Revenue Protection as part of Utility Financial Sustainability
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Synopsis

Revenue Protection is an integral part of a holistic approach to achieve utility financial sustainability. The Paper introduces the definition of a losses value chain, the quantification of losses, and an integrated approach required to minimise losses. This is viewed holistically for a utility and what efforts management should make to improve the business economics of the electricity utility. The authors also draw on experience and benchmarks in research undertaken for utilities abroad and elsewhere in Africa.

1. Introduction: Utility financial sustainability in perspective

Utility financial or commercial sustainability means that the utility can maintain its operations in a financial and commercial sustainable way, where the cash returns from operations maintain positive. This means that the cash received from operations, should be sufficient to pay for all cash expenses, which should include normal expansion programs, debt repayments and alike. The cash required is therefore not the same as normal profit as we know from a business point of view. It can also be defined by the cash coverage ratio, which should be bigger than one for a healthy undertaking . Cash Coverage ratio is defined as operating and other income (after covering operating costs and adjusted for net working capital and non-cash expenses, i.e. depreciation and bad debts, plus consumer deposits) divided by the sum of debt service liabilities, internal funds required for capital investment, and essential contributions like for staff retirement funds.

For a utility to plan for financial 'survival' or sustainability, it must understand the relationship between all the utility activities that affects the cash flow. To achieve financial sustainability, the utility needs to do proper integrated planning, by simulating and evaluating all the factors influencing cash flow, and set appropriate targets accordingly.

To maximise revenue, the utility needs to improve cash collections (reduce cash losses), and curb non technical losses. The utility could also increase revenue by increasing tariffs, but this should be the last resort of effort and should not be used to cater for the operational cash losses in the utility.

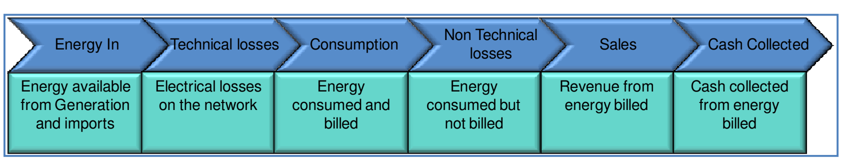
In order to minimise operational cost, the utility needs to look at least cost generation (optimal generation mix); improving utility efficiencies like the correct level of utility operational costs per kilowatt-hour sold; reducing losses, both technical and non technical losses and improve quality of supply.

The reduction in technical losses will reduce the cost of energy available for sale (which include the cost of generation), where the reduction in non technical losses can improve revenues and/or reduce generation cost. It must be noted that technical losses are normally supplied by the most expensive generation, if a least cost generation strategy is followed. By reducing technical losses, one will directly reduce the cost of the most expensive generation and hence enhance the cash flow and the sustainability of the entity as a whole.

Revenue protection is a holistic utility approach and can be defined as all those utility activities that ensure that losses are minimised, both from a revenue and a cost perspective.

2. Losses value chain

Losses in an electrical utility are best described through the losses value chain, shown in the diagram below.



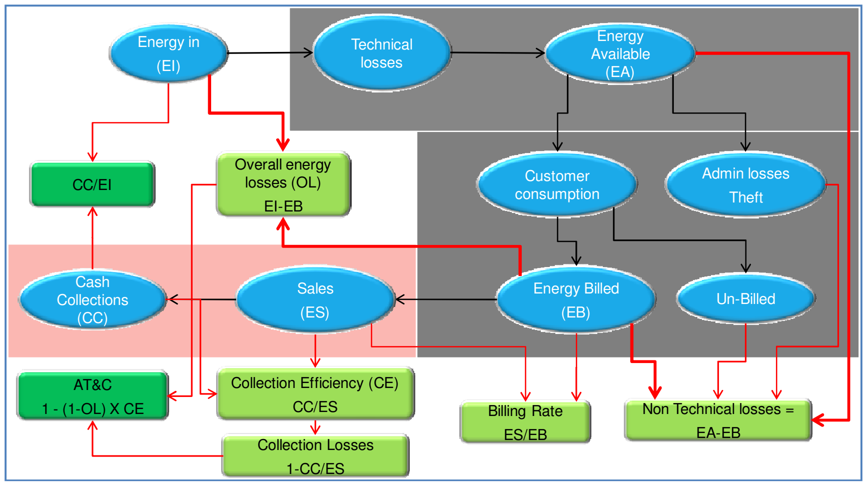
From this it is clear that there are three components to losses, the first two being energy losses, and the third cash losses.

Energy losses are defined as the difference between energy available for distribution, and the actual energy billed to end customers and is given by the sum of technical and non-technical losses. **Cash losses** are the difference between cash collected and the true sales (in Rand) to end user customers.

