The impact of small-scale embedded generation on municipal revenue

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Rapid small-scale embedded generation (SSEG) uptake provides potential benefits for municipalities via cheaper electricity and reduction of technical losses, but many municipalities have valid concerns around how these systems will impact their networks/technical operations and electricity-related revenue.

It is essential that municipalities address these concerns by developing and enforcing appropriate regulations and tariffs.

Many municipalities do not have detailed cost of supply Figures – which should be the foundation of tariff setting. This paper explores the impact of some of the approved municipal SSEG tariffs on municipal revenue and customer 'business case' and outlines key tariff elements to balance access and cost recovery, until such time as detailed costing studies provide specific tariff building blocks. This work is part of the municipal SSEG support programme discussed below.

Four municipal case studies are presented where the revenue impact of growing SSEG on their distribution grids is investigated. The case studies are used to highlight the potential effect SSEG has on municipality revenue and draws out the importance of modelling impact as part of tariff setting and considers key lessons that could be learnt from the tariff structures in use. The paper will conclude by highlighting how revenue loss could be avoided by ensuring that the municipalities develop tariffs that account for the cost of supplying electricity to SSEG customers.

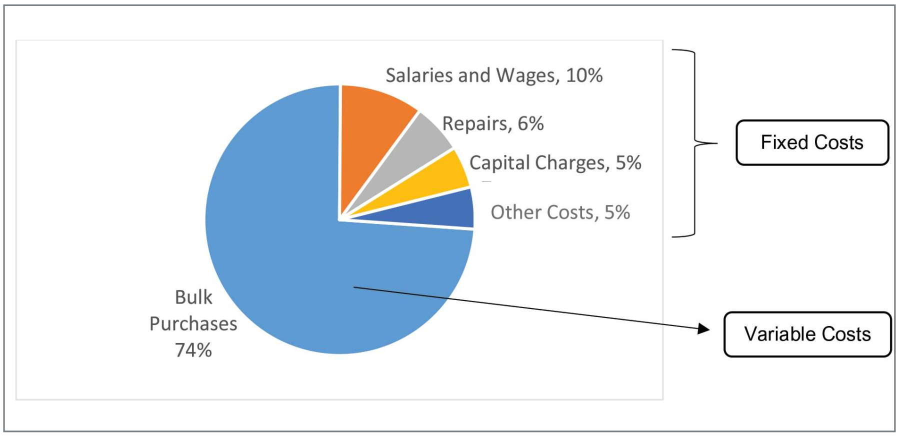

Fig. 1: Average cost structure of municipal electricity distributor.

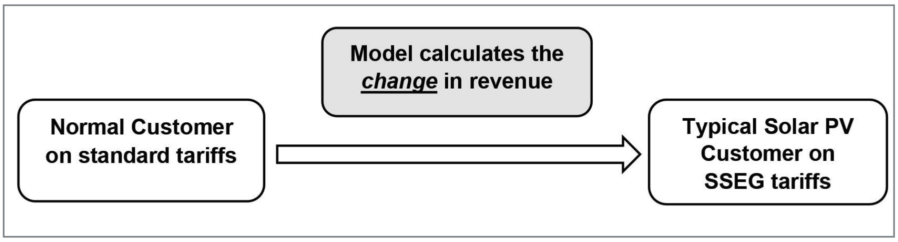

Fig. 2: Approach used to calculate revenue impact of solar PV.

Municipal SSEG support programme

As of October 2018, 41 of the 165 licensed municipal distributors allow SSEG installations – 29 of these municipalities have application systems and 25 have SSEG tariffs [1]. This reflects a strong upward trend from 2016 when only ten municipalities allowed SSEG (of which only five had formal processes), but indicates that many municipal distributors still lack the processes necessary to enable SSEG. In an effort to accommodate the inevitable growth in SSEG and stem the tide of illegal connections, support is being provided to municipalities to develop processes to formally include these embedded generators onto their networks.

