

SMART CITIES AND SMART GRIDS

A VISION FOR SOUTH AFRICA

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Network

Lorem ipsum dolor sit amet, consectetur adipiscing elit eiusmod

Department store

Tariff
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Signal

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Are You Here

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INTRODUCTION: DIGITAL DISRUPTION IN THE PUBLIC SECTOR

Digital connectivity and the use of ICTs have been looked up to as tools for overcoming the complex public sector challenges of today, such as inadequate legacy infrastructures, environmentally unsustainable behaviours and practices, and under-resourced public services. As a result, we have seen the emergence of notions such as ‘smart cities’, ‘smart services’ and ‘smart government’.

Digital disruption reveals itself at many different levels. Globally, companies like Uber are disrupting existing industries, i.e. taxi hire. Similarly, the smart city concept is poised to challenge how we see our cities and towns being managed, operated and accessed. The notion of a smart city and its implementation are about digital disruption at the immediate local scale of a community, a municipality, a city, or a region.

SMART CITIES

As digital infrastructure becomes ubiquitous in urban environments, we encounter ideas of a new urbanism where physical infrastructure becomes of secondary importance to digital infrastructure. By linking physical objects and enabling them to communicate with the people and infrastructures surrounding them, the Internet of Things (IoT) offers a technology setting where wireless sensors can e.g. provide event monitoring for public spaces, signal warnings or alerts, or enable seamless, ‘smart’ interactions between citizens and the city environment¹.

Figure 1 (page 3) links the elements of the smart city concept² to African urban challenges; suggesting how such elements may improve the urban environment on the continent.

SMART GRIDS

Over the past 25 years the electricity sector has seen major transformation worldwide. Prior to the 1990s, electricity utilities tended to operate with a high degree of regulation and centralisation. Competition among utility companies was low, and their relationship with consumers was rather simple. As a result, returns for shareholders were highly predictable³. In many countries, this traditional business model has been transformed in its entirety. Policy mandates to increase competition have led to regulatory reform and privatisation. Through the unbundling of utilities, previously vertically

integrated networks were broken up. For example, electricity services were separated into their basic components (generation, transmission, distribution and retail). Each segment was privatised and competition was fostered.

Increasing awareness of climate change has encouraged investments in energy generation from renewable sources and mechanisms for energy efficiency. The evolution of microgrids (independent grids that can be operated in isolation and rely on the main power network as backup) also poses a challenge to utilities’ business models.

With increased competition, resource challenges and innovation opportunities in the electricity sector, the need for utilities to be ‘smart’ and to manage these uncertainties has emerged. The concurrent evolution of digital technologies has presented a platform for achieving exactly that. Smart meters have introduced the potential of radically disrupting the relationship between energy suppliers and consumers.

Meanwhile, energy grids are coming under pressure to manage the generation and distribution of energy in ‘smart’ and efficient ways. The IoT simplifies the management of the transformed customer relationship, empowers utilities to manage their grids effectively and to supply electricity efficiently, as expected, anytime and anywhere. As electricity demand is changing and conventional utility business models are no longer viable, utility companies need to reinvent themselves to develop new business models and value propositions built around customer needs.

RESEARCH FOCUS

In this report, we set out to consider a variety of aspects and experiences of digital disruption in South Africa’s public sector. We interviewed representatives of companies active in the provision and implementation of smart grid technologies, explored secondary resources available on the Internet and attended industry events (see references).

With a focus on IoT, we consider two pillars of digital disruption within the context of the South African public sector and the energy sector. We explore the notions of smart cities and smart grids, as well as the strategies, experiences and challenges for their implementation. Sustainability and energy efficiency emerge as cross-cutting themes.

¹ Brous & Janssen, 2015

² Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014

³ Alonso, 2015

“ THE SMART CITY CONCEPT IS POISED TO CHALLENGE HOW WE SEE OUR CITIES AND TOWNS BEING MANAGED, OPERATED AND ACCESSED.

FIGURE 1: SMART CITIES AND URBAN CHALLENGES

	URBAN CHALLENGE	SMART CITY ELEMENTS
‘HARD’ DOMAINS	Inadequate physical infrastructure	Natural resources and energy: <ul style="list-style-type: none"> • Smart grids • Public lighting • Green, renewable energy • Waste management • Water management • Food and agriculture
	Urban density and congestion	Transport and mobility: <ul style="list-style-type: none"> • City logistics • Information mobility • People mobility
	Urban slums and informal settlements	Buildings: <ul style="list-style-type: none"> • Facility management • Building services • Housing quality
‘SOFT’ DOMAINS	Low quality, unsustainable and segregated social services	Living: <ul style="list-style-type: none"> • Entertainment • Hospitality • Pollution control • Public safety • Health care • Welfare and social inclusion • Culture • Public spaces management
	Environmental vulnerability and climate change risk	Government: <ul style="list-style-type: none"> • e-government • e-democracy • Procurement • Transparency
	Unemployment and informal urban economy	Economy and people: <ul style="list-style-type: none"> • Innovation and entrepreneurship • Cultural heritage management • Digital education • Human capital management

SOURCE: SLAVOVA & OKWECHIME (2016)

OPPORTUNITIES FOR SMART CITIES IN SOUTH AFRICA

Just as car manufacturers held sway in determining how cities developed in the 20th century, IT companies are set to drive the agenda of future urbanism. Such an agenda is likely to be data-driven and to harness IT infrastructure for the delivery of services to the public.

