# ECONOMICALLY VIABLE SMART GRIDS WITHIN MUNICIPALITIES: LESSONS LEARNT FROM LOCAL CASE STUDIES


Author and Presenter: Bruce Raw M.Sc. (Eng.) Electrical Engineering
Co-Authors: Peter Atkins, Kevin Kotzen

**Abstract:** Smart grids infrastructure in municipalities can improve the efficiency of electricity provision and present new opportunities for economic growth and job creation. This potential business opportunity is currently hampered by barriers that limit municipalities' ability to commit to large scale roll-out of smart grids and associated distributed generation technologies. These barriers to smart grids have many causes, including a lack of national standards which may result in obsolete infrastructure once standards are finalised, and limited knowledge about the capabilities, benefits and financial viability of these technologies. GreenCape has been conducting case studies in Western Cape municipalities to determine the feasibility of implementing smart grid technologies within these municipalities, identify barriers to implementation, and facilitate the uptake of these technologies. This paper presents highlights from these case studies, and lessons learnt from the investigation into smart grids.

## Introduction

The motivation for the GreenCape Smart Grids project was to determine the feasibility of implementing smart grid technologies within Western Cape municipalities, identify barriers to implementation, and facilitate the uptake of these technologies. The underlying aims were economic development, through increased electricity network efficiencies, increased local content and job creation.

In 2013 GreenCape ran three case studies, in Drakenstein, Witzenberg and Saldanha, to develop business cases for implementation of smart grid technologies. In these case studies a roadmap was developed for each municipality to help plan the long term future of the municipal grid with respect to smart technology (GreenCape, 2014b, 2014c, 2014d). In 2014 three more case studies will be conducted with a slightly heavier focus on smart grids role in enabling the green economy, as a sustainable part of the municipal electricity business.

Several lessons were learnt during our various engagement within the municipalities as well as during the modelling and development of the business cases.

## 2013/14 Case Studies

In 2013 GreenCape conducted a project to develop Smart grid business cases within three Western Cape municipalities. These case studies set out to determine the expected requirements and aspirations for each of the municipalities in terms of their electricity business, identify potential smart grid interventions, explore the business case for a smart grid implementation, and make recommendations on the benefits and challenges for smart grid implementation in municipalities in the Western Cape.

### Methodology:

This project, consisting of case studies of three selected municipalities in the Western Cape, was developed following a generic 5-step process outlined below. As emphasised earlier, the development and implementation of smart grid projects is very case specific, and so the outlines to follow merely describe the process followed. The 5-step process is summarised in diagram on the following diagram.

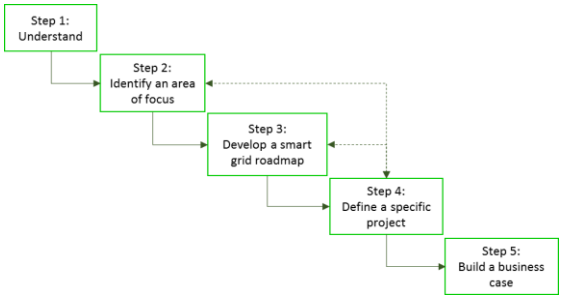


Figure 1. Diagrammatic representation of business case development process

## Drakenstein

(GreenCape, 2014b)

The selected business case project for Drakenstein was a smart metering project to implement a time-of-use tariff for domestic customers, covering the first three areas of the roadmap's initial development, namely: communications platform, smart metering pilot and the extension of the smart metering pilot.

The cost benefit modelling of the project for Drakenstein showed that is it possible under the right conditions for smart metering to pay itself off over its lifespan when all the municipal benefits are taken into account.

During the modelling process we learnt that the viability of a smart metering implementation can shift dramatically depending on the tariff used and the customer's response to this tariff. A graph of the cumulative net benefit of the proposed project can be seen in Figure 2 showing a payback period of just under 15 years giving the project a net present value of R 76 000.

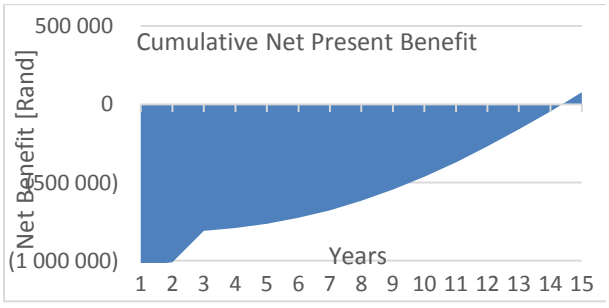


Figure 2. Cumulative net benefit of project

The business case for smart metering is not particularly strong if you consider only the financial benefit for the municipality. While the project should pay itself off, it does not offer a large return on investment during the meters' lifespan. However when the customer savings are taken into account the result is dramatically improved.

