PIESA

THE POWER INSTITUTE FOR EAST & SOUTHERN AFRICA

PIESA 2018 ANNUAL REPORT

The Power Institute for East and Southern Africa (PIESA) is a voluntary regional power utility association established on 28 February 1998. We aim to improve electrification in East and Southern Africa through sharing information, research, technology, skills and experiences for the benefit of customers and suppliers in the electricity distribution industry. The main focus is on technical rationalisation to achieve economies of scale with local manufacturers in an effort to enhance electrification in the region.

CONTENT

05 ABOUT THE POWER INSTITUTE FOR EAST AND SOUTHERN AFRICA (PIESA)

06 VISION AND OBJECTIVES

08 MEMBERS OF THE PIESA BOARD

10 CHAIRMAN'S REVIEW

12 FROM THE DESK OF THE EXECUTIVE OFFICER

14 ADVISORY COMITTEE REVIEWS

18 MEMBERSHIP CATEGORIES AND ELIGIBILITY

20 FINANCIAL STATEMENTS

24 IERE TECHNOLOGY FORESIGHT 2020

30 4TH INDUSTRIAL REVOLUTION

32 REVENUE MANAGEMENT SUCCESSES IN A POWER DISTRIBUTION UTILITY

38 ASSET MANAGEMENT AND THE ELECTRICITY UTILITY BUSINESS

40 COST OF SUPPLY AND TARIFF SETTING FOR ELECTRICITY UTILITIES

ABOUT THE POWER INSTITUTE FOR EAST AND SOUTHERN AFRICA (PIESA)

The Power Institute for East and Southern Africa (PIESA) is a voluntary regional electricity industry association established in 1998 to facilitate and coordinate the sharing of information and technology in the specialised areas of:

- Technology and engineering support;
- Applied research;
- Standardisation;
- Environmental management; and
- Technical development and training

PIESA aims to be the catalyst for sustainable regional technological cooperation in expanding the electricity distribution industry for regional growth and development by:

- Encouraging participation by all regional electricity distributors and supporting industries;
- Compiling, optimising and maintaining integrated information systems for technology related to the distribution of electricity including technical equipment specifications and codes of practice that are appropriate for the regional environment;
- Providing a mechanism for continuously capturing the experiences of members in order to improve efficiency;
- Encouraging the use of local resources and manufacture of equipment for use in the distribution industry;
- Promoting applied research in areas that are relevant to the effective performance of members;
- Fostering a culture of technology transfer and skills development among the members;
- Developing strategic alliances and partnerships with other related organisations involved in or with the electricity distribution industry.

In a nutshell, PIESA aims to improve electrification in East and Southern Africa through sharing information, research,

technology, skills and experiences for the benefit of customers and suppliers in the electricity distribution industry. The main focus is on technical rationalisation to achieve economies of scale with local manufacturers in an effort to enhance electrification in the region.

Membership is open to electric power utilities in East and Southern Africa, manufacturers, suppliers of equipment, researchers, academic institutions, investors, financiers and other associations who wish to participate in PIESA's activities.

PIESA is governed by a Board of Directors with representatives from each participating utility. The prime responsibility of the Board is to determine the objectives and direction of PIESA.

PIESA's core activities are conducted through its four Board Advisory Committees:

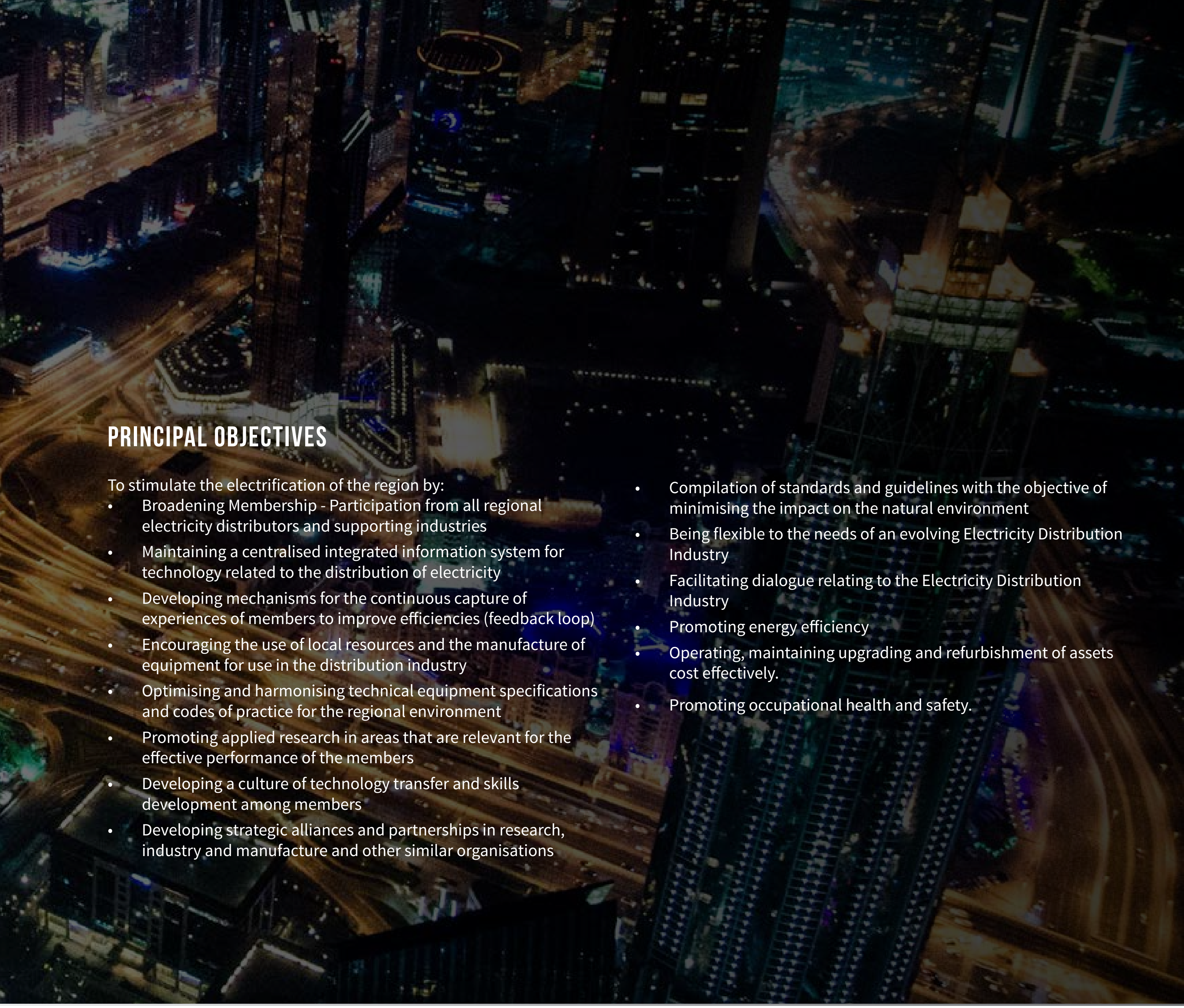
- Electrification
- Non-Technical Loss Reduction
- Environmental and Safety Management
- Standardisation

Members currently include electricity distributors from the following countries: DRCongo, Kenya, Lesotho, Malawi, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.

VISION AND OBJECTIVES

VISION

PIESA's Vision is to be the catalyst for sustainable regional technological cooperation in expanding the Electricity Distribution Industry and stimulating the electrification for regional growth and development.



PRINCIPAL OBJECTIVES

To stimulate the electrification of the region by:

- Broadening Membership - Participation from all regional electricity distributors and supporting industries
- Maintaining a centralised integrated information system for technology related to the distribution of electricity
- Developing mechanisms for the continuous capture of experiences of members to improve efficiencies (feedback loop)
- Encouraging the use of local resources and the manufacture of equipment for use in the distribution industry
- Optimising and harmonising technical equipment specifications and codes of practice for the regional environment
- Promoting applied research in areas that are relevant for the effective performance of the members
- Developing a culture of technology transfer and skills development among members
- Developing strategic alliances and partnerships in research, industry and manufacture and other similar organisations
- Compilation of standards and guidelines with the objective of minimising the impact on the natural environment
- Being flexible to the needs of an evolving Electricity Distribution Industry
- Facilitating dialogue relating to the Electricity Distribution Industry
- Promoting energy efficiency
- Operating, maintaining upgrading and refurbishment of assets cost effectively.
- Promoting occupational health and safety.

MEMBERS OF THE PIESA BOARD

Bukhosi Siso
PIESA board chairman

Vally Padayachee
Executive Officer

Alfred Kaponda
ESCOM – Malawi

Mohlomi Seitlheko
LEC – Lesotho

Refilwe Mokgosi
AMEU – Southern Africa

Simbiso Chimbima
UMEME – Uganda

Benson Muriithi
KPLC – Kenya

Sophia Mgonja
Tanesco – Tanzania

Sumaya Nassiep
Eskom - South Africa

Changala Nswana
Zambia – ZESCO

Rick St John
Affiliates

Mobolama Montala
SNEL – DR Congo

Greg Tosen
IERE - Chairman

CHAIRMAN'S REVIEW

Engineer Bukhosi Siso | Chairman, BSc (Elec.Eng), MSc, MBA, C. Eng, MIET, FzweIE, MInstLM, PIESA Board

Another year has elapsed and it's now time to write the Chairman's report for 2018. It's indeed been an eventful year for the sector that PIESA operates in.

It's common knowledge that access to electricity has been a serious challenge in Africa and still continues to be a serious challenge. As reported previously 600 million Africans are not connected to an electrical network. Businesses in most countries in Africa cite access to electricity amongst the two most severe constraints on their operations and business.

As the PIESA our member countries are also experiencing significant challenges in respect of power supply and power distribution or delivery. Providing and increasing access to electrical energy to eventually 100% of the population. The ability and capability to raise adequate funding to rollout new and much needed infrastructure is still a serious problem. Backlogs in respect of maintenance and refurbishment of essential power supply and power delivery infrastructure still continue to plague the sector that PIESA operates in. Consumers' ability and willingness to pay for electricity will also be key factors in determining electricity demand growth.

According to the World Bank meeting the goal of universal access to modern energy in Sub-Saharan Africa remains a key challenge for the first half of the 21st Century. Only 37 percent of Africans had access to electricity in 2015, with marked disparities between urban and rural areas. Nevertheless, a handful of African countries have begun to show steady progress and have largely embraced multiple supply solutions— from conventional grid systems to emerging technologies in mini-grids and solar home systems

The revenue model on which utility businesses are based is under threat from the shifting industry norms. The 4th industrial revolution is underway and already utilities are witness to digitalisation, decarbonisation and decentralisation – all affecting their traditional strategies.

The fourth industrial revolution can be fundamentally characterised at its core according to Deloittes the "marriage of physical and digital technologies such as analytics, artificial intelligence, cognitive technologies and the internet of things (IoT).".

Unlike the first three industrial revolutions wherein the impact of these changes on society, businesses, industries, industries was relatively slow the impact of the changes that are being and will continue to be generated by the impact of the fourth industrial revolution is going to be astronomical or exponential to say the least.

The electricity utility sector in particular is also being and still going to be impacted by the fourth industrial revolution in the years ahead so much so that the majority of them will have to rethink their business models to remain inter alia viable.

PIESA will be focusing going forward on 4IR emerging technologies to stimulate and accelerate electrification in PIESA member countries for growth and development

The benefits associated with utilising generation capacity from private party electricity generation projects in municipal jurisdictions is a business reality that can no longer be ignored. The dynamic development of the ESI and EDI business environment, coupled with a lack of change control, necessitates decisive leadership, a vision for the energy industry and regulatory certainty. Energy stakeholders agree that the dawn of a new African energy industry is upon us.

Standardisation is key to ensuring that utilities are able to supply and deliver much needed power or electricity to its end use customers in a safe and reliable manner. In this respect PIESA has been on a continued basis helping its members by introducing new and revising and reviewing current or existing standards

The financial sustainability of the ESI and EDI is a challenge to a national fiscus, and the ever-increasing debt burden is a major concern.

The decrease in sales volumes and associated revenue decrease should not come as a surprise when considering the declining cost of alternative energy options (such as that of solar photovoltaic rooftop installations), increasing equipment reliability and energy efficiency, technological innovations and awareness amongst customers of environmental impacts

To ensure the survival of the ESI and EDI it is critical and we believe that the wires and retail business be unbundled and ring-fenced. Tari structuring should also incentivise the desired consumer behaviour to further support business sustainability. In instances where cross subsidies are required, such subsidies should be transparent and effectively managed in the broader business context. Policy and regulatory frameworks should therefore be clear to accommodate the change in the business landscape.