Strategies for the development of ubiquitous digital infrastructure in cities are intrinsically linked to the management of urban growth and service provisioning. Approaches can vary depending on city size and the activities of its citizens.

Large⁴ cities (more than 1m inhabitants, such as Johannesburg, Cape Town and Durban) are often plagued by inadequate physical infrastructure to meet the demands of their growing populations. Here, smart strategies may involve the integrated provisioning of services and deployment of IT, and also prioritising 'hard' domains by opening up, democratizing and repurposing already existing elements of building and transportation infrastructure. The purpose of such a smart city strategy is not only to ensure that 'hard' infrastructure is enhanced by IT but also that it is made fit for purpose.

Medium-sized⁵ cities (500 000 to 1m inhabitants, such as Bloemfontein and East London) tend to become highly specialised⁶. As such cities generally offer higher quality of life than their larger counterparts, they do not necessarily constitute competitive locations in terms of economic activity. Typically they specialise in specific niche⁷ sectors of the economy. While they are not immune to 'hard' infrastructure challenges, medium-sized cities are well positioned to successfully prioritise issues in the 'soft' domains of service delivery, e.g. public transportation, education, entrepreneurship, participatory governance and social cohesion.

An alternative strategy for the creation of smart cities involves the construction of entirely new cities, often as satellites of existing large urban centres. Such undertakings tend to be driven largely by private sector developers, with diminishing participation of government authorities.

The involvement of the private sector in such projects, most notably IT and consulting firms, has been likened to the influence of car manufacturers on the emergence of American cities in the 20th century that were exclusively fit for automobiles⁸. Thus, just as car manufacturers held sway in determining how cities developed, IT companies are set to drive the agenda of future urbanism. Such an agenda is likely to be data-driven and to harness IT infrastructure for the delivery of services to the public.



WATERFALL CITY

Waterfall City is an urban development north of Johannesburg that is privately financed by the Waterfall Investment Company in partnership with Atterbury Property Holdings. Aimed at becoming a 'true lifestyle and blue-chip business destination', the estate includes residential areas, a business district, extensive retail space with the 120,000m² Mall of Africa and even an equestrian estate. With a retail precinct at its epicentre, Waterfall strives to provide an integrated, eco-friendly environment which offers high quality of life and attracts knowledge business (e.g. PwC).

Waterfall City is one of the first estates in South Africa to be directly connected to the Internet via fibre-optic cables. Broadband connectivity at speeds of up to 40 Mbps is provided to residential and business customers by Smart Village, a company considered to be a trendsetter as it offers a converged television, telephone, internet and security service, with one integrated monthly bill and one customer care point for all services.

Scholars have described Waterfall City as 'enclave living' – a format that challenges understandings of urban spaces as finely balanced public-private endeavors. The emerging format blends unrestrained free enterprise within an overarching framework of strict management controls.

SOURCE: MURRAY, 2015, MYBROADBAND.CO.ZA, 2013

⁴ Using classification by Angelopulo, 2015

⁵ Using classification by Angelopulo, 2015

⁶ Henderson, 1997

⁷ Giffinger et al., 2007

⁸ Townsend, 2013

ICT-BASED EXPERIENCES IN SOUTH AFRICA

One initiative towards the development of smart cities is IBM's Smarter Cities Challenge. As part of the challenge, teams studied a local issue, selected by a winning municipality, and developed understandings about the factors involved and potential solutions to the opportunity at hand. At the end of the consultation, IBM presented comprehensive recommendations in line with recognised smart city "best practices".

Considering issues of public safety, for example, IBM proposed a roadmap for the City of Johannesburg consisting of five key safety areas:

- Crime prevention and investigation by means of a data centre with predictive analytics;
- Crisis and emergency responsiveness based on increased sharing of intelligence;
- Asset management and infrastructure safety through improved asset-management capabilities;
- Community education and engagement through improved methods of communication and delivery; and
- Governance and integrated intelligence by means of shared data across city departments.

Those suggestions formed the basis of a five-year public safety strategy.

JOHANNESBURG: A WORLD-CLASS AFRICAN CITY?

As part of its attempts to bridge the digital divide, the City announced the Smart City, Digital Ambassadors and Broadband Base Stations programmes in its 2015/16 financial year. The Smart City initiative aims to provide basic levels of internet access across the City. In 2016, the City aims to achieve 100% access to affordable internet services across City-owned buildings, and significant rollout of broadband access at the household level. By growing the City's ability to provide its residents with affordable and universal access to communication services, it is believed that the City will assist entrepreneurs and businesses to thrive.