The support work is part of the South African German Energy Programme (SAGEN) with co-funding from USAID South African Low Emissions Development Strategy Programme. SALGA and the Department of Energy are lead partners and implementation is being undertaken by Sustainable Energy Africa (SEA) with support from the CSIR and SunCybernetics. Support has included capacity building of staff and the provision of template documents which municipalities can tailor for their requirements. In the most recent phase of this programme 28 additional municipalities have been supported and trained to develop necessary processes and documentation.

The municipal SSEG document set is founded on the AMEU-SALGA Resource Pack - a set of template documents and forms that have been developed for use by municipalities and have been endorsed by SALGA and an AMEU SSEG Working Group. The AMEU-SALGA Resource Pack is available on the www.sseg.org.za website and not only has the function of facilitating the development of SSEG processes in municipalities new to SSEG, but also standardising the approach across municipalities.

The training component assists the municipalities to process SSEG applications, perform commissioning inspections as well as develop appropriate procedures and standards for SSEG integration to ensure grid stability and safety of systems. In addition, capacity is also developed around SSEG tariff development. On completion of the training, municipalities have a full set of customized documents for the entire SSEG application, approval and commissioning process which are ready for council submission for formal adoption. This includes customised SSEG Tariff recommendations for each municipality.

Structure of SSEG tariffs

South African electricity pricing policy indicates that economic efficiency/cost reflectivity should be the foundation of rate setting. Electricity tariffs need to cover the costs of supplying that electricity. Tariffs should therefore be built up from the associated costs. Fig. 1, shows the average cost structure across various size municipalities, as determined from a survey of municipal D-Forms performed by NERSA [2]. It is important to note that some of

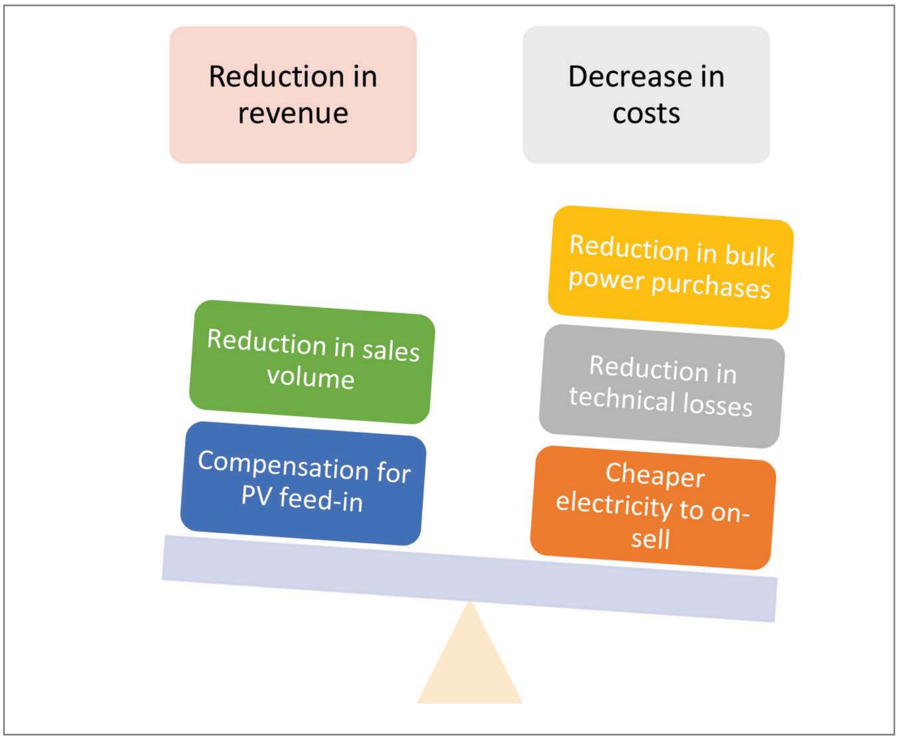

Fig. 3: Factors affecting municipal revenue with the installation of solar PV [4].