Technical losses are those losses experienced in an electrical system that is due to the loading and electrical characteristic of the electrical network (for instance the network and transformer impedance and no-load losses of transformers).

Non-technical losses are those losses of electrical energy that is caused by factors outside the electrical system. This could include inaccurate meters, inaccurate meter readings, technical problems with meter installations, billing errors, errors in record keeping, consumption by non metered installations and energy theft. (Note that free basic electricity is included in sales)

The following flow diagram explains the various concepts and ratios in terms of overall losses. The grey area defines energy losses, where the pink area describes cash losses. From a management point of view, it is essential to develop a monitoring and reporting framework to be able to monitor the various KPI's that track losses.



The following typical KPI's should be monitored:

- Energy in (EI) - (energy available for distribution) in kWh,
- Energy billed (EB) - as obtained from the billing system in kWh ,
- Overall energy losses - EI minus EB in kWh,
- Overall energy losses % - overall energy losses divided by EI,
- Technical losses
  - Maximum demand losses as a % of maximum demand and
  - Energy losses as a % of energy in
- Non technical losses – derived from overall losses minus technical losses in kWh and
- Collection Efficiency – ratio of cash collected versus bills send out (if there is also prepaid meters, the revenue received should be added to cash collected and bills).

There are two industry benchmarks for overall performance, the one being the Aggregate Technical and Commercial losses (AT&C), which aggregates the overall energy losses and cash losses, and secondly the average collection per unit available for distribution (CC/EI).

AT&C is calculated as follows: AT&C=1 - (1-Overall losses %) X Collection Efficiency%
CC/EI is derived from the cash collected divided by the energy in and is given in cents per kWh.

3. Quantification of losses

It is important to quantify the components of losses, as this will enable management in their planning and decision making to decide on the correct strategies to curb losses, and to improve revenues. One can calculate technical losses, whilst it is very difficult to calculate non technical losses. The most common approach to follow is to calculate the technical losses, and derive the non technical losses as the difference between overall energy losses and technical losses. One can then establish the components of non technical losses through various sampling methods (as a percentage of total non technical losses).

For **technical losses** it is important to distinguish between demand losses and energy losses. One can derive the energy losses once the demand losses are known. Demand losses can be calculated through

- A proper network model and configuration and
- Establishing the correct loading on the network, both in terms of maximum demand and the load profile of the various loads on the network.

The **demand losses** are then calculated by doing load flow studies on the network for the maximum demand conditions. This must be done for all the various voltage levels, from the low voltage network to the distribution/transmission system, and all the different feeders. This would normally entail various studies, as one would not model the low voltage network and distribution network in the same model. Due to vast volume of low voltage networks, one would normally model some sample networks that are representative of the network, and use that as benchmarks for determining the demand losses for the remainder of the low voltage networks.

The **energy losses** are derived from the demand losses by establishing loss load factors (LLF) for each network component. The energy losses are calculated as follows: demand losses in kW*LLF*hours in the period under consideration. The demand losses are derived from the load flow studies, and the loss load factors are derived from statistical metering and/or the load profile of the applicable load.

The LLF can be established from statistical metering as follows:

$$LLF = \sum_{n=1}^{35040} (\text{load}_n^{\,2} / \text{peak load}^2) / 35{,}040$$

where:		
	35,040	= the number of 15 minute load recordings in one year
	load_n	= the 15 minute average load in the nth 15 minute period.
	peak load	= the highest 15 minute average load in the year

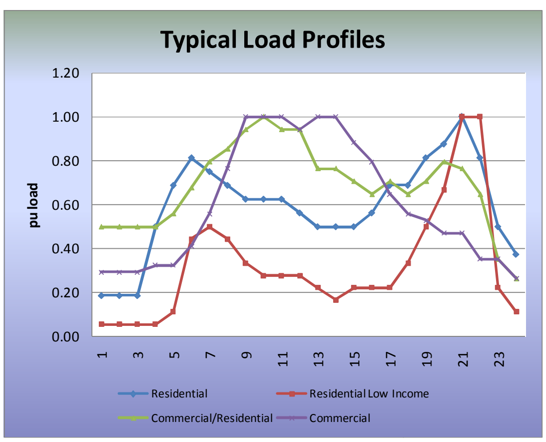
This could also be done for shorter periods, say for instance for a specific month. However the more readings one has, the more accurate the LLF would be.

The load factor (LF) is given as the Total Energy Available/(Maximum Demand in kW*hours in period) over the same period as used to determine the LLF.

If statistical measurements are not available, the LLF can be derived from the LF as follows: LLF= k*LF+(1-k)*LF^2, where the constant k is derived from empirical results. Where no data is available a value of .3 is normally used for k.