In terms of smart city management, it is believed that the implementation of the programme will assist the City to enhance service delivery through interventions such as smart-metering for water and electricity services and e-services such as receiving bills online. The Broadband Base Stations initiative aims to provide universal access through a partnership between City Power and MTN. The intention is to turn light poles into cellular base stations for providing broadband connectivity across the city.

The Digital Ambassadors program (Vulindlel' eJozi) aims to recruit and train 3 000 young people to use the new City portal called Maru a Jozi (a Setswana phrase meaning Joburg clouds), which gives the user free access to a range of basic online services. Each digital ambassador will be equipped with a tablet in order to train community members. The City has also allocated R410-million towards enabling access to internet services within certain community and recreation centres. Furthermore, City Power is continuing with the roll out of prepaid and smart meters. The meters are intended not only

to protect the City's revenue streams but also to mitigate the impact of load-shedding through the load-limiting capabilities of the smart meters. The meters allow City Power to remotely switch off the power to high-consumption households to avert load-shedding.

SMART CITIES AND IOT

As connected objects are increasingly becoming interwoven into the urban fabric, many cities are experimenting with IoT use in the management of the urban environment. The relevance of such developments to the South African context is undisputed:

“ WE BELIEVE THAT MORE AND MORE PEOPLE ARE MOVING INTO CITIES [...] SO YOU ARE BUILDING A CITY. [IT MEANS] MORE AND MORE ELECTRIFICATION. EVERYTHING WE DO HAS AT SOME POINT OR OTHER SOME SENSOR, SOME BUTTON, SOME DEVICE, SOMETHING THAT TURNS [ON AND OFF], SOMETHING THAT OPENS AND CLOSES [...] SO BUILDING TECHNOLOGY [IS] A BIG THING AS PART OF BUILDING INFRASTRUCTURE IN CITIES.” [CEO SIEMENS SMART GRIDS AFRICA, SIEMENS]

Worldwide innovative practices include:

- **Smart bins in Barcelona**⁹ Sensors are installed in order to optimise the routes of refuse collection vehicles, with expected waste disposal cost savings of 10%.
- **Intelligent streetlights in Amsterdam¹⁰ and Glasgow¹¹** Pilots aimed at energy savings by allowing streetlights to automatically turn on and off.
- **Autonomous vehicles and traffic flow management in Singapore¹²** Sensors used for electronic road pricing and sensors attached to taxis help the mapping of traffic conditions.
- **City wide sensing in Santander¹³** The largest city-wide sensing pilot in the world and a testbed for the smart city IoT concept, the project involves 12,000 sensors that collect data on everything from parking space availability to air quality.
- **Energy management solutions for smart buildings in Canary Wharf, London¹⁴** Sensors are used to monitor energy use and manage waste as part of a project to find smart-city alternatives.



⁹ http://www.cisco.com/c/dam/en/us/products/collateral/wireless/mobility-services-engine/city_of_barcelona.pdf

¹⁰ <http://amsterdamsmartcity.com/projects/detail/id/62/slug/flexible-street-lighting>

¹¹ <http://futurecity.glasgow.gov.uk/intelligent-street-lighting/>

¹² <http://www.itsa.gov.sg/content/itsaweb/en/roads-and-motoring/managing-traffic-and-congestion/intelligent-transport-systems.html>

¹³ (Silva & Maló, 2014)

¹⁴ <http://www.edie.net/news/5/Canary-Wharf-trials-two-new-smart-city-innovations/28267>

SMART GRID: DIGITAL DISRUPTION IN THE SOUTH AFRICAN ELECTRICITY SECTOR

“ IF YOU ASK ME, IN THE FUTURE, TEN YEARS FROM NOW, WE WILL BE SELLING ENERGY LIKE THE AIRLINES SELL THEIR SEATS. WE WILL HAVE A VARIABLE PRICE THROUGH THE DAY, AND YOU CAN THEN DECIDE WHETHER YOU WANT TO SWITCH ON YOUR APPLIANCE AT THAT POINT IN TIME.” [EXECUTIVE, ORGANISATIONAL STRATEGY - ESKOM]



THE SOUTH AFRICAN UTILITY MODEL

The current Eskom business model is consistent with traditional utility operations. As a monopoly, Eskom’s operations cover generation, transmission, distribution and retail. As a state-owned company, Eskom’s mandate is to provide electricity in an efficient and sustainable manner that contribute to economic growth and improving the quality of life of people in South Africa as well as the region, while ensuring the security of supply.

Its customer value proposition is centred on the ‘always on’ provisioning of power. Commercially, Eskom is allowed to charge tariffs approved by energy regulator Nersa. These tariffs are often not high enough to ensure Eskom’s rate of return on assets is equal to the cost of its capital.

A huge proportion of its budget is spent on supplies for coal, diesel, nuclear, and water. Roughly, input energy forms about 50% of Eskom’s cost base, manpower is about 15%, maintenance is 20%, and 15% is financing cost.