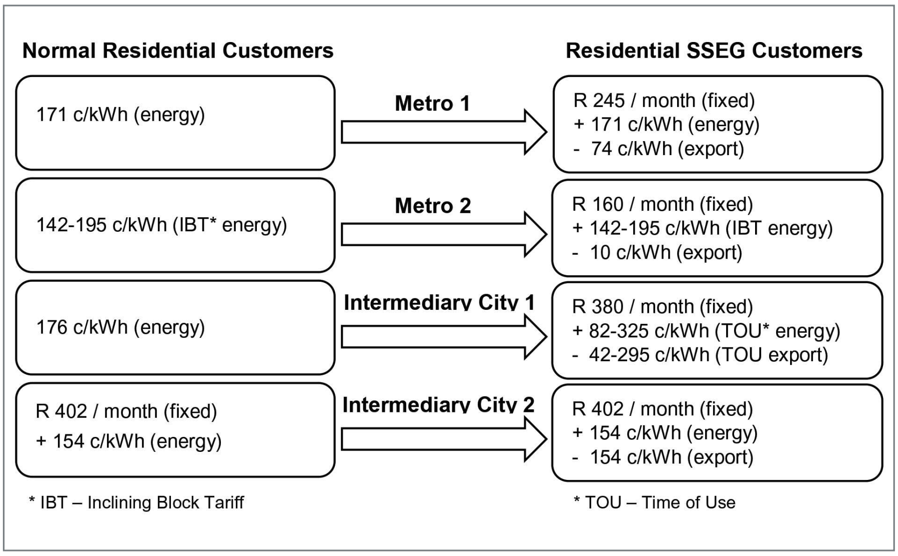

Fig. 4: Tariffs of the four municipalities which were used in the case studies.

these costs are variable (vary with the amount of energy sold) while others are fixed (do not change on a monthly basis).

Revenue recovery based on a single, volumetric charge (i.e. c/kWh) is common amongst municipal residential tariffs. This "bundles" both fixed network costs and volumetric energy costs into one charge. SSEG customers purchase less energy and under current tariff structures they contribute less to the fixed costs of the network and are not covering their share of these costs. To ensure residential SSEG customers cover these fixed costs, many municipalities are introducing a fixed charge, in Rand/month to be connected to the network and an energy charge for each unit they consume.

The final component of a typical residential SSEG tariff is the export tariff: this is the amount customers are compensated for electricity they export into the municipal grid.

A typical residential SSEG tariff therefore generally has three components:

Residential SSEG tariff = fixed charge (R/month) + energy charge (c/kWh) – export tariff (c/kWh)

Business and commercial customers are typically already paying demand charges and fixed charges, so they are often already contributing their fair share to the cost of the network. Therefore, many municipalities are simply introducing an export tariff for these customers to compensate them for any electricity they export into the municipal grid.

The challenge then, in the absence of detailed cost of supply studies, is how to cost each element within this tariff structure. The four case studies are analysed in order to explore how some of the approved tariffs have set these costs and the relative impact of this of municipal revenue and customer business case.

Municipal case studies: methodology

The analysis of the four case study SSEG tariffs which is summarised in this paper was done using a publically available Excel tool [3] known as the SSEG Tariff Tool. The tool is the product of extensive work around the effect of solar PV SSEG on municipal revenue. It investigates the impact of increased uptake of solar PV SSEG on revenue using customer and tariff data specific to the municipality in question. It does this by comparing the revenue generated per customer before the installation of solar PV and the revenue generated from that customer after they install solar PV. The SSEG tariffs can then be varied, and changes in revenue assessed, thereby allowing a revenue impact analysis of SSEG tariffs in specific customer categories in the municipality.