When considering the emerging energy trading related opportunities it becomes clear that it is now the opportune time to consider public private partnerships for retail and energy trading. During the SALGA Energy Summit 2018 held in March 2018 in South Africa tariff reform was debated and it was resolved that: "The reform in the electricity tariff requires cost-reflectivity, grid protection, simplicity in design, increase role for time-of-use pricing, tariff rationalisation and tariff/price convergence. The revised tariff determination framework should also cater for small scale embedded generation (SSEG) and bi-directional energy trading e.g. buying and selling of electricity between a municipality and prosumer. The pricing policy tariff determination framework and regulatory framework needs therefore urgent review".

The following questions are paramount when considering an ESI Transition. Should the ESI value chain be unbundled? If so, what level of unbundling is required? If more and more industry players are entering the market, how can greater market participation be realised for all stakeholders in the ESI? What are the essential interventions while ESI reform are underway?

Main interventions will include ensuring security of supply (keeping the lights burning during reform) and addressing liquidity challenges (the cash conundrum). What are the emerging ESI structure(s) that have the potential to resolve the current challenges? What are the legal and regulatory considerations to realise a sustainable ESI?

We therefore live in very interesting times in trying to secure access to electricity for all of our citizens in our PIESA member countries

In conclusion, I want to take this opportunity to thank my fellow colleagues on the PIESA Board and the wider PIESA team for their continued support and hard work they are willing to put in to ensure that we as the PIESA continue to serve our members, as best we can.

FROM THE DESK OF THE EXECUTIVE OFFICER

THE POWER INSTITUTE FOR EAST AND SOUTHERN AFRICA (PIESA)EXECUTIVE OFFICER'S REPORT 2018

Vally Padayachee

CD (SA); FInstD; FIRMSA; Pr CPM; Pr Cert Eng; MBA; MSc (Eng); PIESA Executive Officer

It gives me great pleasure to once again pen my second report as the Executive Officer of PIESA. I must say I continue "hit the ground sprinting – not running". In this respect and again the year under review has been characterised by numerous challenges that in essence threatens to impede power service delivery and expanding electrification. As I had reported previously the sector that we as a PIESA operate in has been plagued by a number of challenges and problems. Some of these challenges are still the same as reported previously and they include the following:

1. Providing and increasing access to electrical energy to eventually the entire population. The focus on further electrification will be a priority
2. Limited Maintenance Budgets and Funding
3. Lack of Resources especially funding
4. Lack of Knowledge and skills
5. Negligence to O&M practices
6. Decreasing sales of electricity energy
7. Increasing technical and non-technical losses
8. Increasing ingress of renewables especially distributed energy in the energy mix
9. Theft and Vandalism

As a PIESA we will focus our strategies, projects, etc to fast track electrification in our PIESA member countries.

In this respect PIESA will inter alia focus on the following:

1. Cost effective renewable technologies
2. Block chains (NOT bitcoins) but focus on smart contracts, etc
3. Microgrids

With respect to microgrids ABB sponsored a trip to Robben Island, South Africa to visit The ABB microgrid power plant that now virtually provides all the power needed by the Island. Robben Island is very famous because it was the island where President Nelson Mandela was imprisoned for almost two decades.

The electricity utility sector in particular is also being and still going to be impacted by the fourth industrial revolution in the years ahead so much so that the majority of them will have to rethink their business models to remain inter alia viable.

PIESA will be focusing going forward on 4IR emerging technologies to stimulate and accelerate electrification in PIESA member countries for growth and development

We continue to be grateful to IERE for continuing to provide PIESA with much needed funding for key projects and initiatives. In this regard plans are afoot to utilise IERE funding to sponsor relevant training and development for PIESA delegates

PIESA will still focus on sharing case studies, knowledge and information amongst its members.

PIESA continues to explore and investigate ways of introducing eLearning in respect of training, development and mentoring of especially technical and engineering professionals and other resources at its member utilities.

PIESA will continue to support and align its various projects to the African Union Commission adopted Vision 2063 as a roadmap for continental development. Essentially it aligns thinking from across the continent and distils the vision in a set of seven (7) aspirations.

As a PIESA we are still committed to and where possible arranging field trips, for the committee, to member countries with notable alternative energy projects, similar to the planned trip to Northern Uganda.

PIESA has been investigating the pros and cons of strategic purchasing and group sourcing of material, for the benefit of PIESA member countries. In this regard PIESA will explore the possibility of instituting national framework contracts for procuring relevant equipment and service similar to the recently introduced South African MISA national framework contracts

Standardisation continues to also be a key focus for PIESA especially from a perspective of improving service delivery and fast tracking electrification rollout. In this respect and as reported previously the following is noted:

1. Continue favourable cooperation with AFSEC
2. All member countries continue to share list of commonly used PIESA standards
3. A catalogue of all PIESA standards to be published and made available

Based on some excellent experiences by some members in rolling out smart metering projects PIESA members are seriously exploring the rollout of cost effective smart metering projects in their respective countries. In this regard a pilot project involving an affiliate and some countries is being investigated for implementation.

A major challenge that is looming is the TID 2024 rollover challenges associated with STS type prepayment meters.
What is the TID rollover?

A unique token identifier (TID) is calculated and coded into the token every time a token is created at the POS. The meter records the TID when the token is entered into the meter - this prevents token replay. The TID is currently calculated as the number of minutes that have elapsed since a base date of 1993.

The TID has a limited range of 31.9 years. In November 2024 the TID will reset (roll over) to zero. Any new tokens after this date will not be accepted by the meter as the meter will consider these as being “OLD”. The remedy is to clear the meter’s memory of previously accepted TIDs and to change the meter’s cryptographic key at the same time in order to prevent token replay

There is also an appreciation by most of the PIESA member countries that the existing and traditional business model by utilities of selling energy (kWh) is no longer proving to be a viable business model. In keeping with global trends PIESA is also investing time and effort to look at in a very prudent manner other more viable business models. The latter approach is gaining reasonable acceleration given the increasing ingress of distributed generation for self-generation or own use by certain customers.

PIESA has been and will also be giving increased focus to increasing its membership base especially the affiliate’s membership.

I also want to take this opportunity of thanking the members of the Board of Directors for their continued leadership and stewardship of PIESA, the PIESA Secretariat and all the other members of PIESA and especially those that have assisted in keeping the PIESA ship afloat during the past year under review.

ADVISORY GROUPS REVIEWS

PIESA Advisory Groups are to function as forums where members and technology partners can meet and discuss pertinent issues and agree on regional strategies and actions. Each Advisory Group will have a Chairperson to act as the convener, and be responsible In conjunction with the PIESA Secretariat to call the meetings and set the agenda. A Deputy Chair is to provide continuity in the event of absence of the Chair from a meeting and a Secretary to provide an administration service for the Advisory Group such as agenda and minutes of meetings.

Each Advisory Group will also have a 'sponsor member' who will have a particular interest in the terms of reference of the particular Advisory Committee. This 'Sponsor' shall be a member of the PIESA Board, and will be responsible to liaise between the Board and the Advisory Group and convey specific requests for agenda items from the board.

Pursuant to giving effect to the above four advisory groups have been established as follows:

1. Standardisation
2. Electrification
3. Revenue Protection (Non-technical loss reduction)
4. Environmental and Safety management

The participants are mandated by their corresponding utilities and a chairman is appointed to each Advisory Committees by the PIESA Board. The Advisory Committees delegate strategies and executable projects to any or all of the four services secretariats. Information flow and committee administration conducted by an operations manager situated in the general administration secretariat.

In particular, terms of reference for the Advisory Committees would be to inter alia :

1. Meet on a regular basis,
2. Identify pertinent subjects,
3. Debate and exchange information,
4. Network with each other,
5. Develop regional plans, strategies and initiatives,
6. Share experiences and best practices,

The following reflects some of the major achievements of each of the aforementioned Advisory Groups during the ensuing financial year:

1. **Electrification Advisory Group**
    a. Attendance of members to meetings of this Group was also poor
    b. A major achievement was the approval by the PIESA Board of the definition of access to electrical energy
    c. This Advisory Group is also investigating the pros and cons of strategic purchasing and group sourcing of material, for the benefit of PIESA member countries based on value adding experience from other countries
    d. The PIESA member Utilities are encouraged to implement the electrification related projects in their respective countries, which have been tried and tested by the other PIESA countries
    e. The Electrification Advisory Group also coordinates the sharing of electrification statistics of member countries amongst the member countries
    f. The Electrification Advisory Group will continue with following initiatives;
        i. To share the strategies of other advisory or working groups on the document portal.
        ii. To survey members on their electrification %, based on the Board's acceptance of the revised access to electrical energy definition

"PIESA AIMS TO BE THE CATALYST FOR SUSTAINABLE REGIONAL TECHNOLOGICAL COOPERATION"

iii. To explore ways and means to assist member countries to rollout electrification infrastructure much quicker
iv. To assist member countries to raise much needed funding to rollout electrification infrastructure
v. To explore alternative business models given that the current model of selling electrical energy (kWh) is proving to be no longer viable for most member utilities
vi. To investigate the further incorporation of cost effective renewable energy technologies in the energy mix.
vii. Formalising an electrification partnership with POWER AFRICA
viii. To investigate and rollout smart technologies, smart grids, etc with a view to improving service delivery
ix. Significant attention is being paid to training, development and mentoring initiatives especially with respect to the upskilling of personnel especially technical, engineering and leadership personnel

2. The Environmental and Safety Management Advisory Group

a. Attendance of members to meetings of this Group was also poor
b. There was a need to raise the profile of environmental and safety in the various utilities
c. The Advisory Group resolved that to improve the safety and environment culture in utilities, it is also important to briefly discuss important and relevant safety and environmental issues that would benefit the attendees
d. A wayleave guideline has been prepared and circulated to members
e. The aspect of encroachments was still a cause for concern and requires further investigation to provide relief
f. With respect to Practical Environmental & Social Impact Assessment (ESIA)

Eskom will arrange ESIA presentation and site visit.

g. The Advisory Group suggested that each utility should submit a PCB inventory and provided a template to be used which was circulated to all members. The PCB template was workshopped and forwarded to all to populate

3. The Revenue Protection Advisory Group

a. The Advisory Group suggested that the Electrification Advisory Group address the issue about the IPP matters
b. Investigating the construction of a 400kV line from Mozambique
c. The Advisory Group noted that various utilities in South Africa are busy with smart meter pilot projects
d. The Advisory Group resolved create a PIESA user group for sharing pilot programme information

4. The Standardisation Advisory Group

a. To survey members for their standards used for common procurements using the updated list of procurement items drafted in Malawi end October 2016,
b. AFSEC members have the opportunity to comment on new IEC standards and/or comment on proposed changes to existing standards. In order to do so member countries in Africa must organize themselves effectively to be able to have meaningful influence to changes in IEC documents.
c. Technical cooperation agreement between SADCSTAN and PIESA - the agreement is still in place and binding between the two organizations
d. All member countries are to present a list of commonly used PIESA standards for the purposes of Procurement
e. A catalogue of all PIESA standards to be published and made available

MEMBERSHIP CATEGORIES AND ELIGIBILITY

Membership of PIESA is open to the electricity industry. The number of members from time to time shall not be limited, but shall at no time be less than five (5). Membership may not be assigned or transferred to any other person, company or concern.

Membership of PIESA is open to the electricity industry. The number of members from time to time shall not be limited, but shall at no time be less than five (5). Membership may not be assigned or transferred to any other person, company or concern.

Membership is obtained by paying the prescribed contributions as stipulated in Article 14.2 following the acceptance by the PIESA Board of the application for membership.

PIESA has the following categories of membership: Full Members are organisations that:

(a) Generate, transmit, distribute or buy and sell electricity; or

(b) Represent an organisation contemplated in (a).

- Coordinate with like-minded organisations e.g. SADCSTAN, UPDEA towards the common goal of harmonised standards;
- Participate in training activities, exchange programmes and development projects;
- Participate in regional workshops and conferences, and network with strategic decision-makers in the electricity industry;
- Provide opportunities for market growth and economies of scale for regional manufacturers and suppliers of equipment and services.

Affiliate Members are organisations or individuals with an allied interest to PIESA, and would include, inter alia, manufacturers and suppliers of services or equipment to the electricity distribution industry, researchers, consultants and financiers.