Meanwhile, its customer segments are predominantly municipal (about 42% of its load is sold to municipalities), industrial, commercial (e.g. mining, agriculture), as well as residential. Yet, considerable inefficiencies are ingrained in the vertically integrated system:

“IF WE LOOK AT THE COMBINATION OF GENERATION AND PRIMARY ENERGY, AND THE VAST MAJORITY OF OUR FLEET IS COAL POWERED, YOU ARE LUCKY IF YOU GET THERMAL EFFICIENCY OF 0.33 [1 IS PERFECT EFFICIENCY]. SO THERE IS ENORMOUS AMOUNT OF ENERGY THAT IS LOST, ALL THE WAY DOWN THAT CHAIN. SO WHAT WE ARE GETTING OUT IS A FRACTION OF WHAT WE ARE PUTTING IN, AND A FRACTION OF WHAT WE ARE [EARNING] ALONG THE WAY. SO HOW DO WE MAKE THAT MORE EFFICIENT?” [EXECUTIVE, ORGANISATIONAL STRATEGY - ESKOM]

ESKOM’S CHALLENGES

GRID MANAGEMENT

Eskom’s electricity grid is built on legacy electrical infrastructure, with electricity largely flowing in a south-west direction, away from the coal fields in Mpumalanga and Limpopo, where the bulk of South Africa’s electricity generation capacity is located. However, with the recent inclusion of renewable energy sources in the Eastern, Northern and Western Cape to the grid, this pattern has been somewhat disrupted. Other independent power producers (IPPs) have also been supplying electricity to the grid.

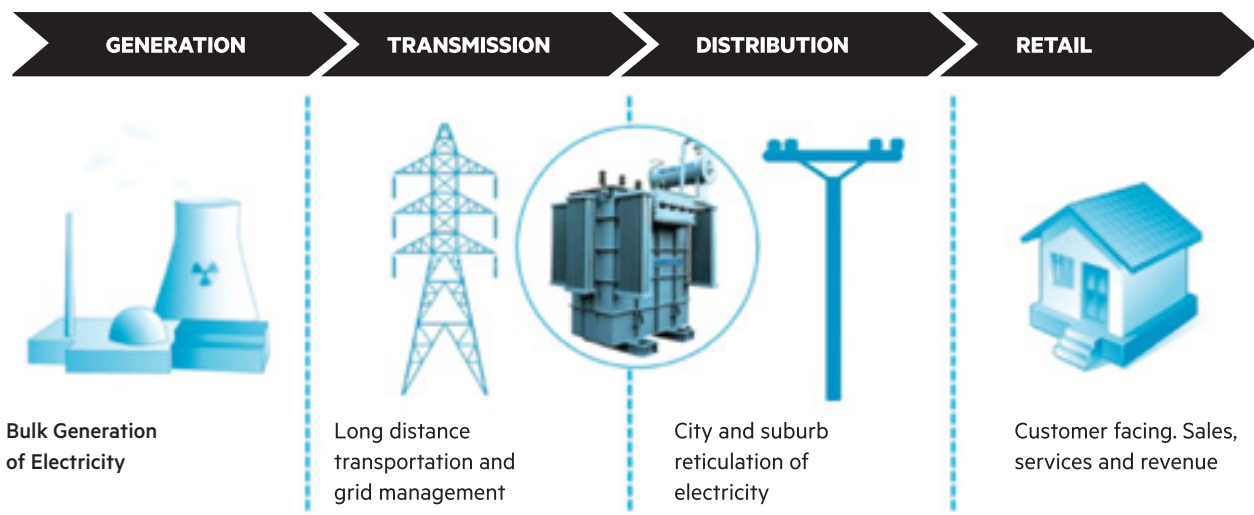
This means the power coming onto the grid is no longer flowing mostly in one direction. Generation can happen anywhere on the grid, at a different capacity, at different times of the day, leading to a disruption in Eskom’s traditional grid organisation (see figure 2). While individual consumers are starting to be able to generate electricity via solar panels, they cannot currently supply any excess power to the grid. Yet, if and when the regulatory barriers are removed the existing electricity grid is bound for further disruption.

With IPPs generating electricity from different sources, such as wind, solar and methane gas, and in various parts of the country, there is a need for the electrical infrastructure to evolve:

“In the old days it was a question of pushing energy on one side of the grid, and just pulling it out on the other side, making sure that there is enough. Now energy is flowing in all directions and you have to be able to manage that. You have to switch it on and off, and that’s not a trivial activity. But you also have to modulate it. There is no point in pushing too much energy into the grid and there is no point in pushing too little” [CEO Siemens Smart Grids Africa – Siemens]

Renewable energy adds to concerns for energy security and energy reliability because it is very variable. The typical load profile for South Africa tends to have two demand peaks during the course of the day – one in the morning (6-8am) and one in the evening (6-8pm). Solar power usually comes

FIGURE 2: TRADITIONAL GRID ORGANISATION



SOURCE: APPS, S. 2015

in around the middle of the day, while wind is rather erratic and tends to occur in the late afternoon, which makes it suitable for meeting peak demand in the evenings (see figure 3).