Solar PV can affect a municipality's revenue in a number of ways. Fig. 3, shows the basic architecture of the revenue impact of the model. Revenue is reduced in two ways: reduced sales volume to SSEG customers and compensating these customers for the electricity that is fed onto the grid. At the same time the municipality's costs decrease because of (i) a reduction in bulk power purchases from Eskom, (ii) a reduction in technical losses from these purchases, and (iii) cheaper electricity from SSEG customers can be on-sold to other customers with a slightly higher profit margin than from the bulk purchases.

When setting tariffs, it is important to balance cost recovery for services and utility sustainability with fair grid access and affordable tariffs. These are key objectives of South Africa's energy sector, as highlighted in the White Paper on Energy Policy (1998) [5] and the Electricity Pricing Policy (2008) [6]. Therefore, it is vital to understand the impact of SSEG tariffs on a customer's electricity bill. Experience suggests that if the tariffs are too unattractive, frustrated customers will be driven to invest in off-grid solutions or connect their SSEG installations illegally.

To consider the customer's perspective, the model indicates how favourable the customer's business case is to install solar PV under the proposed SSEG tariffs by calculating the payback period of the solar PV installation i.e. the time it takes the savings on the customer's monthly electricity bill to recover the initial cost of the installation. Favourable payback periods are typically considered to be less than five years, while a payback period of more than ten years is generally considered unfavourable.

Municipal case studies: results

To investigate how current SSEG tariff approaches are affecting municipalities' revenue, four South African municipalities have been chosen as case studies. All the analyses have been done using publically available data. The case studies are separated into residential and commercial customers. The tariffs considered and discussed are all excluding VAT.

The four municipal case studies cover different city characteristics – two are metros and two intermediary cities – as well as reflecting an array of different approaches to SSEG tariff setting.

Residential customers

Fig. 4, shows the selected tariffs of four municipalities which were used in the case studies. The revenue impact of customers migrating from the normal residential tariffs to the SSEG tariffs is then investigated.

Fig. 5 shows the forecasted impact of these tariffs on each municipality's revenue. The x-axis of the Fig. represents increasing percentage of customers installing solar PV while the y-axis of the Fig. shows the percentage change in revenue in that tariff category after the introduction of the SSEG tariff.

From Fig. 5, it is clear that SSEG tariffs can impact a municipality's revenue significantly. For example, under Metro 2's current SSEG tariffs if 10% of residential customers were to install solar PV, it would result in a 7% increase in revenue from this tariff category. On the other hand, Intermediary City 2 will see a noteworthy reduction in its revenue as customers install solar PV on their current SSEG tariffs.

Metro 1 results

Metro 1 introduces a fixed charge of R245/month and an export tariff of 74 c/kWh for SSEG customers. This results in a virtually revenue-neutral SSEG tariff.

Under Metro 1's tariffs, the business case for residential customers to install solar PV is 8 to 12 years, but because the SSEG tariff is revenue-neutral for the municipality, this can be considered a fair balance between the interests of the municipality and customer.