Benefits to members include:

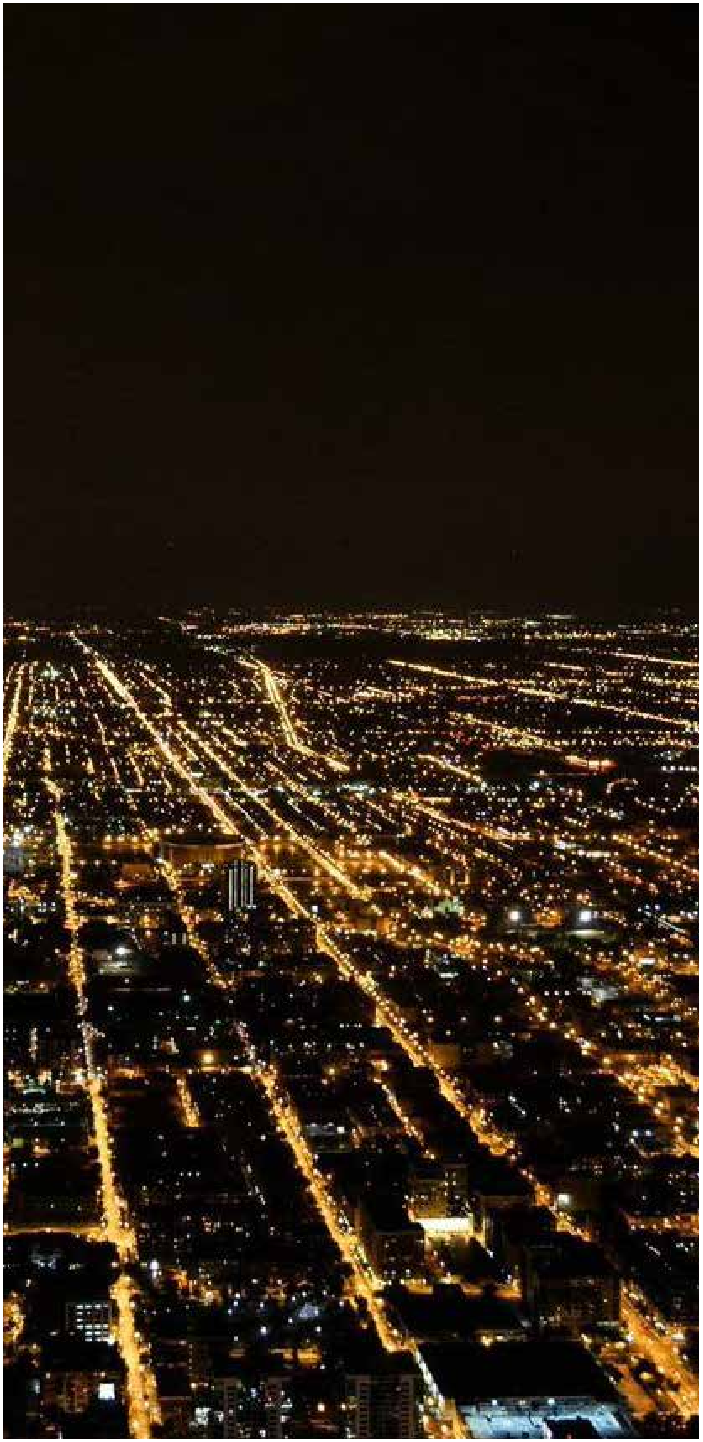
- Access to and participation in the development of standards for the electricity distribution sector;
- Sharing of information, technology and skills and, in particular, experiences gained from pilot projects and implementation of new technologies, and local solutions to recurrent problems experienced in the region;
- Network with like-minded organisations, joint research activities and access to information from international research organisations e.g. IERE, EPRI, SAPURAB;
- Influence the development of standard specifications appropriate for the region through active involvement in the Advisory Commitee;

Members

- AMEU - Association of Municipal Electricity Utilities (Southern Africa)
- ESCOM - Electricity Supply Commission of Malawi
- KPLC - Kenya Power and Lighting Company
- ESKOM - South African electricity supply company
- LEC - Lesotho Electricity Company
- TANESCO - Tanzania Electric Supply Company Limited
- UMEME - Umeme Company Limited
- ZESA – Zimbabwe Electricity Supply Authority
- ZESCO - Zambia Electricity Supply Corporation Limited

Affiliate Members

- Aberdare Cables
- Circuit Breaker Industries
- Hi-Tech Transformers Maintenance
- Landis + Gyr (Pty) Ltd
- Lucy Electric South Africa
- Metal Frabicators - Zambia PLC
- Powertech Transformers
- Reinhausen South Africa
- Schneider Electric
- Siemens Southern Africa
- TE Connectivity



FINANCIAL STATEMENTS

APPROVAL OF THE BOARD

The financial statements set out on the following three pages.

The Board are responsible for the preparation and fair presentation of the financial statements of The Power Institute for East and Southern Africa, comprising the statement of financial position at 28 February 2017, and the statement of comprehensive income for the year then ended, and the notes to the financial statements which include the basis of accounting and other explanatory notes, as set out in the audited statements.

The Board are also responsible for such internal control as the Board determines in necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error, and for maintaining adequate accounting records and an efficient system of risk management.

The Board have made an assessment of the ability of the association to continue as a going concern and have no reason to believe that the business will not be a going concern in the year ahead.

The auditor is responsible for reporting on whether the financial statements are fairly presented in accordance with the basis of accounting described in the financial statements.

Approval of financial statements

The financial statements of the Power Institute for East and Southern Africa, as identified in the first paragraph, were approved by the Board and signed by the chairman.

Statement of Financial Position

Balance Sheet as at 28 February 2018

	Notes	2018	2017
		R	R
Assets			
Current assets			
Trade and other receivable	2	**248,435**	558,998
Cash and cash equivalents	3	**1,205,241**	292,286
Total assets		**1,453,676**	851,284
Reserves and liabilities			
Reserves			
Retained income		1,130,805	787,480
Current liabilities			
Trade and other payables	4	322,871	63,804
Total accumulated surplus and liabilities		**1,453,676**	851,284

Statement of Comprehensive Income

Balance Sheet as at 28 February 2018

	Note(s)	2018 R	2017 R
Income			
Membership tees		1,447,842	1,067,159
Sponsorships		130,944	311,718
Interest received		24,328	28,204
		1,603,114	1,407,081
Operating expenses			
Annual report		12,586	9,058
Auditors remuneration		31,320	31,000
Auditors remuneration - prior year adjustment		7,180	-
Bank charges		8,499	8.888
Bad debts		-	200,404
Conference venue and meeting costs		8,938	147,594
Marketing		-	1,450
Printing and stationery		4,460	4,914
Secretariat fees		1,092,825	1,163,000
Subscriptions		81,681	103,592
Travel - local		1,096	40,724
Website and communication costs		11,204	11,961
		1,259,789	1,722,585
Profit (loss) for the year		343,325	(315,504)
Opening balance		787,480	1,102,984
Retained income at the end of the year		1,130,805	787,480

Statement of Comprehensive Income

Notes to the Annual Financial Statements

	2018 R	2018 R
2. Trade and other receivables		
IERE Membership	73,937	81,700
VAT	174,498	403,725
VdW & Co	-	73,573
	248,435	**558,998**
3. Cash and cash equivalents		
Cash and cash equivalents consist of:		
Bank balances	727,095	265,335
ABSA Call account	478,146	26,951
	1,205,241	**292,286**
4. Trade and other payables		
Education funds	32,804	32,804
Refund due to Eskom	62,019	-
Subscriptions in advance	197,048	-
Audit fee	31,000	31,000
	322,871	**63,804**

5. Taxation

No provision has been made for 2018 tax as the association is exempt from paying tax.

IERE TECHNOLOGY FORESIGHT 2020

TOP 20 EMERGING TECHNOLOGIES & TOP 5 FRINGE TECHNOLOGIES

We want and need to acknowledge at the very outset that the information contained in this article has been fully extracted from The International Electric Research Exchange ("IERE") Technology Foresight 2020 Report that was compiled by FROST & SULLIVAN on behalf of IERE (and its membership).

The International Electric Research Exchange ("IERE"), was established in October 1968. With the leadership of the 4 founding members (EPRI, UNIPEDE, CEA and Japan IERE Council), IERE has been promoting information exchange on R&D and cooperative activities among the leading electric utilities of the world for mutual benefit.

PIESA has been the recipient of grant funding from IERE for a number of projects undertaken by PIESA in the last few years. PIESA is indeed grateful to IERE for so kindly making this funding accessible to PIESA to execute the said projects

For the purpose of this Technology Foresight 2020, the following definitions for "Emerging Technologies" and "Fringe Technologies" were adopted.

Emerging Technologies are new or alternative technologies increasingly adopted by the energy industry, where only emerging technologies that have been commercialized were considered.

Fringe Technologies are technologies considered to have remote possibilities, but could potentially disrupt the energy industry. "BLACK SWAN" technologies are acknowledged as being of increasing importance.

The selection of the Top 20 Emerging Technologies was selected based on the highest votes as received during the IERE Member Survey. However, the sequence of the Top 20 Emerging Technologies and Top 5 Fringe were primarily influenced by two factors; a) Potential for Market Transformation, and b) Likelihood to Impact Industry in 3 to 5 Years (for Top 20 Emerging Technologies), OR 10 years (for Top 5 Fringe).

"The power system is changing at an exponential pace into a highly interconnected, complex, and interactive network of power systems, telecommunications, the Internet, and electronic commerce applications. Virtually every element of the power system will need to incorporate sensors, communications and computational ability.

No longer will society depend primarily on central station power and one-way flow on the grid, since the use of distributed generation, distributed energy storage and smart cities will proliferate. At the same time, the move towards competitive electricity markets requires a much more sophisticated infrastructure for supporting the myriad of informational, financial, and physical transactions between the several members of the electricity value chain that supplements or replaces the vertically integrated utility. Thus the rise of the "utility of the future" is upon us and thus requires a fundamental shift in our current thinking.

The IERE, a non-profit organization, serving the electricity industry across the world as a "global platform" of information exchange and collaboration in electricity technology research, development, demonstration, and deployment (RDD&D).

In particular, IERE has three organizational missions:

- Evaluate innovative and emerging technologies and their implementation
- Help establish corporate strategy related to R&D under changing business climate
- Facilitate technology transfer from developed economies to developing economies

There are many factors driving the rapid changes in the worldwide electric industry today. Increased presence of nonconventional energy sources, advancement of utility grid operations technologies, and further penetration of enabling technologies that support demand-side resources are just few such examples. As an industry-leading organization with global and world-class expertise in supporting and promoting technology innovations in the global electric industry, IERE is in a strong position to provide thought leadership on technology solutions that could shape the future trajectory of the industry.

To this end, the IERE has undertaken a study in which a complete market survey and developed profiles of critical technologies that formed the foundation for our Technology Foresight 2020 report. The objectives for this report include:

- Present the groups of technologies that IERE members identify as critical for the coming decades and addressing climate change
- Provide background information on the selected technologies (costs, development status, etc.)
- Provide information on IERE members' experts and projects related to these technologies" [Greg Tosen, Chairman IERE and PIESA Board Member]

HYBRID RENEWABLE ENERGY SYSTEMS COMBINE MORE THAN ONE RENEWABLE ENERGY RESOURCE, SUCH AS BIOMASS, GEOTHERMAL, HYDROPOWER, SOLAR, AND WIND TO BALANCE ENERGY GENERATION, ARTICULARLY FOR AREAS THAT ARE FAR AWAY FROM ELECTRICAL GRIDS.

TOP 20 EMERGING TECHNOLOGIES

1. Prosumer Technologies

Prosumer technologies are technologies that enable end users to become both consumers and producers of energy. Prosumerism enables consumers to have greater control to choose where, how, and when energy is generated for their consumption.

2. Energy Storage Devices

Energy storage systems store electrical energy in the form of chemical, mechanical, or electrical energy.

3. Big Data Applications

Big Data analytics refers to a set of data management tools, applications, and techniques for effective analysis of big datasets so as to derive intelligence on business operations and customer interactions.

4. Renewable and Distributed Generation

In distributed generation ("DG"), power is generated using small-scale systems sited close to the point of use. DG depends mostly on renewable sources, such as solar, and cogeneration technology, to provide secure and reliable power supply. However, the size of the DG unit is not clearly defined. All generation units installed privately in home and private premises, with the maximum generation capability ranging from 50 to 100 MW, are called DG by the International Council on Large Electric Systems ("CIGRE")

5. Climate Modelling

Climate modelling involves computer-based tools to predict climate behaviour, for instance, possibilities of extreme climate (drought and monsoon), or response of clouds and circulation systems to changes in temperature.

6. Smart Grid

A smart grid is an intelligent grid that can be monitored and controlled by combining automation, communication, and data processing technologies.