The swings in generation over the course of the day, and its low levels of reliability (e.g. the impact of cloud cover on solar power generation) increase the complexity of grid management.

LOAD BALANCING

The core grid management problem for Eskom consists of balancing energy generation and load [demand] at the critical grid frequency of 50Hz. In real time, electricity supply must always equal demand. In other words, electricity generation needs to be balanced against the load demanded by customers (see figure 4).

Currently, the customer relationship is based on the assumption that whenever users demand electricity, they should be able to ‘turn the tap on’ and have their demand met, regardless of the cost to Eskom.

In order to transform its working model, Eskom needs not only to manage its energy costs more effectively, but also

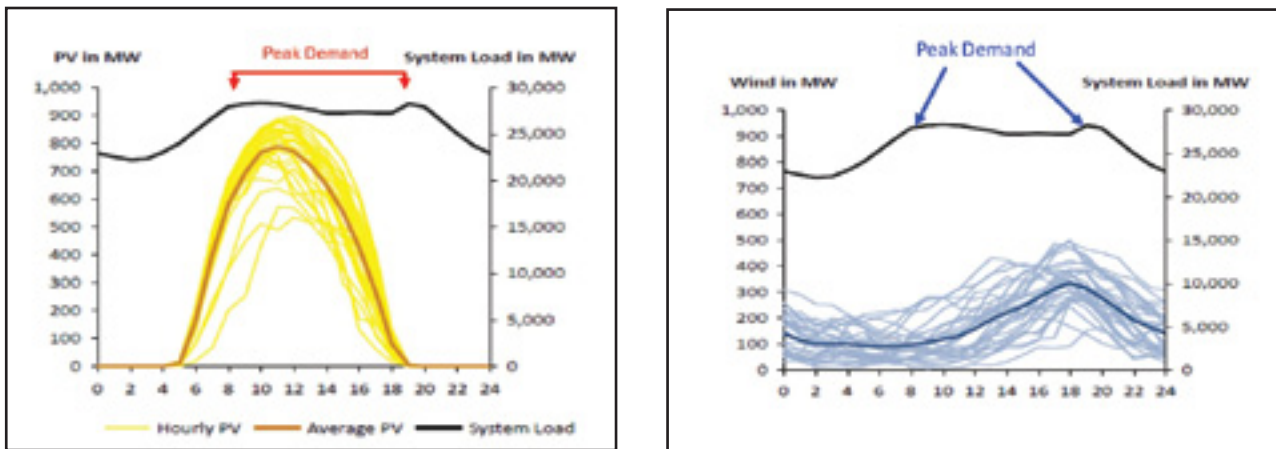
to manage its relationships with consumers. The utility is looking to transform its current position of advance electricity generation, aimed at meeting any level of customer demand, to load-following generation.

IoT technologies, and smart meters in particular, could address precisely this load management challenge. With quality measurements, good control equipment and sensitive information being collected throughout the generation, transmission and distribution network, utilities are in a position to improve enormously the efficiency of distribution by switching loads:

“You can now become very very clever and you can have arrangements with certain customers that they don’t use electricity between certain times [...] and you can switch them off. It is called surgical data curtailment. And with strategies like that you can manage supply and demand.” [CEO Siemens Smart Grids Africa]

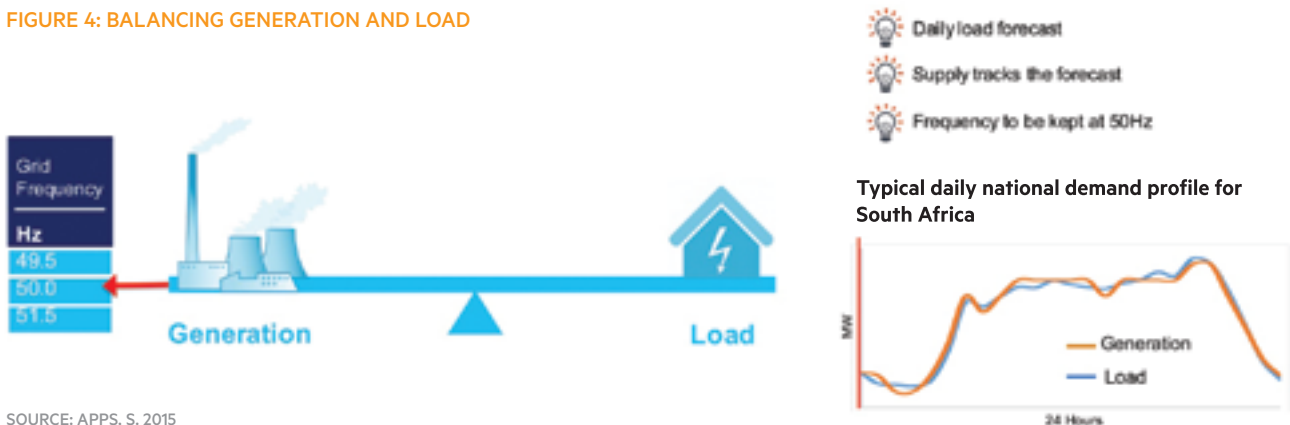
The technology also allows for variable pricing according to differentiated tariffs based on the level of demand, and can keep customers up-to-date on their spending.