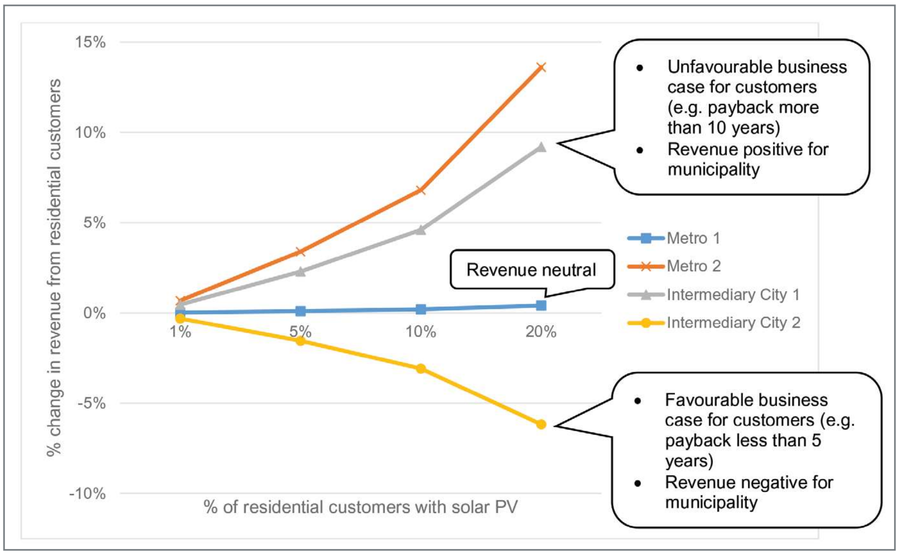

Fig. 5: Impact of SSEG tariffs on the four municipalities' revenue from residential customers.

Metro 2 results

Metro 2's approach has been to introduce a lower fixed charge of R160 per month and a very low export tariff of 10 c/kWh. The low export tariff of 10 c/kWh means that the metro makes a significant profit when on-selling this electricity.

The customer's business case is highly unfavourable in Metro 2, with a payback period of 20 years. The low compensation for exported electricity (10 c/kWh) gives little encouragement for customers to export electricity onto the grid. Even though the fixed charge for residential customers is relatively low, the tariff does not appear to reflect a balance of customer and municipal interests. Furthermore, the unfavourable business case may drive frustrated customers to invest in off-grid solutions or to connect their installations illegally.

Intermediary City 1 results

This municipality has taken the approach of introducing a fixed charge for SSEG customers (R380 per month), as well as shifting them onto a TOU energy charge and a TOU export tariff. Since municipalities purchase bulk energy at TOU tariffs, selling electricity at TOU tariffs and buying from SSEGs at TOU tariffs is a well-founded principle, and results in more cost-reflective tariffs. In terms of the revenue impact of Intermediary City 1's SSEG tariffs, they are seeing a considerable increase in revenue. This is due to the high fixed charge coupled with the profit made from TOU export energy charges.

The business case is poor for SSEG customers in Intermediary City 1 – upward of 15 years. However, since this municipality offers TOU energy charges and TOU export tariffs, load shifting to consume out of peak times is encouraged which is likely to improve the customer's business case to some extent (the model only considers a static load profile before and after SSEG). While initially the SSEG tariffs therefore appear to be biased towards the interests of the municipality over those of the customer, the introduction of TOU tariffs reflects forward thinking which allows the customer to improve their returns, and is resilient into the future when storage becomes a common part of such installations.

Intermediary City 2 results

Intermediary City 2 already charges normal residential customers a fixed charge (R402 per month). This fixed charge is kept constant for SSEG customers. So when customers migrate from normal residential tariffs to SSEG tariffs, only an export tariff is introduced. This export tariff is equal to the energy charge – 154 c/kWh – i.e. net metering (meaning that customers get compensated for their exports to the same value as what they pay for electricity). This situation means that the municipality can purchase electricity from Eskom for much cheaper than what they are compensating SSEG customers. Considering the lack of additional revenue from introducing a fixed charge specifically for SSEG customers (it is already in place for normal customers) and the high compensation for exported energy, Intermediary City 2 sees considerable revenue loss when customers install solar PV.

The business case for customers to install solar PV is very favourable – payback periods are in the order of 2 to 4 years. It appears that the balance of interests between the municipality and customer is biased towards the customer, although the resulting economic stimulus can be a sound reason for such an approach.