The value of k can be derived for various load profiles if both the LF and LLF is known, by using the formula k=(LLF-LF^2)/(LF-LF^2).

The following graph and table shows typical load profiles, LF, LLF and k for specific customer groups.



	Residential	Residential Low Income	Commercial/ Residential	Commercial
LF	0.59	0.32	0.69	0.61
LLF	0.40	0.17	0.50	0.44
k	0.18	0.30	0.16	0.32

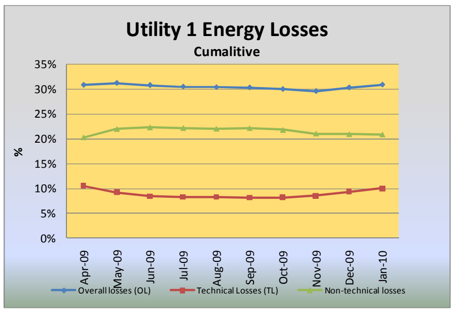
Even in calculating the energy losses as described above, it still remains an estimation, as the transformer no-load losses remains constant. The only accurate determination of the losses would be through continuous measurement. From a management perspective, and to quantify the quantum of energy losses, the above procedure would yield accurate enough results.

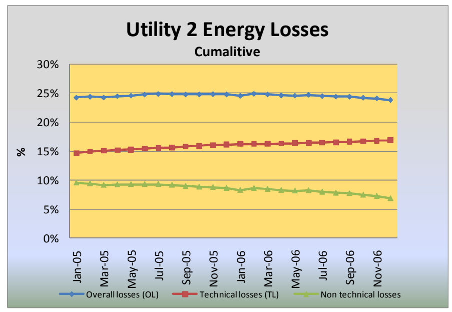
Once the energy losses have been determined for a specific period, say a month, as described above, the non-technical losses are determined as being the difference between overall losses and the technical losses.

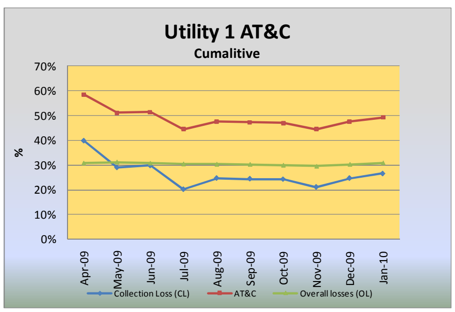
The **cash losses** are easy to determine, as this is the difference between the sales in Rand as determined from the billing system (including sales from a prepayment system if it exists), and the actual cash collected from sales (and sales from the prepayment system, if it exists). From a management perspective, one would also like to distinguish cash collections from current debtors (and the type of debtors), versus the collections from old debtors (more than 30 days), as this could influence the revenue protection strategies.

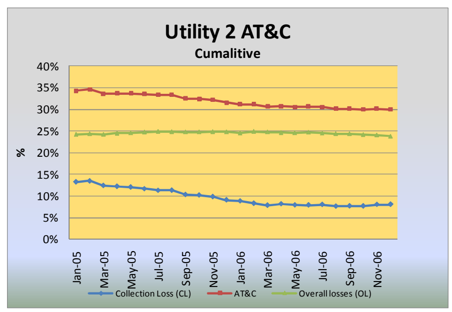
4. Typical results from utilities in developing countries

Our experience has shown that most utilities do have huge energy losses, as well as poor cash collections. Energy losses are in the region of 20-35%, and collection efficiencies from 65-90%. What must be kept in mind is that technical losses will increase exponentially as load increases. So although it is normally easier to reduce non technical losses, this saving is off-set by the increase in technical losses. This is evident from the results from Utility 2. Loss reduction strategies were in place for 3 years prior to the results shown for Utility 2, where as Utility 1 still has to introduce losses savings strategies.









Technical losses are dependant on the network characteristics and loading. The technical losses will therefore follow the same seasonal pattern as the demand of the utility. Technical losses increase with the square root of the increase in loading. Network overloading and unbalanced loads are the main contributors to excessive technical losses.

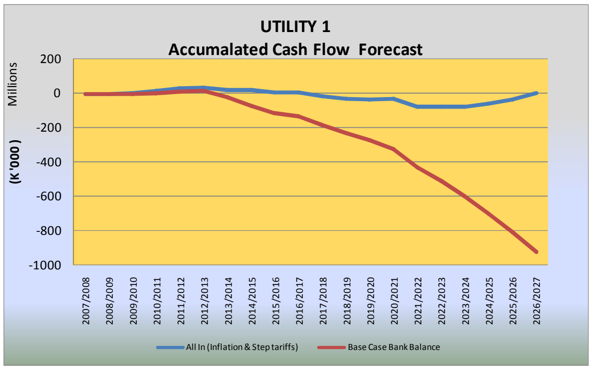
It is also evident from experience that it is easier to manage down non technical and cash losses, but in a utility where there is growth, a lack of capital investment for electrical network expansion or network upgrading, will contribute to higher technical losses.