FIGURE 3: HOURLY PV (LEFT) AND WIND PRODUCTION FOR DEC 2014



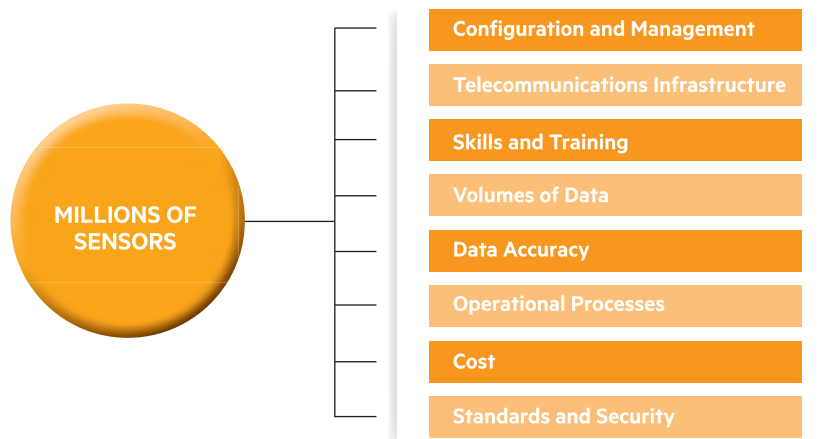
SOURCE: APPS, S. 2015

FIGURE 4: BALANCING GENERATION AND LOAD



SOURCE: APPS, S. 2015

FIGURE 5: THE SMART GRID CHALLENGE



SOURCE: APPS, S. 2015

SMART GRID OPPORTUNITIES

The notion of a smart grid captures the rising complexity of the generation process and seeks to align it with the variable loads demanded by consumers. It involves adding a layer of intelligence onto the grid which allows the monitoring of supply and demand through sensors, and adjusting this through appropriate switches.

For Eskom, IoT offers the following opportunities:

Improved engagement with customers and the ability to support them, measure their consumption accurately, and to collect the revenue that is due;
 Balance electricity supply and the demanded loads; and
 Solutions around asset management and disaster prevention.
“[...] there are lots of opportunities to instrument the value chain, improve the granularity of the control because you’ve got better visibility. If you’ve got better visibility, you’ve got better control. If you’ve got visibility, you can run analytics and do all sorts of clever things.” [Executive, Organisational Strategy - Eskom]

While the concept is very appealing in terms of improvements to grid management, it brings a number of challenges. These include the need for considerable capital investments, insufficient skills in data management, variable quality of telecommunications infrastructure throughout the country, big data volumes and often unreliable data accuracy (see figure 5).

The investments required in order to transform the South African electricity grid into a smart grid are probably the most conspicuous challenge. Therefore, the maturity of the technology and its price point are critical. For Eskom, operating at margins of 2-2.5%, it is important that the technology they deploy is cheap to install and cheap to maintain. At the moment, Eskom is focused on investing in business cases that show an internal rate of return of 16% or more. Such business cases tend to occur in retail, rather than in operational use:

“The next question is, ‘Is IoT ready for mass deployment?’. And the answer I would give is no, not yet. It is ready for selective deployment where you’ve got robust business cases. ‘But is it

at the point where I could afford to put it into everything, get the data from everything and analyse it?’ Not yet. ‘Would it get there within five years?’ Oh yes.” [Executive, Organisational Strategy - Eskom]

DISRUPTION: IOT FOR OPERATIONAL USE

SUPPLY CHAINS

The vertical network of electricity generation and transmission presents plentiful opportunities for improvements in efficiency and reductions in technical losses.

One important use case covers transparency of the supply chain. As old collieries are mined out and coal-fired power stations are no longer tied to a specific mine, coal gets supplied from various collieries. If Eskom are able to capture each ton of coal and its quality as it arrives, it would be possible to ensure the correct coal consistency enters the power plants.

Variations in coal consistency cause enormous swings in power generation. By tracking the coal, measuring its quality, or simply tagging coal shipments with disposable sensors, Eskom have looked to improve the resource supply process. When the coal enters the energy plant it is pulverized, blown into the boiler house and blended with heavy fuels because of its low quality. Heavy fuel shipments also need to be tracked and its quality measured in order to reduce the inefficiencies in the generation process.

GENERATION

Efficiency improvements in power generation include monitoring boiler rooms for pipe breaks and plant outages by means of battery powered sensors, which wirelessly transmit information about the state of the equipment. IoT offers an opportunity for re-instrumenting the existing power generation plants, the majority of which are about 30 years old, in their entirety.