7. Wireless Sensors

Wireless sensors are spatially distributed autonomous sensors, mostly battery operated, which are used to monitor three core aspects of the power industry, that is, generation, distribution, and consumption. They play a significant role in increasing the efficiency of the grid by monitoring large areas at low range and low cost.

8. Internet of Things (”IoT”)

The Internet-of-Things (“IoT”) describes technologies that facilitate the linking of sensors, controllers, sensors, and persons over the Internet. An important criterion for a device to become a part of IoT is that it should be assigned an IP address.

9. Electric, Hybrid & Fuel Cell Vehicles

An electric vehicle (EV) is a type of vehicle that utilizes electricity to drive a motor to propel it forward. Electricity is generated either from a battery or fuel cell, most likely operated with hydrogen

10. Lithium-ion Battery

Lithium-ion batteries store electrical energy in the chemical form for later use through electrochemical reactions. They are tremendously popular as power sources for many electronic devices, as they are compact and deliver high power density and high energy density.

11. Smart X

Smart and connected devices play a dominant role in a myriad of applications and technical developments, such as smart grids, connected health, Internet of Things (IoT), and smart homes. They help in collecting data, monitoring, and automating any environment in a seamless way. The Smart X solutions, which include smart cities, smart energy, smart meters, and utilities like thermostats, help to collect and transmit information to a central control unit.

12. Water Resource Planning

Integrated Water Resource Planning (IWRP) is defined as a holistic approach to the management of water systems, which combines water supply, water demand, water quality, environmental protection and enhancement, rate structures, financial planning, and public participation

13. Water Recovery and Reuse

Power plants consume significant amounts of water. The various types of wastewater released from a thermal power plant are cooling tower make-up, boiler feed water, condensate polishing and filtration, cooling tower side stream, cooling tower blowdown, flue gas desulfurization (FGD) wastewater, and dry ash pond effluent.

14. Grid and Home Cybersecurity

Electrical systems are evolving to be more cyber physical in nature. Even the traditional grid has industrial control systems installed for remote monitoring and data collection, where this feature is getting more sophisticated by the day. Hence the need for a better system to secure the data and information generated is also growing.

15. Offshore Wind Energy

Offshore wind energy is preferred for more continuous and higher power generation, compared to conventional land-based systems. The presence of stronger and more reliable winds and flow patterns makes them a better choice and helps in achieving more annual full load hours compared to onshore wind farms.

16. Carbon Capture, Utilization & Storage

The carbon capture, utilization, and storage (CCUS) process involves the capture of anthropogenic carbon emissions from the waste gas released from large stationary point sources before the gas is released back into the atmosphere. The carbon dioxide (CO2) can subsequently be stored or converted later into valuable products such as chemicals or fuels. This method is part of the CO2 point removal process

17. Hydrogen Energy Storage

Hydrogen energy storage is intended to store surplus electricity either from renewable or non-renewable power generation in the form of hydrogen gas, which can be used directly either in a fuel cell or in a hydrogen gas turbine, when the need for electricity arises.

18. Hybrid Energy Systems

Hybrid renewable energy systems combine more than one renewable energy resource, such as biomass, geothermal, hydropower, solar, and wind to balance energy generation, articularly for areas that are far away from electrical grids. These systems can then be augmented by fossil fuelled generators to ensure electrical production. Another important component for hybrid renewable energy is energy storage, in order to balance out intermittency of the generation.

19. Nuclear Power Gen III+

Generation III reactors have improvements over Generation II reactors in terms of thermal efficiency, modularization, and fuel technologies. The main differentiation in terms of function design and operation between the previous generations and the Generation III+ reactors include better design in terms of simplicity and ruggedness, better safety measures that require minimal active control and manual intervention, and reduced chances of reactor core melting.

20. Virtual Power Plant

A Virtual Power Plant (VPP) brings together a number of power sources, distributed, storage and conventional, and also communication and control technologies together to ensure reliable power supply. The major differences between distributed power generation and Virtual Power Plants (VPPs) are the interlinking of sources and better demand management in the latter case.

Top 5 Fringe Technologies

1. Artificial Intelligence

Artificial Intelligence (AI) is focused on developing humanlike cognitive capabilities such as learning, reasoning, problem solving, planning, and self-correction for machines to enable them to perform cognitive functions efficiently.

2. DC Grid

The three main components of DC (direct current) grids in the future would be solar panels and solar farms, energy storage systems, and the integration of electric vehicles (EVs). The output for the first two components would be DC power while the power required to charge EVs would be DC. The main function of the DC grid is to enable the deployment of solar solutions such as rooftop, building integrated photovoltaics (BIPV), and solar farms. This infrastructure would also come handy in regions where the adoption of EVs is high.

3. Advanced PV

Development of advanced photovoltaic (PV) is taking two different routes, either 1) the low-cost, lightweight, transparent, and flexible route, mainly by using different materials or increasing the efficiency, or via 2) advanced silicon-based solar cells.

4. Advanced Nuclear

For the purpose of this review, advanced nuclear technology refers to Generation IV (Gen IV) reactors, small modular reactors (considered to be Generation III+, and typically below 300 MW) and nuclear fusion. The first two systems refer to nuclear fission processes while the latter refers to the nuclear fusion process. All three technologies refer to generation of electricity from a controlled thermonuclear process, where the released energy from the thermonuclear process is used to generate electricity.

5. Artificial Photosynthesis

Artificial photosynthesis is a process, which mimics natural photosynthesis, where fuels and chemicals are produced using carbon dioxide, water, and sunlight. It is used to refer any process that captures and stores energy from sunlight in chemical bonds of a fuel.

4TH INDUSTRIAL REVOLUTION:

WHAT MUST POWER UTILITIES DO TO SAFEGUARD THEIR RELEVANCE IN THE POWER MARKET GIVEN THE IMPACT OF THE 4IR ?

by **Vally Padayachee**, CD (SA), FInstD, MBA, MSc (Eng), EDP (Wits), **Executive Officer, PIESA**

THE REVENUE MODEL ON WHICH UTILITY BUSINESSES ARE BASED ON IS UNDER THREAT FROM THE SHIFTING INDUSTRY NORMS. THE 4TH INDUSTRIAL REVOLUTION IS UNDERWAY AND ALREADY UTILITIES ARE WITNESS TO DIGITALISATION, DECARBONISATION AND DECENTRALISATION – ALL AFFECTING THEIR TRADITIONAL STRATEGIES.

The fourth industrial revolution can be fundamentally characterised at its core according to Deloittes the "marriage of physical and digital technologies such as analytics, artificial intelligence, cognitive technologies and the internet of things (IoT).".

Unlike the first three industrial revolutions wherein the impact of these changes on society, businesses, industries, industries was relatively slow the impact of the changes that are being and will continue to be generated by the impact of the fourth industrial revolution is going to be astronomical or exponential to say the least.

According to the IEA , "the pace of digitalisation in energy is increasing. Investment in digital technologies by energy

companies has risen sharply over the last few years. For example, global investment in digital electricity infrastructure and software has grown by over 20% annually since 2014, reaching USD 47 billion in 2016. This digital investment in 2016 was almost 40% higher than investment in gas-fired power generation worldwide (USD 34 billion) and almost equal to total investment in India's electricity sector (USD 55 billion)..".

The electricity utility sector in particular is also being and still going to be impacted by the fourth industrial revolution in the years ahead so much so that the majority of them will have to rethink their business models to remain inter alia viable.

At the SALGA Energy Summit held in March 2018 it was reported by City Power Johannesburg South Africa that :

1. Since 2009, City Power Johannesburg has seen a full 10% reduction in kWh sales, from 13 100 GWh down to 11 780 GWh per annum.
2. Since 2002, City Power has connected up 60 000 new customers (largely in the low income residential sector)
3. Individual customers are becoming energy efficient but still rely on the convenience of the grid for their energy needs
4. The metropolitan municipality utility economy seems to be becoming less energy intensive while businesses still need a reliable grid to prosper
5. Tariffs that are based purely on energy (R/kWh charges) will result in declining revenues
6. Tariffs that include a defined (fixed) charge component to be connected to the grid and a separate energy component are sustainable"

Is our future power distribution utility business a transition from a commodity sales (kWh) based business to a commodity transport based business (i.e. kWh + network access), or somewhere in between?

How much of the business is there to provide product i.e. just energy in the form of kWhs' ?

How much of the business is there to provide network services i.e. access into or out of an energy highway?

The weighting and ratio of fixed network charges to variable charges of future tariffs will depend on how these questions are answered.

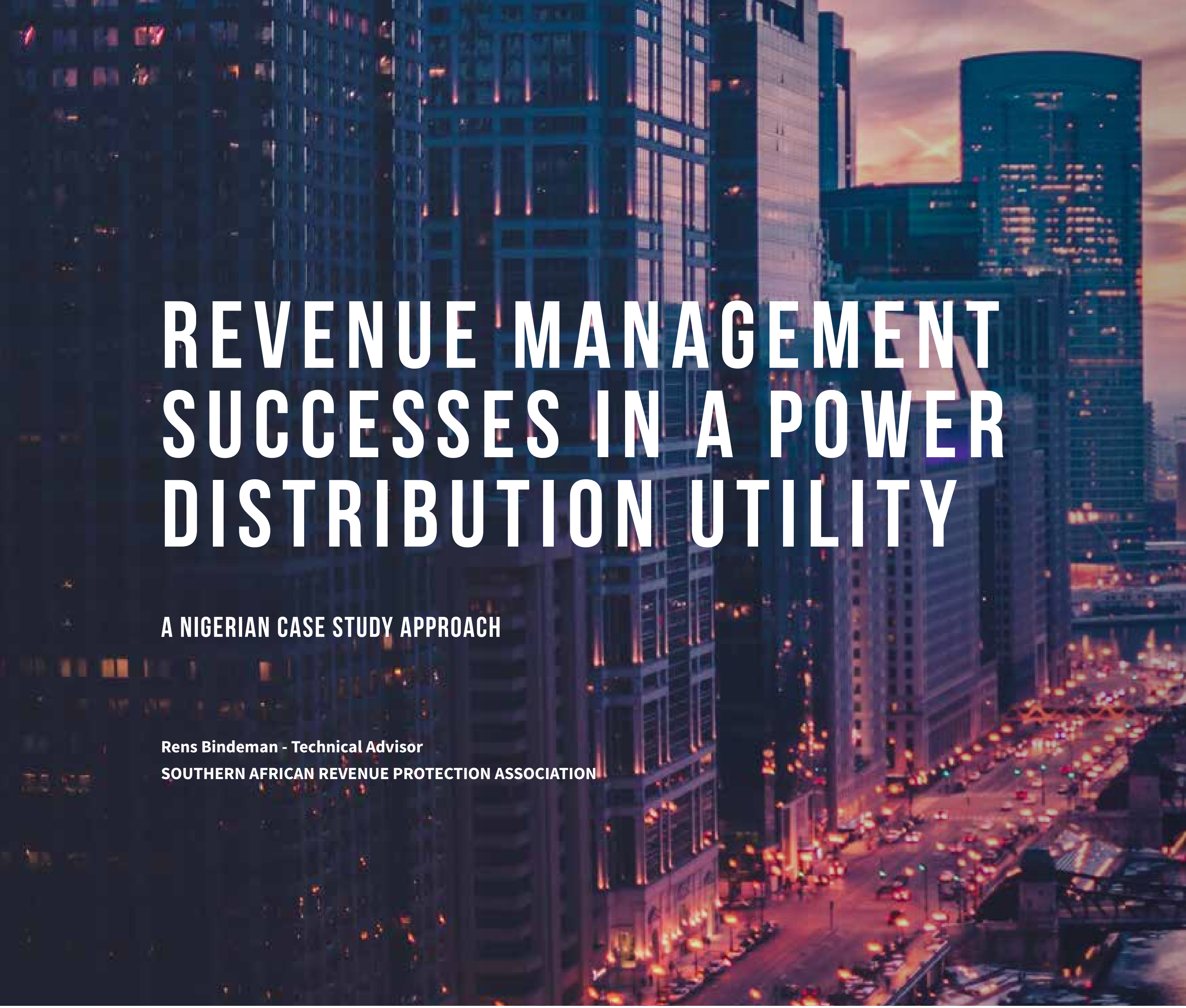
The author is of the view (also shared by many others) that for a power distribution utility which includes in general a South African power distribution utility that the so called "kWh" commodity business is a **"dead business".**

PwC in an excellent article titled "Looking ahead: future market and business models" for the power sectors recommends eight (8) business models for power companies to consider to inter alia remain profitable. PwC believes that " a greater emphasis will be placed on obtaining higher margin from prices/revenues rather than cost reduction to get higher earnings and profit growth".