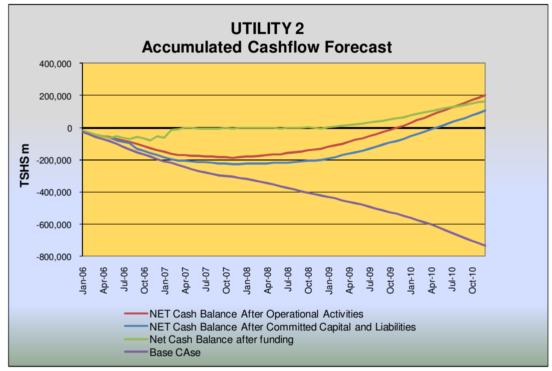
Non technical losses are reduced through appropriate revenue protection strategies that should be tailored based on a thorough analysis of current revenue protection strategies. This should include appropriate systems (especially billing), metering and meter reading strategies, meter audits, organisational change to allow proper governance for the revenue protection value chain, cut-off and re-connection strategies to name some.

Other forms of losses which is not covered by the above, is losses due to poor system performance. This could be caused by poor or lack of maintenance, or poor design and construction, where unnecessary outages add to loss of revenue and customer dissatisfaction. This should be taken into account when addressing financial sustainability.

5. Holistic approach to utility financial sustainability

To achieve financial sustainability, one needs to follow a holistic approach, whereby all the various utility activities are modelled, to determine the impact thereof on future cash flows. This should include utility business economic modelling (BEM), network modelling, loss quantification modelling and monitoring and reporting through appropriate KPI's. The following two examples show typical results of BEM.





For Utility 1, the following strategies were applied to achieve financial sustainability:

- Reduce technical losses with 2% from 16 to 14 % and non technical losses from 5.5% to 2.5% ,
- Increase the collection efficiency from 93% to 97.5%,
- Collection of old debtors over a 3 year period,
- Increase in operational efficiency with 40% (measured in kWh per employee or number of customers per employee). This would mean the increase in the number of customers,
- Additional step tariffs above inflationary tariffs to cater for the increased investment program not covered by inflationary tariffs and
- Monitoring and reporting through appropriate KPI's.

For Utility 2, the following strategies were applied

- Loss reduction from 26% to 20%,
- Maintain collection efficiency,
- Convert expensive generation, and optimise generation mix,
- Restructuring of debt,
- Increase the quality of supply and reducing outages,
- Increase sales through electrification and large mining loads,
- Additional step tariffs in short term and
- Overdraft to support short term cash deficit.

It is therefore clear that one needs to understand each utility's performance from a holistic point of view, and understand the impact of such performance on the overall cash flow. The strategies to achieve financial sustainability will therefore differ from utility to utility, but will include the reduction in losses, both energy and cash losses.

6. How will a utility gain from managing losses

- Technical losses
  - Reduction of technical losses will reduce the cost of supply, as this will reduce the cost of generation and imports (or purchases where a utility only buys power from a bulk supplier) ,
  - Least cost generation will save on the most expensive generation,
  - Network optimisation (optimal switching arrangements, balanced loading, optimal voltage levels) will reduce technical losses but will not need capital investment (except if new switchgear is required to implement the optimal open points) and
  - where network strengthening is required to reduce technical losses, the utility would need investment.
- Non technical losses
  - A reduction in non technical losses will either be converted to additional sales, or reduction in generation cost (same as for technical losses), or both,
  - Normally the reduction in non technical losses will not need huge investments, but might increase short term operational expenses to implement the necessary strategies and
  - It will also encourage efficient usage of electricity as customers will pay for what they consume (the quid pro quo principle) and tend to force average consumption down.

7. Conclusion

It can be concluded that utility managers must see revenue protection as part of a holistic approach to ensure utility financial sustainability. All utilities will have losses, which could me managed down to sustainable levels, by implementing custom made strategies.

In South Africa we also have many ailing utilities, due to unnecessary high losses. Management can take up this challenge by implementing a proper monitoring and reporting framework, by understanding the utility from a financial point of view, quantifying these losses, and applying appropriate strategies to become financial sustainable and still charging market related tariffs.

The revenue or cash loss should be solved by first segregating the revenue cycle, analysing it, measuring the performance and optimise the process before relying on tariff increases.

Always bear in mind: ***One cannot manage what you do not know.***