Insights from residential customers

The above case studies have shown that current approaches to setting SSEG tariffs

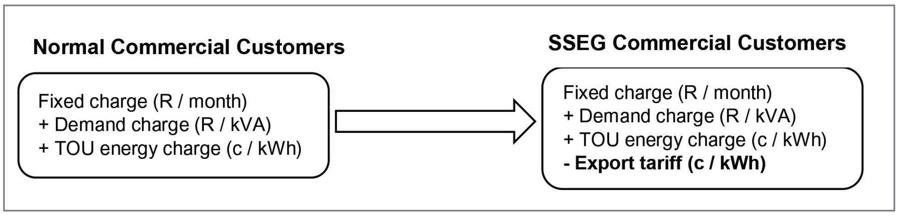

Fig. 6: Commercial tariff structures for the four case-study municipalities.

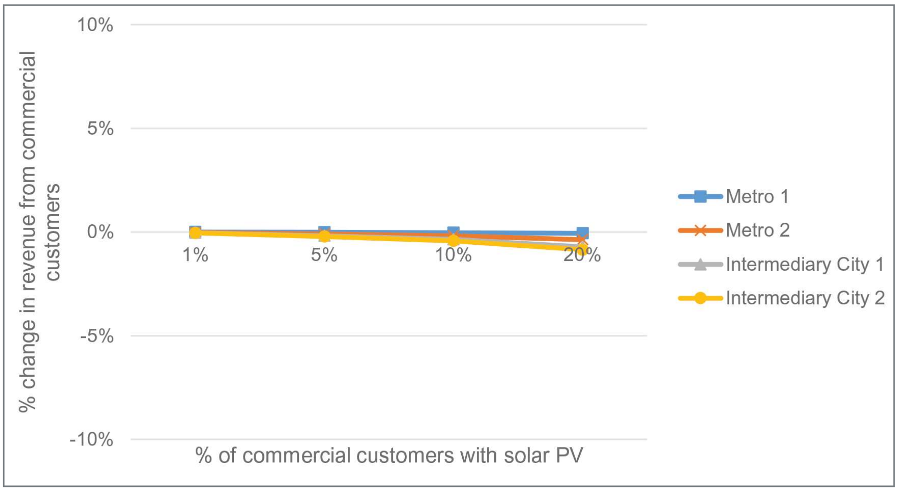

Fig. 7: Impact of commercial SSEG tariffs on municipal revenue.

differ greatly. Although all four municipalities are structuring their SSEG tariffs in a similar way – fixed charge, energy charge and export tariff – the value of these tariffs range widely between municipalities. This considerably impacts, either positively or negatively, both the revenue of the municipality and the business case for installing solar PV. Both need to be considered when setting SSEG tariffs.

The case studies help clarify some SSEG tariff setting pointers:

- A sensible SSEG tariff includes a fixed charge to recover most of the fixed costs – usually in the order of R200 to R400 per month. A few cost of supply studies examined suggest that fixed costs of between R200 to R400 per month are appropriate for residential customers. However, it is recognised that fixed charges are not always well-received by customers, and so phasing in the fixed charge over a few years may be a strategic approach.
- Regarding energy charges to recover variable costs, SSEG customers often are kept on the same energy charge as before for simplicity, however, since these volumetric tariffs generally are already recovering some fixed costs, the municipality should be careful not to double recover these fixed costs. Thus, the energy charge and the fixed charge are interdependent, and if the energy charge is indeed kept the same a lower fixed charge could be considered.
- The tariff for exported electricity should be related to the avoided bulk purchases less the technical losses. This is usually in the order of 60 to 80 c/kWh.

Looking into the future, it is important for municipalities to move towards TOU tariffs – this is reflected in the Electricity Prising Policy [7]. When customers install solar PV, their daytime demand reduces, but when the sun sets, the customer still consumes expensive peak-time electricity. If this time-dependent cost is not reflected in tariffs, the municipality remains vulnerable to under-recovering.

Commercial customers

Unlike residential customers, virtually all municipalities charge normal commercial customers a fixed charge and a demand charge. Fig. 6, below, shows the commercial tariff structure for the four case-study municipalities. When commercial customers install solar PV SSEG, the only tariff modification is to introduce an export tariff.