“We ask, ‘Why can’t we improve the performance of the plant?’ Well, the measurement is terrible. If you want to improve the performance of the plant, improve the measurements. If you want to improve the measurements, how do you improve your sample rate? How do you improve the collection rate? [...] We do have online condition monitoring but it is a bit like listening

to your heartbeat with a four-pound hammer. We need to change that four-pound hammer out for a stethoscope.”
[Executive, Organisational Strategy – Eskom]

TRANSMISSION

During electricity transmission, there are considerable technical losses throughout the network. At every transformation stage, every transformer loses energy. Transformers often break, short-circuit and degrade. As they age, they tend to start generating more heat, rather than converting energy. Often transmission lines stretch and become too thin; consequently their resistance goes up and more energy is lost along the line.

With the help of IoT, all such faults can be identified and measured. Without IoT sensors, it may take a long time to detect these faults. When a switch fails, a technician would have to drive out to the exact position of the fault in order to remedy it. Using IoT, such issues can be remedied remotely by rerouting the power via other lines. As a consequence, new grid structures emerge and complexity rises.

Currently, there are about 6 million kilometres of low-voltage distribution (i.e. residential) networks. These are the cables that come down the street or past your house, and they are not instrumented – which means no measurements are being collected from this part of the grid. The investments required in order to instrument this network at a fine-grained level of control and resolution are considerable. Smart metering could allow the voltage on the network and the currents to be measured. It would also give a view of the load on the network and allow direct revenue opportunities with customers.

DISRUPTION: IOT FOR ‘SMART’ RETAIL MANAGING DEMAND

As more intelligence is brought onto the electricity grid, opportunities arise for ubiquitous metering at the level of individual customers. Traditionally, utilities consumption has always been metered at the customer level by means of ‘dumb’ meters that were subsequently read by utility representatives. Smart meters are looked at as a new interface for direct engagement with Eskom customers. Smart meters not only measure electricity use but they also communicate the measurements. Readings are communicated over the power line or wirelessly via a mobile network. As such information is aggregated into meter data management systems, utilities are able to start controlling switching.

Over the years, Eskom has developed extensive experience in conducting smart meter pilots and learned a lot about such projects. The latest smart meter project conducted by Eskom took place in 2012. At the time, the meters used cost about R6 500 each. With typical monthly bills of less than R1 000, for Eskom the rate of return from the capital investment was negative. Nowadays, the technology has matured and the same capability costs much less – approximately R2 200. The technology has evolved from very fat meters, with limited communications, to very thin meters with huge communications capabilities, linked to a backend. The processing of the data has been removed from the meter to the remote backend. Meanwhile, meter prices are continuously

moving down. Summarizing the experience of Eskom, Executive, Organisational Strategy noted:

“[...] in previous work we found technology issues, we found huge communication issues, we found vendor reliability issues. Each time we got a little bit of a toe in the water. We ran a project, installed a couple of thousand of these meters, and then cancelled contracts and pulled back and said, ‘this market is still not ready’; particularly from a technology point of view.”

As price signals and smart meters are beginning to drive energy-conscious electricity consumption, trust in the meter interface and its usability are becoming critical factors. As Eskom’s Executive, Organisational Strategy explains: “You are not going to make decisions if you don’t trust what the meter says. So that means the meter needs to be real-time and talk to you in real-time. So you trust the decisions that your meter makes, or suggests to you; or to your home automation system”.

While smart meters enable differential pricing, they are also key to energy management opportunities. For customers, they can become a valuable tool for managing their consumption by connecting their meter to multiple switches. Among residential customers, the smart meter allows for the automated on and off switching of geysers, or swimming pool pumps and tennis court lights.

Among business customers, smart meters control energy management systems of entire office environments. Siemens case studies show that electricity consumption in buildings can be reduced by between 10% and 14% by simple measures—metering, the additional switching off of lights, heating and cooling, linking it to outside temperatures and installing roof solar panels to add generation capacity.

“If you ask me, in the future, ten years from now, we will be selling energy like the airlines sell their seats. We will have a variable price through the day, and you can then decide whether you want to switch on your appliance at that point in time. It also talks into that home automation space [...] it is energy management.” [Executive, Organisational Strategy – Eskom]

As electricity customers are increasingly becoming generators of power through the installation of rooftop PVs¹⁶, smart meters offer an interface not only for selling but also for buying power supply. Enormous disruption in the sector is emerging because customers no longer need utility companies to cover their full needs, but only serve as a backup and to provide for the differential between their needs and their own generation.

NON-TECHNICAL LOSSES

While in the chain of generation, transmission and distribution, there are many technical losses which can be addressed by IoT. In the retail space, utility companies have to grapple with what are known as ‘non-technical’ losses. Direct non-technical losses occur as a result of people tampering with equipment, by-passing or manipulating meters or devising other mechanisms for electricity theft. Indirect non-technical losses consist simply of customer non-payment. In

¹⁵ Interview with Executive, Organisational Strategy, Eskom

¹⁶ Photovoltaic

¹⁷ Executive, Organisational Strategy, Eskom



“ BY MEASURING ENERGY CONSUMPTION WHILE ACCOUNTING FOR CHANGES SUCH AS REDUCTIONS DURING HOLIDAY PERIODS OR SUDDEN SPIKES, UTILITY COMPANIES ARE IN A POSITION TO DETECT EQUIPMENT TAMPERING AND MAKE DECISIONS ON HOW TO RESPOND . . . ”

South Africa, non-technical losses have a considerable impact on Eskom's revenue.