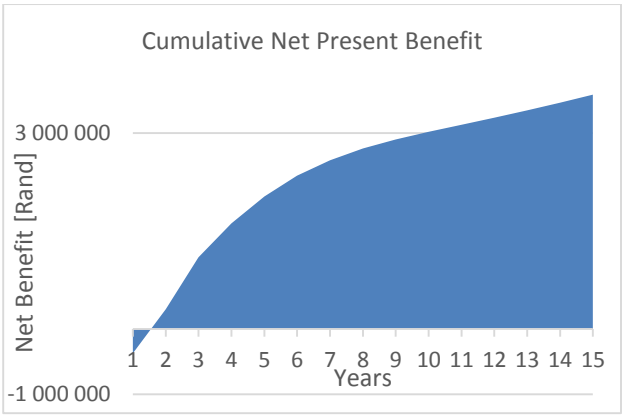


Figure 3. Cumulative net benefit of project with customer savings included

This showed that there is great economic value to be gained through load shifting even if the direct value to the municipality is low. This value requires users to both understand the tariff, as well as have sufficient incentive to shift load.

## Saldanha

(GreenCape, 2014c)

The business case project for the Saldanha Bay municipality explored a substation metering proposal followed by a fault detection proposal. The project covers the first three areas of the roadmap's initial development, namely: communications platform, substation metering project and mini-substation fault detection.
The implementation plan for the Saldanha project was required to be split into sections of work that could be implemented and see benefit within 3-5 years. This restriction made it difficult to build a plan to roll out smart grid technology because individual implementations add little value as stand-alone solutions.

## Witzenberg

(GreenCape, 2014d)

The Witzenberg case study focussed on the impact of net metering as opposed to the current situation of detent-free mechanical meters (allowed to spin backwards). The proposed feed-in tariff, in which electricity is fed back onto the municipal grid at cost (at the same tariff as paid to Eskom by the municipality), shows the reduction in profit from a typical customer installing PV is reduced by about 19%. This means that the meter cost is easily recoverable.

The business case thus calls for a well thought out feed-in tariff to mitigate potential threats to municipal revenue, while also encouraging the uptake of renewable energy generation. This will contribute to national efforts at sustainable development –particularly through changing the country's energy mix and thereby reducing emissions from electricity provision.

## 2014 Case Studies

In 2014 GreenCape will be running three additional case studies. These case studies are planned to focus on the role of smart grid technologies in enabling the green economy while still being part of a sustainable municipal electricity business.

These new case studies will look at the interactions between various grid technologies and the rapidly changing space of distributed and embedded generation and energy efficiency.

## Smart Metering

Smart metering forms a large part of a smart grid, and as such is a key component when looking into smart grids. It was quickly identified that the lack of stable standards was a large barrier for most municipalities.

The GreenCape smart grids project team has also been involved in researching and developing smart metering standards. We have been focussing specifically on the development of a standard for a smart split[1] prepaid meter.
At present there is limited availability of suitable smart split prepaid meters. This is because split prepaid meters are not widely used internationally and the fragmented South African market is not currently large enough to warrant making a special meter – even if an agreed South African standard was in place. The situation might change in the light of the recent designation of smart meters for local procurement – which will encourage local manufacture (South African Government News, 2014).

This standards process is ongoing, and we will continue to assist the process in any way we can.

Currently the business case for smart meters is not very strong for the municipalities we have looked at, as the high price of the meter makes it difficult to recover costs fully. Smart meters do add significant saving opportunities for the customers however, so if funding becomes available that does not require short pay-back times, smart meters are very attractive.
It is also possible to get a much stronger business case if the rollout is done only to replace meters that are being replaced anyway rather than a full replacement project.

## Lessons Learnt

### Building Business Cases
(GreenCape, 2014a)

One of the most visible lessons learnt from our business case modelling is that the financial case for smart grid technologies is not always easy to build. Many of the benefits gained from technologies such as smart metering and outage management do not come in the form of direct financial return to the utility. A large part of the benefits gained directly benefit the customer. Nevertheless, due to the fact that service delivery is a core principal of municipalities, these benefits serve as good motivation for moving towards a smart grid. It is important when building a business case for a smart grid technology that these customer benefits be included.
Note that the municipality's objective is not to make a profit, but to provide the agreed service delivery in the most cost-effective way. Customer benefits can be regarded as a part of service delivery, so in this sense the municipality's decision to invest in smart technology mainly for the benefit of the customer, is a political decision.

The difficulty with the motivation of these technologies, based purely on service delivery, is that they are competing for funding with other projects that also offer improved services to the community. Smart grid technologies do however offer significant value to the municipality outside of service delivery, which when combined with the customer benefits can lead to large benefits for the municipality, at little or no net cost.

### Pilot Projects

One difficulty is identifying where all of the gains for the municipality will be found. There are many variables that can impact the outcome of the project by very large margins, such as the user's response to smart metering. Without accurate

[1] Split meters have that meter itself in a secure kiosk outside the customer premises and a display unit plus a keypad inside the premises.

information it is almost impossible to predict exactly what value will be gained from a project and in our case studies it was seen that this information will only be gained after implementation of the project has begun.