In respect of power distribution utility companies the following PwC recommendations are noted:

7. **A product innovator model –** in this model a company that offers electricity as well as behind-the meter products to customers. This model focuses on expanding the role of the energy retailer and changing the level of customer expectations.
8. **A 'partner of partners' utility model -** is a company that offers not only standard power and gas products and associated services, but also a range of other energy-related services, from life-cycle EV battery change out, to home-related convenience services like new service set-up coordination, to management of net metering-driven grid sell-back
9. **A value-added enabler utility model –** is a company that leverages its fundamental capacities for information management to expand the role that a utility can provide on behalf of its customers
10. **A virtual utility model –** is a company that can aggregate the generation from various distributed systems and act as the intermediary between and with energy markets.

In light of the above the author is of the view that power distribution utilities will need to give serious consideration to relooking the current business models given inter alia the impact of the fourth industrial revolution on the power deliver sector business across the entire value chain



REVENUE MANAGEMENT SUCCESSES IN A POWER DISTRIBUTION UTILITY

A NIGERIAN CASE STUDY APPROACH

Rens Bindeman - Technical Advisor
SOUTHERN AFRICAN REVENUE PROTECTION ASSOCIATION

The implementation of a Revenue Management project in any Electricity Utiliity Globally is a challenge in itself as electricity is the third most stolen commodity in the world. With the process of dividing the Nigerian electricity distribution company NEPA into 11 private companies came a new dawn of opportunities to develop a revenue loss model for an entire country.

Such a bold move needed the implementation of an Integrated Revenue Loss Management Model that was specially developed for the Electricity Distribution Companies (Discos) in Nigeria. With a 5 year period as the goal and a lack of policies or standards in this regard it was up to experts to come up with the necessary goods.

The biggest threat to Revenue Generation and Service Delivery in the Nigerian Electricity Supply Industry (NESI) is the Commercial losses. These losses undermine the performance of utilities, discourage investments and stunts economic growth.

To design an Integrated Revenue Loss Management Plan which would provide a comprehensive range of customised and tailored made processes and operational solutions and technology for an entire country is in itself a daunting task. Some of the challenges to do this is:-

Should the function be internal or external (outsourced) – Some Disco's planned to go that way but in the end only one that got close to it was one who utilised the technical partner to drive the revenue protection section. In another even after planning the outsourcing effort over a period of two years, it never came off. It is therefore accepted that the internal function was still the best option. The thinking behind the concept of moving the function out of the company was that internal involvement in non-technical losses was such a big problem that it would be impossible to find the resources that could be trusted to perform the tasks. However, after extensive training processes in most of the Disco's and the development of Standards, Policies, Guidelines and Procedures coupled to many checks and balances, it was found that the revenue protection units were picking up the baton and that results were forthcoming.

It took a very long time to convince Executive members that Revenue Protection units could and should be self-sustainable entities.

Especially in a high loss area like that experienced in Nigeria Electricity Distribution environment, this should not be a huge task. However, with structures and guidelines not in place it became a nightmare. Everyone was very scared to make decisions and it needed very strong leadership to take the chance and embark on new ventures. Several such ventures wasted lots of time and money to be abandoned even before implementation. This frustrated many and there was a constant change in senior personnel.

Traditionally the main influencing factors that leads to Commercial Losses are: consumers cannot afford the ever increasing electricity increases, metering inefficiencies, the opportunity to commit illegal acts, sense of entitlement, corruption & collusion, operational inefficiencies, data system errors, ineffective billing systems, lack of procedures and Management's inability to deal with the relevant issues in a decisive way. On the Technical side the tampering with metering installations, illegal connections and theft of infrastructure also contributes to such losses.

From this it was derived in the Nigerian environment that the Commercial Losses could be categorised into the three categories namely:

- Electricity consumed but not metered
- Electricity consumption metered but not billed
- Consumption billed but not paid

The latter proved to be the biggest challenge in this case, as the vast number of inefficiencies were absolutely impossible to deal with. The fact that the supply is normally so erratic, necessitated most consumers to have generator backup. Therefore, there is no need to make outstanding payments

Deploying the resources into the field to identify the issues is one thing, while dealing with each one effectively was another. Every action needs a reaction and the fact that there is no clear guidelines or resources to actually make this work leads to frustration and inertia. For example to deal with a zero consumption list of meters that has not vended since installation of over a hundred thousand or to find and replace 40 000 defective meters is no easy task. It was found that some prepaid meters were declared "faulty" in order to allow the staff to switch back to the post-paid mode, where readings could be estimated and bribes could be collected. On the other hand huge amounts of new prepaid meters were blocked on installation, due to the fact that consumers have outstanding arrears on their post-paid meters. These consumers either tampered with their meters or they simply went on to "generator power".

In order to deal with this immense issues it was strategically decided that the key success factors would be minimising of technical as well as non-technical losses, maximise revenue collection by updating billing systems, data systems and internal controls, optimising Revenue Recovery by training Specialists and appointing Key Account Managers, establishing a Revenue Loss Forum to eliminate the "working in silos' effect

The key role players to have in place in each Distributor was adjudged to be the following:

- Head of Revenue Protection / Revenue Protection Expert
- Revenue Recovery Specialist
- Legal Specialist
- Data Analyst

To Integrated Revenue Protection Strategic approach that was developed for this environment could be summed up as follows:

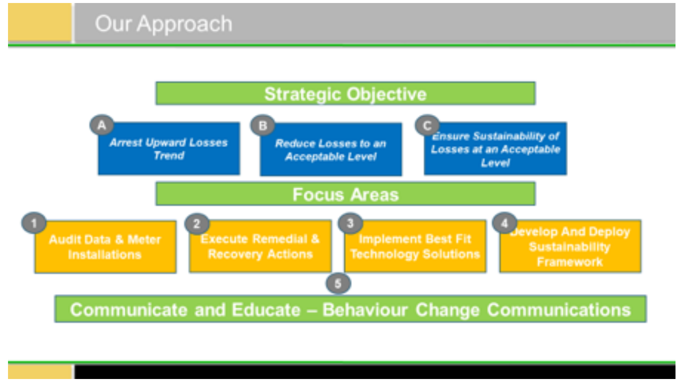
- **Skills development processes:** These processes can be divided into formal training courses, workshops, sensitising sessions, on job training, mentorship programs and performance enhancing processes
- **Revenue Recovery Processes:** By utilising the "Revenue Recovery Toolkit" the unit will be able to analyse processes and engage with entities within the company to determine the reasons for not recovering lost revenues, or even the direct reasons for lost revenue
- **Meter audits:** Meters could be audited by utilising several different methods depending on what the need is or the situation requires
- **Remedial actions:** Remedial actions conducted by Revenue Protection staff members are done in a different way from what is done during normal credit control activities and it includes different levels of actions from a soft disconnection to removal of service
- **Standardisation:** Personnel ensured access to knowledge regarding all related standards and participation in standardisation development processes
- Appoint a Capable Revenue Protection Manager
- Appoint Dedicated Staff Members
- Accountability and Bottom Line Responsibility
- Attack the "Big Fish" first (MD meters / Large Power users)

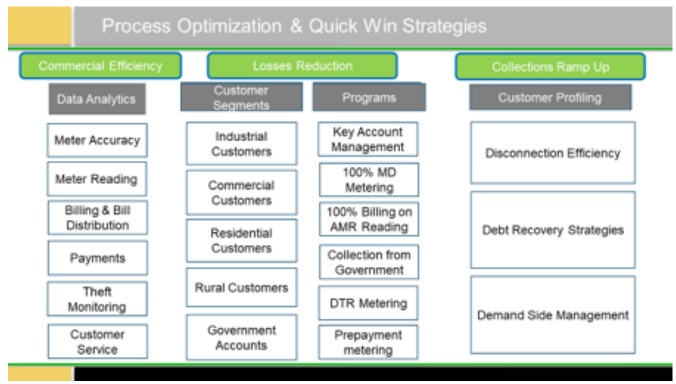
The "Quick Wins" on minimising Commercial losses proved to be as follows:

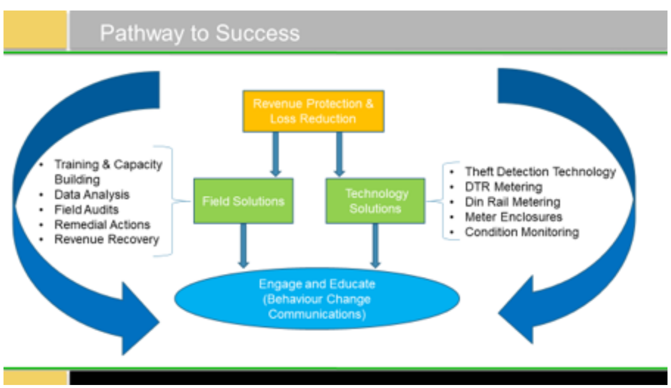
- 100% MD Meter Recertification process
- 100% MD Meter Installations
- 100% Billing on AMR
- 90% Collections target
- MD Customer Enumeration project
- Faulty Meters Replacement project
- Outstanding Debt Recovery project
- Data Cleansing process

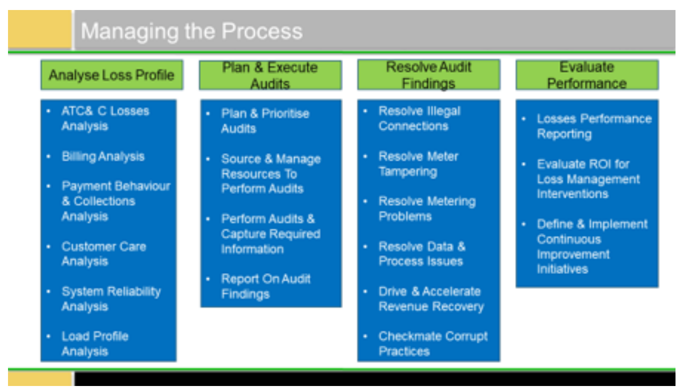
The Critical Success factors were identified as:

- Multi-Departmental and Stakeholder Collaboration
- Data Driven Operations
- Adoption of Best Practices and Effective Operational Procedures
- Close Monitoring and Proactive Restitution
- KPI's for objective performance measurement and operational focus
- Top Level Management Support and Involvement
- Revenue Protection Champions









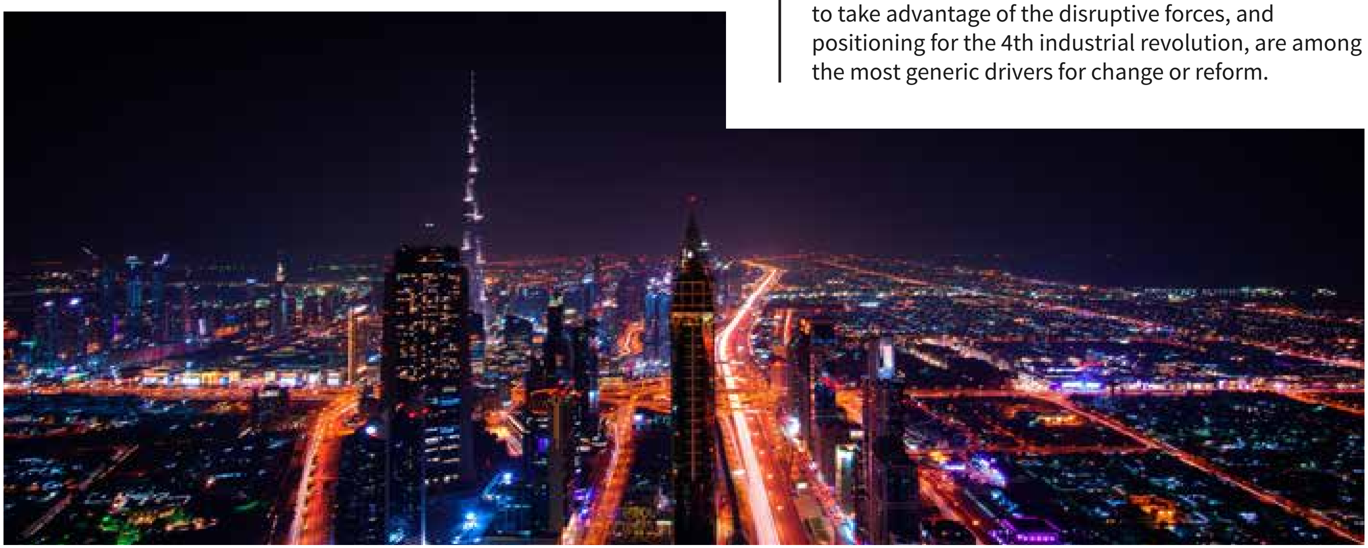
ASSET MANAGEMENT AND THE ELECTRICITY UTILITY BUSINESS

DR WILLEM J DE BEER, CONSULTANT, AURECON AND EX ESKOM AND EDIH

The focus of this article is on practical asset management from an electricity utility perspective. However, most of the asset management principles are equally applicable to other infrastructure intensive utilities.