Non-technical losses can be linked to institutionalised expectations and attitudes which vary across the country. For example, problems in Soweto with non-payment have been well publicized where, in some areas, up to 70%¹⁷ of the energy delivered results in non-technical losses.

While the human factor is key in addressing such problems in their entirety, IoT solutions offer a number of instruments which could contribute to a change in attitudes. Equipping the low-voltage networks with IoT technologies and installing digital meters will enable the utility to improve the detection

of and response to direct non-technical losses. Meanwhile, converting meters to prepaid smart meters could alleviate indirect non-technical losses.

By measuring energy consumption while accounting for changes such as reductions during holiday periods or sudden spikes, utility companies are in a position to detect equipment tampering and make decisions on how to respond (e.g. notify the control centre or law enforcement agencies). Indirect non-technical losses can be addressed through the introduction of prepaid metering systems. While such solutions have been around for a long time, the digitisation of payment mechanisms has improved their usability and reduced the inconveniences they impose on customers.



“ WHAT IS COMMON AMONG SUCCESSFUL INITIATIVES OVERSEAS IS THAT INDIVIDUALS, ORGANISATIONS AND TECHNOLOGY COMPANIES JOIN FORCES . . . ”

A VISION FOR A ‘SMART’ PUBLIC SECTOR

In South Africa, both local government and the electricity sector are focused on the public good. However, smart cities and smart grids remain the domain of developers, master planners and investors and are rarely the result of broader public participation, debate and discussion. Finding mechanisms to improve participation and open up this debate is critical to achieving positive results.

What is common among successful initiatives overseas is that individuals, organisations and technology companies join forces to address the problems of urban living and reinvent it through the collective entrepreneurial and creative actions of citizens and consumers¹⁸.

In order to facilitate the transition towards people-centred smart cities and smart grids, we suggest attention is paid to the following aspects of smart interventions:¹⁹

- **Collaborative economy** By connecting organisations and groups of individuals via technology, societies are enabled to make more efficient use of underutilised goods (e.g. vehicles and housing), available skills and even privately generated green energy. This presents a potentially valuable tool for the South African public sector where needs can be pressing and resources are often limited. Leveraging technology use towards improved sustainability and efficiency in the use of resources should form the core of smart initiatives.
- **Crowdfunding and crowd intelligence** ICT tools can be used to connect communities online and to mobilise funds for community projects. Moreover, crowdfunding can be used as a participatory tool to inform spending decisions. City governments can integrate such tools in the decision-making process so that funding decisions more accurately reflect the needs and wishes of its citizens. Digital tools make it easier for people to get involved in policymaking and planning, and to help cities make smarter and more democratic decisions.
- **IoT and crowdsourced data** Low-cost sensors can be used to detect traffic flow, pollution levels, parking space availability, as well as undesirable behaviours. In addition to deployed sensors, citizens encounter and share observations about their cities on a daily basis. By integrating sensor data with crowdsourced data from social media and mobile phone sensors, maps of urban environments can be created to monitor service delivery issues.

¹⁸ Haque, 2012

¹⁹ Saunders & Baeck, 2015

METHOD AND SAMPLE

In order to explore stakeholders' opinions and experiences of smart cities and smart grids we employed a multi-method data collection approach. We conducted interview meetings, explored resources on the Internet and attended industry events.

Special thanks to our six interviewees who took part in the study of smart grids. As representatives of companies active in the provisioning and implementation of smart grid technologies (see figure 6) they were able to provide us with very valuable insights. Participants were also able to refer us to additional contacts.

Access to sources on smart cities proved more challenging. The researcher relied on secondary documents, attendance at relevant industry events and one interview with an expert stakeholder. Data collection was carried out between 23 July and 9 December, 2015.

FIGURE 6: PARTICIPANTS

	FOCUS	DATA COLLECTION METHOD
SMART GRIDS	Siemens	CEO Siemens Smart Grids Africa (interview)
	Eskom	Executive, Organisational Strategy (interview)
	Accenture	Corporate Technical Specialist, Smart grid and energy efficiency and Manager, Smart Grids Centre of Excellence (interview)
	Schneider Electric	Senior Principal – Accenture Smart Grid Services (interview)
SMART CITIES	Attendances	Energy Crisis – Solutions for Business Continuity, GIBS, Oct 2015 Africities Summit 2015, Johannesburg
	Central University of Technology, Free State	Senior Lecturer (interview)
	City of Johannesburg	Secondary documents
	City of Tshwane	Secondary documents
	City of Cape Town	Secondary documents



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