff is a flat rate tariff of 236 c/kWh and a service charge of R 308 p/m.

The reflective tariff is calculated with a fixed charge of R 869 p/m, a network charge of R 365 / kVA / pm and a reduced energy charge of 160 c/kWh.

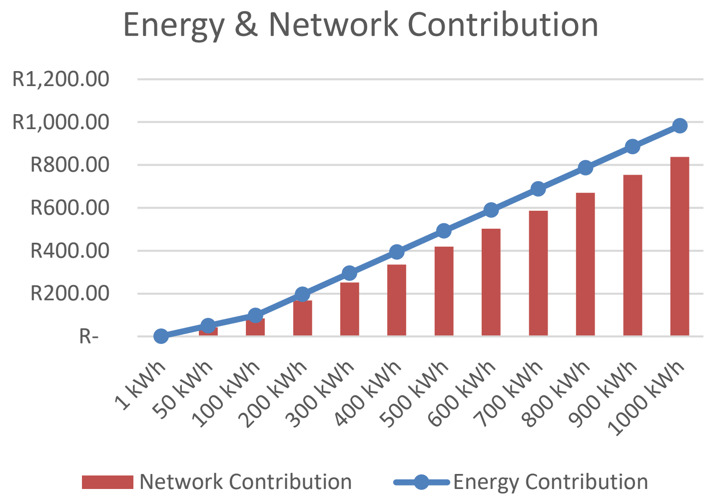
Low-consumption users will be severely impacted during the move to cost-reflective tariffs. Moving to CTS tariffs results in low-consumption customers not enjoying the subsidies provided by the higher-consumption customers.

Unless there is an alternate form of subsidisation, low-consumption customers will bear the brunt of migrating to CTS-aligned tariffs.

kWh Use	Existing Bill		Bill after implementing cost to serve		Increase	% of customers
100	R	262	R	2,854	989%	80%
200	R	524	R	3,014	475%	
300	R	786	R	3,174	304%	
400	R	1,048	R	3,334	218%	
500	R	1,310	R	3,494	167%	
600	R	1,572	R	3,654	132%	
700	R	1,834	R	3,814	108%	
800	R	2,096	R	3,974	90%	
900	R	2,358	R	4,134	75%	
1000	R	2,620	R	4,294	64%	
s1200	R	3,144	R	4,614	47%	
1400	R	3,668	R	4,934	35%	
1600	R	4,192	R	5,254	25%	
5500	R	14,410	R	11,494	-20%	

7 TARIFF STRUCTURAL REFLECTIVITY AND INTRA-CROSS SUBSIDISATION

A poor level of structural reflectivity will naturally lead to an intra-subsidy being present within the tariff structure. Intra-subsidy can be seen in the residential and business tariffs. This residential and business tariff is highly dependent on the recovery of network charges via the volumetric non-seasonal and non-time differentiated energy charge. 100% of the residential and 96% of the business network charges are recovered via the energy charge. Recovering network charges via energy charges results in a scenario that will automatically recover more network charges from higher load factor customers [23].
Further, as higher load factor customers start to reduce load, the overall price of the tariff starts to rise. This pricing method is not sustainable, and efforts must be made to remedy this [24]. However, evaluating the socio-economic, political and affordability aspects is essential before making relevant tariff changes.



Residential and business customers with the same circuit breaker size but varying loading levels contribute to the network charges. Low-consumption customers make a reduced network contribution, while higher-consumption customers counteract this and contribute more due to their consumption.

Dedicated network charges will remedy this anomaly; however, it will also shift how costs are recovered from the sector.

Figure 18 Graph indicating the relationship between structural reflectivity and intra-cross subsidisation

7.1 Electricity Tariffs for The Future

Incorrect cost recovery levels and tariffs with poor levels of structural reflectivity will, unfortunately, lead to customers procuring electricity on inefficient tariff structures. Inefficient tariffs do not provide the correct pricing signals for customers to respond. Incorrect cost recovery and poor price reflectivity allow customers to seek alternate electricity and promote grid deflection [5].

The grid's future is predicted to incorporate growing levels of renewable energy and battery technologies, which unfortunately exposes the realities of poor cost recovery and structural reflection within tariffs. There are views that distribution girds will become obsolete as renewable and storage technologies become more price competitive. The future role of the grid is not clearly defined yet; however, what is certain is that the role of the grid will evolve. To ensure municipalities are ready to respond to the rapidly changing environments, they need to commence with tariff structure reflectivity studies and understand the revenue recovery models within their customer base. Furthermore, they must migrate their tariffs to higher cost and structural reflectivity levels, ensuring a smoother transition to the looming changes.

Subsidy provision is a reality within electricity tariffs as it enables a more significant contingent of customers to enjoy access to the grid. Renewable energy and storage technologies will reduce overall consumption and affect the subsidy provision mechanism within the existing tariff. Careful consideration must be applied in all future tariff designs to ensure a careful balance that promotes RE technologies and the protection of indigent customers within the network. The commencement of an indigent register within eThekwini Municipality is a forward-looking step that could target deserving customers in respect of subsidy provision as opposed to the current mechanism of providing a subsidy through low electricity consumption for all customers.

8 CONCLUSION

Understanding and quantifying the level of cost and structural reflectivity within electricity tariffs is fundamental. It is a prerequisite before designing new tariffs or amending the current suite of tariffs. However, carrying out reflectivity studies requires access to accurate and credible data, which is not always available in municipalities. Challenges include a lack of reporting systems and severe skill shortages. This has resulted in a few municipalities successfully carrying out the cost to serve studies.

As depicted in this paper, the approach defines the tariff reflectivity level via cost and structural reflectivity. Cost reflectivity is based on the ability to identify the costs and allocate them to customer categories accordingly. Structural reflectivity evaluates if the cost is being recovered in accordance with how the cost is being experienced.

In the case of EThekwini Municipality, a comparison of the residential, business and industrial customer categories has indicated that the relevant tariffs are not fully cost reflective and rely on inter-cross subsidies. Further, Investigating the individual tariff components for the residential and business sectors reveals that the sectors are affected by intra-cross subsidies, i.e. low consumption customers within the customer category are subsidised by higher consumption customers.

Structural reflectivity was extremely low for the residential sector, i.e. 33% and marginally better for the business sector at 40%. The introduction of seasonal tariffs, time-based tariffs and dedicated network charges must be considered to improve the level of reflectivity. On the other hand, the industrial sector displays a high structural reflectivity within its tariff.

Due to the low structural reflectivity in some tariffs, renewable energy, wheeling and storage options will introduce revenue losses and threaten the municipality's sustainability. Therefore, the tariffs should be redesigned to include network charges for those intending to generate electricity.

Improving the structural or cost reflectiveness will affect the tariff's subsidy mechanism, causing low-consumption customers to pay more. Therefore, coinciding with the improvement of cost or structural reflectiveness for all customers with the introduction of renewable energy is not supported, as it will create the false impression that renewable is responsible for the higher prices. However, it is due to a change in tariff pricing methods. Communication with customers is key, and the failure to properly communicate on tariff related issues would usually result in backlash from customers. This backlash often prevents municipalities and regulators from advancing tariff methodologies [12].

Municipalities experiencing or envisaging high penetration rates of embedded renewable energy should introduce renewable energy tariffs (promoting high levels of cost reflectivity and structural reflectivity) for renewable energy customers only. Improving cost and structural reflectiveness for other customer tariffs should only commence after the social, economic, technical and political implications have been investigated and understood.

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