It is for this reason that in all our project plans we suggested starting with a pilot project or small initial rollout so that risk can be properly managed, and maximum benefits can be drawn from the investment.

## Tariffs

During our modelling process it was noticed that the tariff structure impacted the business case far beyond what we had initially expected. While it was always obvious that adjusting the tariff would have a significant effect on municipal revenue, when looking at time of use tariffs it was quickly seen that this effect extends past just raising or lowering the cost of electricity.

There are links between the tariff and the user's response that make modelling the effects of a tariff change complex. Increasing the differential between peak and standard pricing not only impacts the revenue collected when the tariff is implemented and the change in revenue when a customer shifts load, but also the likely hood that the customer will shift their load. Making the differential too high means that the municipality will lose revenue if the customer shifts load and making it too low provides no incentive for the customer to shift load.

In the modelling done for Drakenstein, we found that it is possible to make a tariff that both provides the customer incentive to shift load and increases municipal gross electricity profit while still ensuring that the average customer bill is not changed when shifting on to time of use.

This tariff development process requires a good knowledge of the consumption of the users that are going to be on the time of use tariff. Acquiring detailed consumption data and carrying out appropriate modelling is not a trivial process; however it can make a large difference to the success of the tariff.

## Road Map

The high cost of smart grid technology makes it prohibitive for a municipality to roll out an entire smart grid in a single project. For most municipalities the cost of upgrading to a smart grid is many years' worth of budget.

This means that smart grid interventions need to be staged in manageable parts and because all of the parts of a smart grid derive additional benefits from the other parts, how the interventions are selected is important.

Preparing a long term vision and roadmap for progression to a smart grid will allow municipalities to better manage their choices as they move forward and enable them to make the best selection of technology to suit their needs at each stage (Bipath, 2014).

# Conclusion

The GreenCape smart grid projects have highlighted some of the difficulties that will be faced by municipalities looking at moving towards a smarter grid. While most Western Cape municipalities are not yet at the point where it makes sense for large investment into smart grids, it is clear that the path of the grid is moving towards smarter technology. It is important for municipalities to develop a roadmap for moving their grid towards a smarter grid and plan their upcoming spending wisely. The business cases for smart meters and other smart grid technologies are not always viable just yet, but as technology becomes cheaper and energy more expensive the cases get better. Nevertheless, if customer and municipal benefits are included in the business case, smart meters do make sense and the decision to invest then becomes a political service delivery decision.

The tariff design for time of use tariffs has a much larger impact on revenue and is a lot more complex than standard tariff design. Residential customers do not have the same flexibility as large industrial users in terms of shifting load, and as such require a different tariff for time of use to be successful. We strongly suggest that great care is taken in the development of residential time of use tariffs. Time of use tariffs, if designed and implemented correctly, can increase a municipality's financial stability and ultimately allow them to insulate themselves against the impact of price increases and embedded generation (e.g. rooftop PV) and energy efficiency interventions.

Municipalities need a significant amount of information about their grid before they can make the correct decisions on issues like tariff design and capital expenditure. This data is often not being measured at all at present, which means projects like metering mini substations and smart metering pilots are very important for the future of the grid, despite them not having a particularly strong business case in their own right. However,

the data on its own does not necessarily add value, there also needs to be the ability to analyse and act on the findings and this will require both people and systems capacity, which needs to be factored into the projects.

Implementing smart grid technology in a big bang manner is not usually financially feasible and can be risky. A phased approach following a roadmap, is safer and more financially viable. In adopting a phased approach, it is necessary to understand that the individual phases don't necessarily each pay for themselves, but taken together they do.

## Acknowledgements

We would like to acknowledge the British High Commission (through the prosperity fund) and Western Cape Government Department of Economic Development and Tourism (DEDAT) for funding the 2013/14 project and DEDAT Green Economy for funding the 2014/15 project. In addition, we would also like to acknowledge the contributions from the following people/institutions: the Smart Grids Project Steering Committee, municipalities of Cape Town, Drakenstein, Witzenberg and Saldanha, and Bernard Bekker (2013/14 project manager).

## References

Bipath, M. (2014). *Proposed Smart Grid Vision for South Africa*.

GreenCape. (2014a). *D1 - Guidelines to developing Smart Grid Business Cases - Final*.

GreenCape. (2014b). *Towards a Smart Grid in Drakenstein Municipality*. Retrieved from http://green-cape.co.za/smartgrids/docs/D3.pdf

GreenCape. (2014c). *Towards a Smart Grid in Saldanha Bay Municipality*. Retrieved from http://green-cape.co.za/smartgrids/docs/D4.pdf

GreenCape. (2014d). *Towards a Smart Grid in Witzenberg Municipality*. Retrieved from http://green-cape.co.za/smartgrids/docs/D5.pdf

South African Government News. (2014). Govt committed to supporting local procurement. *SAnews.gov.za*. Retrieved August 21, 2014, from http://www.sanews.gov.za/south-africa/govt-committed-supporting-local-procurement