In this article the author leverages his 45 years of experience in the electricity supply industry and reflects on what assisted in building a legacy from an asset management perspective.

Globally the electricity supply industry is going through changes, and Africa is not an exception in this regard. The drivers for change vary from country to country and therefore in every jurisdiction the reform journey is influenced by the local reform agenda. However, improved service levels, business sustainability & growth, improved business efficiency, hedging against a declining sales base, be investor attractive, accommodating renewable energy options, reposition to take advantage of the disruptive forces, and positioning for the 4th industrial revolution, are among the most generic drivers for change or reform.



It is a rather common trend to find that asset management happen to be one of the first areas to experience investment decline when the business is under financial pressure or when reform is considered. In particular, the maintenance element of the asset management philosophy is the first to experience the investment “cut back”. Furthermore, during periods of financial pressure there is also an inclination to drive for “cheaper” procurement options and lower specification compliance. While it is acknowledged that customer centricity is key to the success of the utility business, it must be remembered that the utility business by its nature is an infrastructure intensive business. You cannot wish this out of the “DNA” of the electricity utility business. Neglecting the infrastructure is one sure recipe for business disaster. While infrastructure deterioration might be visible through potholes in the case of roads or water leaks in the case of water reticulation, it is not so easy to observe the electricity related “potholes and leaks”. Power outages (frequency and duration), increase in technical losses, increase in plant & equipment failure, increase in operating costs are some of the early indicators of asset management neglect. Plant & equipment in the context of this article refers to the broader collection of infrastructure associated with electricity distribution e.g. transformers, switchgear, communication & protection equipment, grid sensors, metering, etc. From an electricity utility business perspective, it is not possible to leverage any business opportunities through weak or under performing infrastructure. Shareholder confidence, service quality, access to the grid, technical loss reduction, pursuing new business opportunities, regulatory compliance, optimise costs and efficiencies are among the business elements dependent on well performing infrastructure. The first key lesson is therefore, whether it is eform or business as usual, you will not succeed if the infrastructure is not performing at a sound recognised industry benchmark level. The second lesson relates to the early asset management neglect indicators. In this regard the question is; how many of these indicators are “flashing red” in your business and what are you doing about it?

Within the context of effective asset management, it is important to know your business. If you do not know your business, it is not possible to effectively manage your business. The first critical step in effective asset management starts with a reliable asset register. Without a reliable asset register it is among others not possible to develop an integrated asset management strategy, to define the asset operating regime, optimise planning, define resource requirements and compile a budget (operating and capital). In the context of this article the third lesson relates to access to a reliable asset register to inform your asset management strategy and your revenue requirement from an asset management perspective.

Considering the electricity utility business complexity from an asset management perspective, it is essential to understand the plant and equipment deployment in the broader context of the infrastructure. This is of particular importance in managing plant and equipment within the prescribed design parameters or within down-rated limits or under specific operating conditions. Plant and equipment should therefore be specified accurately at the stage of tender and procurement to ensure compatibility, match the planned operating regime, envisaged asset deployment and future business expectations. Therefore, the asset management representatives must define the specifications and be involved right from inception of the procurement process.

asset lifecycle considerations must form part of the procurement evaluation to ensure that the best business decision is taken. Lowest cost might not be the most optimal cost when considering the plant and equipment lifecycle. If the wrong or suboptimal plant and equipment is procured, you cannot obtain the optimal performance through “after fit” or maintenance interventions. Buying the wrong equipment or pursuing the lowest cost option might save some initial capital but it will catch up on you through the maintenance and operating costs. The latter is the more difficult part to manage since the operating cost will keep on escalating. Considering the escalating cost to serve customers and the tariff increases associated with energy and services procurement, it is critical to focus on all opportunities that could lead to the responsible reduction of operating costs. A regulated business requires a fine balance between capital investment and operating costs. Lesson number four relates to the correct specifications of plant and equipment to be procured, considering the asset lifecycle and the purpose and conditions under which it will operate.

There are numerous good practices, guidelines and checklists available to assist in developing a physical asset management strategy. PAS 55 is an example of a publicly available specification published by the British Standards Institution. Of importance is to develop an asset management strategy that will work best for the specific utility. Factors such as compatibility, environmental conditions, weather conditions, network loading, and future expansion, are but some of the factors that should be considered in defining the asset management strategy. Infrastructure maintenance forms an integral part of effective asset management. There are various maintenance options/approaches available, however there is not a “one -size fit all” option available. Therefore, it is most likely that a well-defined maintenance approach will consist of a hybrid of maintenance options/approaches. However, once a decision is taken on the maintenance approach it is important to ensure compliance with the maintenance standards and execution of the maintenance. To this end data quality and accuracy of maintenance recording are of critical importance. Furthermore, maintenance must be executed by duly competent people qualified to execute maintenance in full compliance with the maintenance specifications.

To be able to execute maintenance effectively, requires the right tools and specialised equipment where such equipment is required. Therefore, the infrastructure deployment must inform the most prudent maintenance option/approach and the maintenance approach should be reviewed regularly. Regular review of the maintenance approach will ensure that optimal infrastructure performance is achieved while costs are optimised. While “run-to-fail” could be an option from a maintenance perspective, this cannot be the “default” maintenance approach of your utility. Sadly, the latter is found to be the “default approach” adopted by some utilities in the electricity distribution industry. The impact on plant & equipment, the medium to long term financial consequences, the direct and indirect losses and impact on stakeholder relationships must never be underestimated when deciding on your maintenance philosophy. Lesson number five relates to the development and deployment of an asset management strategy and supporting maintenance philosophy, based on the evaluation of best practices and the adoption of guidelines which will best address the specific utility requirements.

Experience proved that the better the grid/network visibility and ability to exercise real-time network control interventions, the higher the network reliability and availability will be. This requires grid sensors, accurate & real time data collection and ability to interpret the data received. Proactive infrastructure/asset management will contribute to regulatory compliance, ensure that the optimal investment returns will be yield, while improved customer satisfaction will be a direct added business benefit. Effective technology deployment and the selection of relevant smart grid applications are key enablers in this regard. Lesson number six relates to the deployment of relevant technologies and smart grid applications that will enhance grid/network visibility.

The importance of effective maintenance execution can never be overstated. To be able to effectively execute a maintenance plan requires the right skills, tools, equipment and spares. It also requires training and knowledge in respect of the plant, equipment and infrastructure to be maintained. To this end it is essential to consider the maintenance requirements when infrastructure is created.

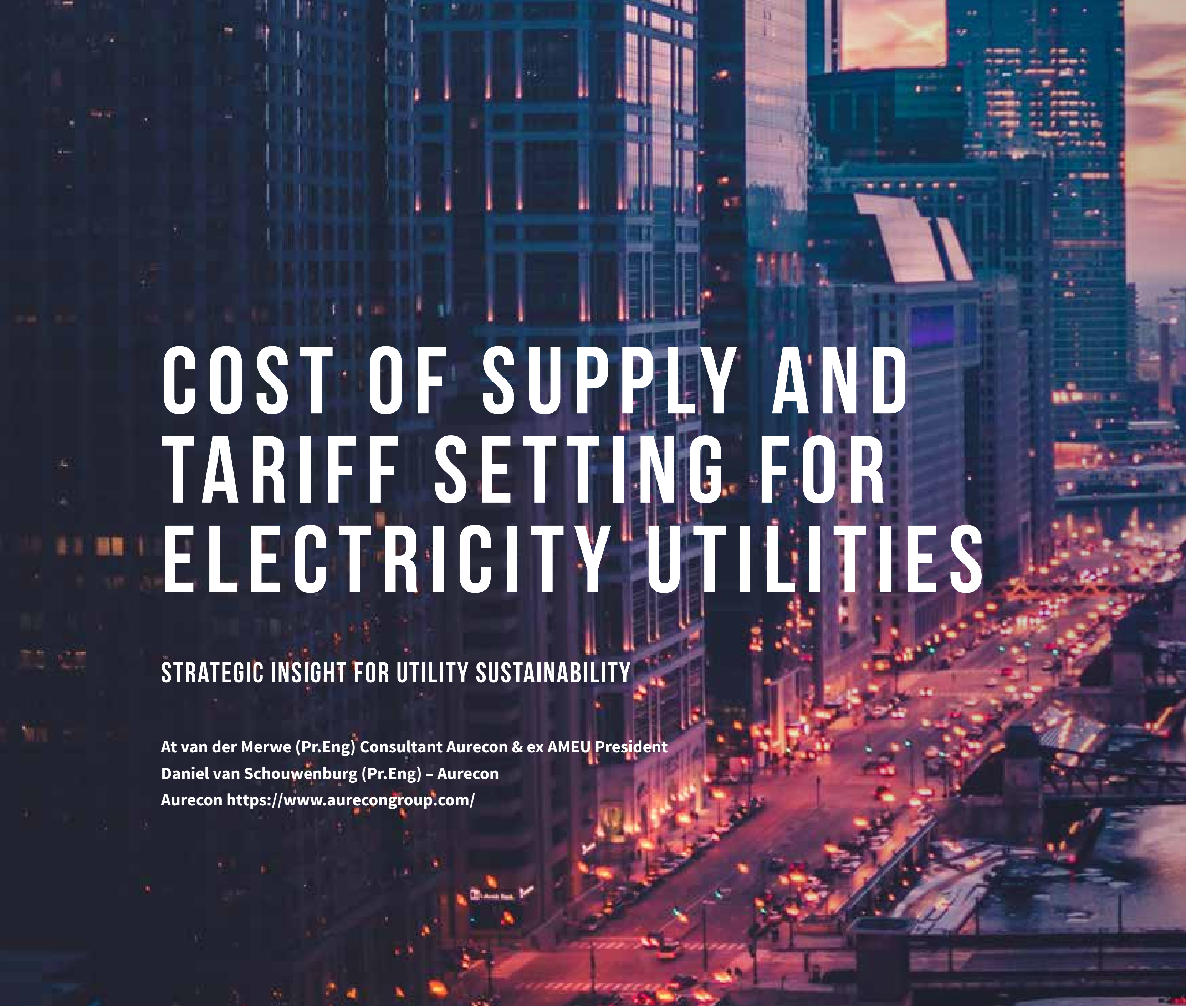
LOWEST COST MIGHT NOT BE THE MOST OPTIMAL COST WHEN CONSIDERING THE PLANT AND EQUIPMENT LIFECYCLE.

If special skills and equipment is required to construct and commission infrastructure, it is most likely that special skills and equipment will be required to maintain the infrastructure. The South African Electricity Distribution Industry (EDI) infrastructure investment backlog, clearly indicates that there is a correlation between maintenance neglect, need for refurbishment and need for replacement to address what started as a maintenance backlog. The original study indicated that 10% of the backlog could still be rescued through maintenance, while 30% of the investment will have to go into refurbishment with the balance of the required investment will be needed for replacement/infrastructure strengthening. This to a large degree demonstrates that it is wise to invest in maintenance and that it is the right thing to do. Lesson number seven suggest that to neglect infrastructure maintenance will catch up with you and it will cost you much more in the long run than executing maintenance as per a well-defined plan.

Without measuring the performance of the business, it is hard to determine where to improve. Measuring without reputable integrated benchmarks to compare against, cannot yield the optimal results. Without analysing infrastructure related incidents and defining the root causes, it is impossible to proactively implement corrective action and to hedge against plant and equipment failure. Therefore, lesson number eight suggest that it is essential to have an ongoing benchmarking, monitoring and evaluation process in place.

In conclusion it is ultimately the retained earnings, after all the business commitments (inclusive of assets management investment) have been met, that will determine the ability to grow the business and lead to sustainability. The cost to serve and the ability to generate the required revenue must therefore be clearly understood. There is no room for inefficiencies whether it is from an operating or capital perspective. To create the correct signals and generate investor confidence, electricity utility businesses require a clear and effective regulatory regime as well as a market arrangement conducive to business prosperity and economic growth. There must be consequences for non-compliance, infrastructure neglect and bad performance.

Successful asset management requires a comprehensive understanding and a passion for infrastructure management.