Fig. 7, shows the impact of commercial customers installing solar PV and migrating to the SSEG tariffs in the four case-study municipalities.

The impact of commercial SSEG customers on municipal revenue is shown to be less of a concern than residential customers because commercial customers are already paying fixed charges. Although these customers reduce their consumption of municipal electricity when they install solar PV, the fixed costs of the network are largely still covered by the fixed charges.

Although the impact of commercial SSEG customers is significantly less than that of residential customers, the case studies show that revenue is slightly negatively affected by SSEG. This is can be because the fixed charges are not adequately cost-reflective. Such fixed charges should be informed by a cost of supply study to improve this situation.

The importance of Cost of Supply studies

The approach in this paper has been to investigate the impact on revenue of customers installing solar PV and migrating to SSEG tariffs. Currently it is common practice for these to be based on current tariffs, as with most of the case studies covered. This approach also allows municipalities to set sensible SSEG tariffs without detailed knowledge of their costs, but nevertheless feel secure around the revenue impact that could result. However, since the purpose of tariffs is to ensure the municipality covers the costs of providing the service, these tariffs should actually be based on costs, and not revenue protection.

This situation can result in income loss not proportionate with cost reduction, and less than optimal customer decisions e.g. leaving the grid due to incorrect price signals. While SSEG has the potential to deliver substantial benefit to the power system (decreased costs and emissions and increased reliability and customer choice), under a traditional tariff scheme SSEG may increase inequities through cost shifting by wealthy customers who can afford it. The NERSA requirement for municipalities to undertake cost of supply studies is increasingly important. Municipalities need to develop a thorough understanding of their costs as a basis for tariff setting. This will be a focus of municipal support going forward.

NERSA's cost of supply framework utilises the cost plus methodology which allows for a surplus of 15% on total costs, inclusive of energy costs. This approach means that when customers consume less electricity after the installation of SSEG, the municipality loses the 15% surplus it was receiving from each unit sold. With cost reflective SSEG tariffs in place municipal revenue is substantially protected in terms of cost recovery, but overall revenue may decrease in the longer term. Municipalities and NERSA will need to address this particular revenue vulnerability.

Conclusion

This paper has shown that the rapid uptake of SSEG has the potential to significantly impact municipal revenue. Four case studies were explored where municipalities used varying approaches to SSEG tariff setting, and the outcomes ranged from significant revenue growth to considerable revenue loss. Some municipalities charge high fixed charges coupled with generous export tariffs, while other municipalities charge low fixed charges while offering very low export tariffs for exported electricity.

Although tariff setting should be informed by cost of supply information, an interim approach can result in a sensible SSEG tariff that balances municipal revenue interests with the customer business case. The analysis of the commercial sector revealed that it is robust in the face of SSEG due to the already existing separation of fixed network and variable energy costs. Metro 1, which closely approximates the recommended tariff approach for the residential sector (fixed charge between R200 to R400 and an export tariff that approximates the avoided bulk purchase costs), demonstrates that revenue can be protected whilst ensuring a reasonable (economically cost reflective) business case for SSEG customers.

A concern around revenue loss is not a valid reason to resist the adoption of SSEG into a municipal network given that it is easy to mitigate negative revenue impact, as illustrated in this paper. The SSEG tariff model provides a useful tool through which to explore tariffs that balance revenue protection with fair investment signals within each municipality.

References

[1] Status of Small Scale Embedded Generation (SSEG) in South African Municipalities, SALGA (2018)

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[6] EPP (2008) is available online:http://www.eskom.co.za/CustomerCare/TariffsAndCharges/Documents/18671 not13981.pdf

[7] Although these four municipalities are not named in this paper, they are existing (not hypothetical) municipalities and their actual data on customer base and tariffs is used.

[8] Available online: https://www.sseq.orq.za/?s=electricity+pricinq+policy

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