COST OF SUPPLY AND TARIFF SETTING FOR ELECTRICITY UTILITIES

STRATEGIC INSIGHT FOR UTILITY SUSTAINABILITY

At van der Merwe (Pr.Eng) Consultant Aurecon & ex AMEU President
Daniel van Schouwenburg (Pr.Eng) – Aurecon
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1 BACKGROUND AND CONTEXT

Electricity utilities are increasingly confronted with the sustainability of their current operations and the impact of the so-called ‘death spiral’[1], which is brought about due to increasing costs, reduced demand and disruption in the traditional distribution utility business model. There is an increased risk of stranded assets for services in the vertical value chain as new “non-utility” role players, such as IPPs, SSEG’s and special service providers, enter the market.

An essential step in ensuring utility sustainability and mitigating against the death spiral is to ensure that cost reflectivity in all services is provided, and that the correct tariff signals are sent to customers to encourage desired behaviour. Once costs and cost drivers are understood, these should be translated into appropriate tariffs that enable utilities to recover costs associate with providing a service and having infrastructure in place.

In order to fully comprehend and understand cost causality and the drivers responsible, a comprehensive cost of service (CoS) study is required. While CoS supply is not a novel concept, it is often only undertaken for regulatory compliance to gain approval for tariffs. As a result, often shortcuts are taken in executing the CoS methodology, and while regulatory approval may still be achieved, incorrect utility management decisions are made on the back of flawed calculations. This paper argues that an accurate and comprehensive CoS study provides invaluable information for utility managers and remain a cornerstone for a sustainable utility. The paper provides some insights to the CoS methodology, together with the requirements of a comprehensive tool and common shortcuts to be avoided. The learning and insights obtained from recent studies is also discussed.

2 COST OF SUPPLY REQUIREMENT

Although the electricity sector has various structures internationally, in Africa it remains mostly a vertically integrated value chain with limited private sector participation through IPPs, SSEGs and selected behind the meter offerings. The determining question for the basis of the cost of supply (or service) methodology is actually one of what the appropriate revenue level is what needs to be achieved to ensure long term sustainability of the utility and what will be allowed by the regulatory regime to base the tariff on. The essence of such a cost allocation study is to ensure that the eventual pricing covers justified cost of the service.

Due to this monopolistic environment, Regulators are required to ensure efficiency in the sector by monitoring the level of service, prescribing standards and setting tariff levels. For tariffs, the Regulatory approach aims to protect the interest of the public with affordable and fair tariffs, while allowing utilities a fair rate of return to ensure sustainable utility operations. The death Spiral is caused when the decrease in sales and revenue, whilst cost (remains the same or) increases give rise to increasing electricity prices; customers invest in energy efficiency and renewable energy causing even a further decrease in sales leading to renewed increase in electricity prices thus causing a vicious circle of decline. The guiding principles in tariff setting in South Africa by the National Energy Regulator (NERSA) include efficiency, transparency, consistency and predictability. NERSA follow the process prescribed by NRS 058. The main steps of this process is shown in the adjacent figure, while the methodology is discussed in more detail below. It should be noted that while the output of CoS is not a set of tariffs, understanding the true cost of service to each customer group on the network is an essential input to tariff design process (which is the final step of the CoS process).

3 COST OF SUPPLY METHODOLOGY

The primary principle of CoS is that the customer should pay for the equivalent portion of costs incurred to supply power to them. In the principle of cost causation, it is the customers that do cause the particular load on the system (or as such the cost) that need to pay for that portion of the cost to be supplied. For example, a customer connected to 11 kV on the network, should not pay for the costs incurred on lower voltage levels of the 6.6 kV and 400 kV parts of the network, as this customer does not use this infrastructure. Below, an overview of the methodology is presented.

The NRS058 methodology includes the following elements in the CoS methodology:

- Revenue requirements – Determining the total revenue required to cover all costs for performing the electricity utility's regulated services. This can typically be divided into two types of costs which include costs associated with bulk purchases or generation costs, and costs associated with the utility's own operations. Key requirements for establishing total revenue requirements for own operations include:

Figure 1 CoS methodology steps

[2] NRS 058 (Int):2000, First Addition, Cost of supply methodology for application in electrical distribution industry, South African Bureau of Standards

[3] Cost of supply framework for licensed electricity distributors in South Africa, NERSA

- An updated regulatory asset base (RAB), with asset values including current replacement cost and depreciated replacement cost,
- A schematic representation of the network (SLD), translated into a reduced network diagram (RND),
- Demand and energy forecasts,
- Capital and refurbishment budgets (annualised) and
- Prudent operational costs from budgets. The above is used to determine the utility's revenue requirements in operating and maintaining the network, and in investing in the network.

- **Cost functionalisation –** Assessment of the utilities operational budgets, ringfencing of these costs and determining which costs are part of the utility's regulated service, and which costs are prudent4. It is important to note that some costs typically included in the electricity utility's budgets, such as costs for streetlights, traffic lights, EE and RE initiatives etc. are not part of the regulated service of electricity supply, and should thus not form part of the revenue requirement allowance for tariff setting.

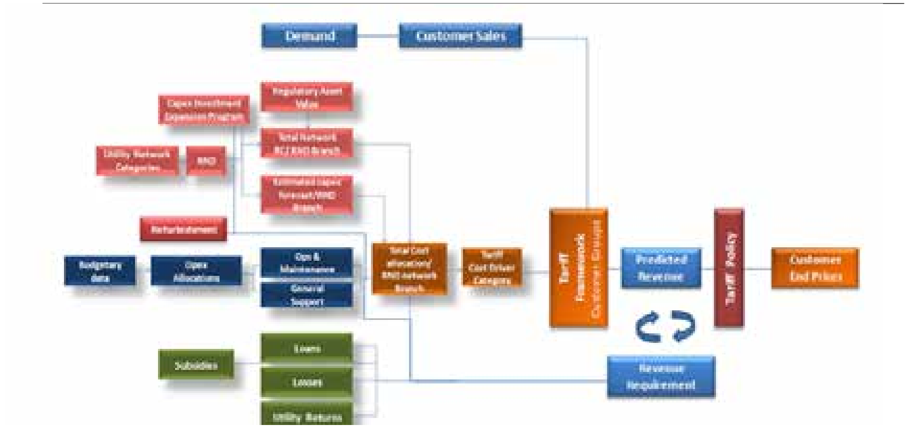


Figure 2 CoS methodology

- **Cost classification -** Costs should be expressed in a manner that will ultimately be applied to derive the tariffs, according to anappropriate cost driver. By using the correct cost driver for each cost component, inappropriate pooling of costs is eliminated. The cost drivers used to classify costs would typically be:

  i. Energy ($/kWh);
  ii. Demand ($/kVA);
  iii Capacity ($/kVA);
  iv Fixed ($/Customer/Month).

- **Cost allocation -** Various cost allocation methods can be followed, while NRS058 recommends the Average and Excess method. Essentially what these cost allocation methods are designed to do is to share the cost amongst Customers (Customer Groups) in a fair and equitable manner, based on the principle of 'who uses the network should pay for the network'. Accordingly, customers do not 'fund or pay' (share in cost allocation) for the network downstream of their connection point.

Key requirements to appropriate cost allocation are:
- Customer categories,
- Customer connection point to the grid,
- Customer demand profiles,
- Points of delivery and 4 Prudent cost is the real (true) cost required in effecting services to the customers
- Cost allocation method and weighting criteria.

The impact of losses should

Although the electricity sector has various structures internationally, in Africa it remains mostly a vertically integrated value chain.

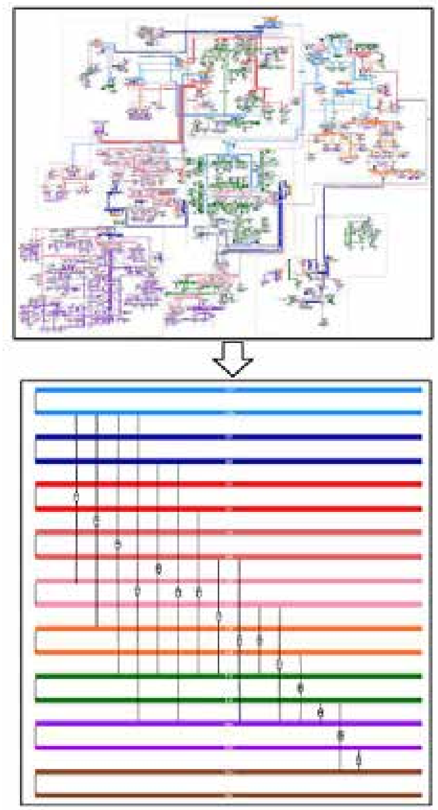


Figure 3 Translate SLD to RND

also be factored into the total cost of supply. It should be remembered that the technical and non-technical losses (ATC&C) of voltage levels and customer groups differ and should be considered appropriately across the different voltage levels and customer groupings.

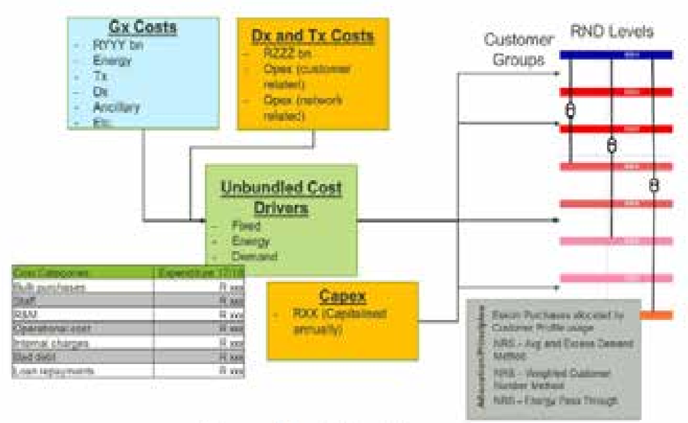


Figure 4 Cost allocation process

- **Rate design –** Once the cost reflective levels of providing services to the different customer groups on the network is known, these costs need to be translated into tariffs. Tariff design should reflect the strategic intent of the utility and should also consider practicalities of everyday utility operations. For example, it is common practice that a degree of cross-subsidisation is implemented between customer groups. Often, more affluent and industrial customers will subsidise costs of poor customers. Cross-subsidisation is a typical practice but should be done in a transparent way where the level of subsidisation and the potential impact on the customer groups is understood. Further, while tariffs should as far as possible be cost reflective per tariff driver, practicalities such as the cost of more sophisticated meters often counter the implementation of full tariff signals consisting of all tariff drivers, particularly for poor residential customers that cannot afford demand meters. In practice, the cost versus benefit of implementation should be considered, and form part of tariff setting policy.

4 COMMON COST OF SUPPLY SHORTCUTS

The principle that customers should pay for the equivalent costs incurred to provide the service, is a relatively simple concept. However, the actual implementation thereof is often more complex. For a CoS study to accurately apportion costs to different customers, the following must be considered:

- Points of delivery and the equivalent cost thereof. Bulk purchases are often delivered at various voltage levels. Further, the cost of bulk purchases can vary depending on the voltage level of the purchase point.
- Electrical flow paths on the network from the offtake point to the supply point. Often, multiple parallel paths exist. Thus, the physical make-up of the network (RND), including network capacity of the different paths, will dictate energy flow over the network is essential to the CoS.
- The customer's connection point and demand profile.
- The utility energy balance, which include purchase and sales per voltage level, and losses of different network components and customer groups.
- Time of use of supply, which should consider all 8760 hours per annum to accurately account for high and low demand periods and seasonal pricing.

Figure 5 above shows the requirements to perform a CoS study with sufficient granularity in calculation to produce results for economic decision making. CoS studies are data intensive, requiring engineering and economics analyses and interpretation of the services provided. Typically, complex mathematics that include arrays and subsets are used to calculate the TOU contribution of each customer group to the total cost of supply for the period of assessment. It is unfortunately often seen that various shortcuts are taken to calculate cost of supply. These include:

- **Inappropriate pooling of assets –** the fundamental underpin of the CoS study is an accurate representation and the correct placement of points of delivery and customers on the network (RND). The RND is used to allocate costs and model flow across the network (including losses). It is often seen that the RND is discarded, and that high-level assumptions are made for pooling of assets (such as HV, MV and LV). As a result, assumptions are made on collective losses and costs are also not correctly allocated to customer groups, based on the usage of the assets.
- **Incorrect calculation of revenue requirements –** best practice dictates that revenue from tariffs should be only for the regulated services provided. It is often seen that non-prudent costs and cost incurred for unregulated services (such as streetlights and traffic lights) are included in the revenue requirements. Further, asset replacement costs (through a depreciation value) should be calculated on the current

replacement costs and be inclrevenue requirements to ensure sufficient investment for sustained utility operations. In order to accurately identify and calculate these costs, P&Ls, budget and the regulatory asset base should be scrutinized and understood, or else the incorrect revenue requirements would be tariffed for.

- **Lack of use of appropriate cost drivers –** Costs should be correctly allocated to the different cost drivers, including energy, demand, capacity and fixed charges. Often, all costs are grouped to energy (which result in a single $/kWh charge). This results in skewed and incorrect (non cost reflective) tariff signals. With increasing disruption and introduction of different players (service providers) in the value chain, it is essential that utility's move away from pure kWh-based signals to remain sustainable.
- **Use of averages –** Due to time of use and seasonal periods, it is fundamentally incorrect to make use of averages when calculating supply costs. Unfortunately, it is often seen that TOU modelling is discarded and averages used. This will result in incorrect tariffs and will not ensure long term sustainability.

5 AURECON COST OF SUPPLY MODEL

Aurecon has developed a CoS and tariff setting methodology and application that fully implements the NRS 058 requirements. The application makes use of commercial Systems Dynamics Platform software, resulting in a solution that is:

- Fit for purpose and scalable,
- Based on graphical model principles with visual
- relational representation,
- Accepts multiple input formats, including
- spreadsheets, text files, etc,
- Introduces the use of subscripts that allows for
- multi-dimensional representation of variable
- (key for a comprehensive COS) and
- Is time-step based, which allows for accurate
- modelling of TOU.

The Aurecon methodology has successfully been implemented in various utilities across Africa. Our approach is to take at least a three year view, which includes modelling of two years of actual information (base year based on audited financial statements and current year on actuals and budgets) and the future year, for which tariff design will be done. This allows for the validation of the model and assessment of the status-quo. We calculate the surplus (or deficit) of each customer group, per cost driver. This allows clear visibility on cross-subsidisation between customer groups and assists utility managers to develop tariffs with appropriate tariff signals. The tariff tool allows for toggling of tariff drivers per tariff groups, enabling the migration of tariff signals to be more cost reflective.

In recent additions to the application, a small scale embedded generator (SSEG) module assists utility managers to comprehend the impact on utility surplus of SSEG introduction to their network. It is important to take a view on the surplus, as reduced sales due to SSEGs would also result in reduced bulk purchases. In a recent study undertaken, rates were calculated as a fixed network access cost per customer group to mitigate the loss in surplus due to SSEG penetration into the local utility business. Interestingly, depending on the tariff signals and TOU cost of supply (on-sell differential), the introduction of SSEG could potentially be to the benefit of utilities. The opposite could also be true, hence the requirement for a proper analysis of the cost reflectiveness of the tariff signals charged.

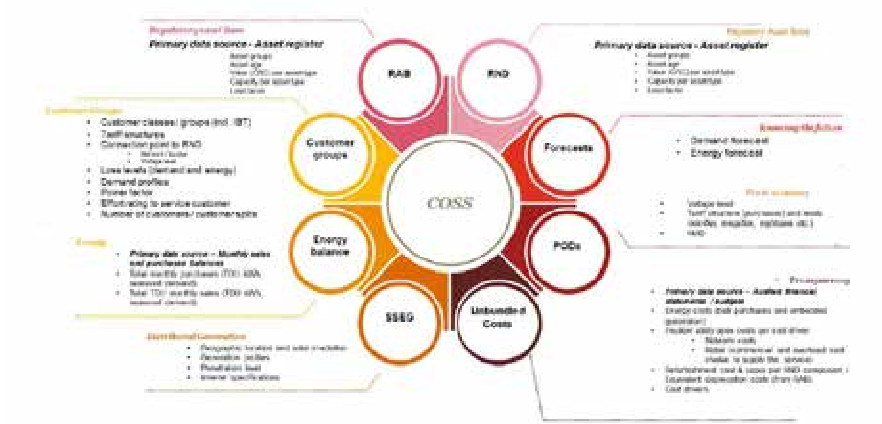


Figure 5

6 INSIGHTS FROM COST OF SUPPLY

Although CoS is often undertaken by utilities as a mere 'tick-box' for tariff approvals as part of the regulatory requirement, it is evident from previous studies performed that CoS provides utility managers an abundance of valuable information and strategic decision-making insight. Apart from being a primary input to tariff design, the following insights have been obtained from recent studies:

- In general, bulk purchases consists dominant of an energy signal in RSA. Utilities often replicate the bulk purchases tariff signal, meaning that the influence of decline in customer sales effect the utility surplus (profits) dramatically (electricity utilities are still kWh on-selling business instead of a network service provider approach in their tariff setting)
- It is essential for utilities to understand and ringfence their prudent costs and costs associated with regulated services. Understanding contributions to shared services and costs associated with internal transfers and services provided is often lacking.
- Assets are often valued at and accounted for based on historic costs. As a result, utilities are under recovering for their network refurbishment investment needs. Utilities need an updated RAB and depreciated replacement cost (DRC) value and need to tariff for depreciation of assets.
- Impact on surplus is TOU dependent and averages will result in incorrect conclusions. For example, the influence that SSEG would have on utility surplus and when customers contribute to surplus depends greatly on TOU.
- Impact of ATC&C is critical in tariff calculations and need to be part of energy balance.
- Each tariff component within the tariff category should be cost reflective to ensure correct tariff signals and customer behaviour. For example, a purely kWh-based tariff signal will result in the acceleration of the death spiral with the introduction of grid connected SSEGs. Utilities need to move away from pure energy signals to include cost reflective network access charge (NAC), demand and capacity charges (wires charges that provide for the network - NSP)
- Unbundling of tariffs and cost reflective tariff signals will enable utilities to provide additional services, such as wheeling of power over the network, by understanding network related costs at different voltage levels.
- COS has proven that kWhs can come from anywhere (IPPs, SSEG or state owned Gx utility) at different price levels, and as a result could have a big influence on surpluses.
- Correct assumptions regarding future demand is critical. Overestimating sales could lead to unsustainability, particularly for kWh-based sales.

7 CONCLUSION

Traditionally, the electricity supply sector was monopolistic where customers did not have a choice. Due to this dynamic electricity tariffs were often structured to be kWh-based, as utilities could recover all electricity supply costs through the on-selling of kWhs. This reality has however changed due to various disruptive forces in the electricity supply industry. Utilities need to understand the causality of their different costs and appropriately allocate these to different cost drives to mitigate against loss of revenues and surplus. This is typically achieved through a Cost of Supply study.

Performing a CoS study as part of a tariff application process has long been common practice for most utilities. However, it is evident that many utilities perform these studies purely from a regulatory compliance tick-box point of view, with little understanding of the insights and value add that the CoS may bring to strategic decision making for utilities. Due to this tick-box approach and lack of information readily available, utilities and their service providers often take various shortcuts in performing the CoS. These shortcuts could have serious implications to the sustainability of the utility due to:

- Under recovery of revenue due to incorrectly stated revenue requirements, such as insufficient allocation for depreciation and capital requirements,
- Incorrect cost allocation resulting in wrong tariff signals and levels and
- Inability to mitigate against the introduction of SSEG and collection of additional revenues (such as wires-related revenues) due to inappropriate tariff signals. It is likely that electricity supply utilities will become increasingly unsustainable and fall prey to the utility death spiral with the continued implementing a kWh-based business model. It is however evident that tariff design informed by a comprehensive understanding cost causality (through a thorough CoS study) would allow utilities to mitigate against the death spiral. It would further enable utilities to tariff appropriately to unlock new sustainable service offerings (such as wheeling), in doing so migrating to a wire-based business model.

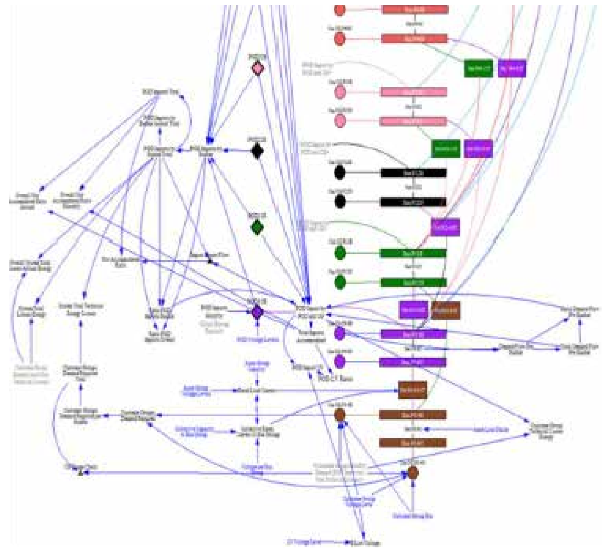
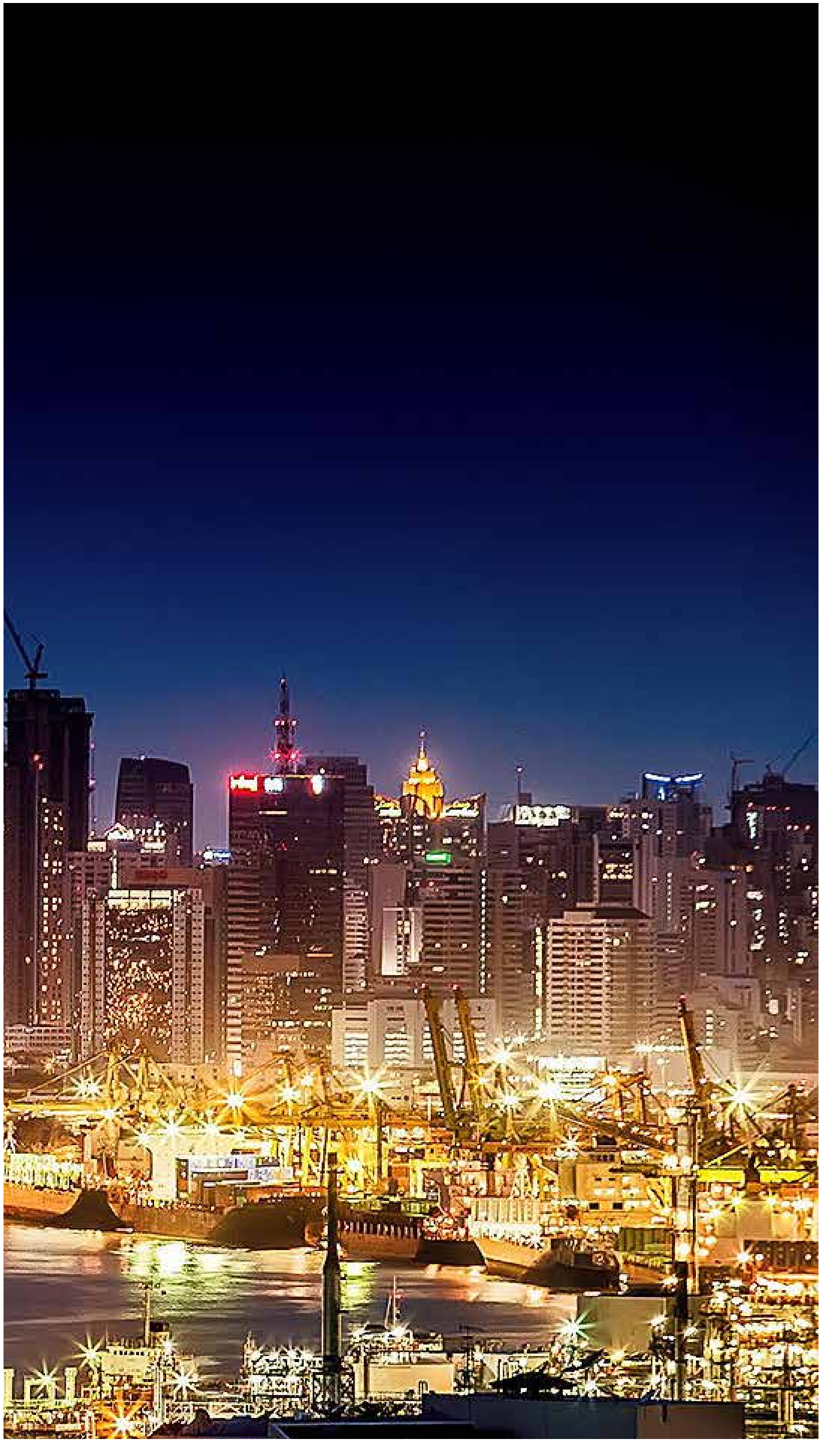


Figure 6 Visual representation of RND, customers and PODs in Aurecon model



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