Non Technical Losses – How do other countries tackle the problem?

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Abstract *- Technical losses in a distribution network are well understood and their reduction is finite and essentially an engineering issue.*

Non technical losses, on the other hand, although also well understood have evolved into an art form and their reduction requires innovation and persistence. Utilities around the world are actively addressing the issues.

In South Africa prepayment meters were adopted as the "solution" in the poorer communities but it has been said that theft and non-payment of electricity are equivalent to the output of one Eskom "Six Pack" power station. The term "Viva the Meter" would appear a common "Terms of Reference" for urban based "Meter Consultants". In these days of a critical generation shortage and low spinning reserve the financial impact of the high level of non technical losses is very significant.

A recent PB project required research into the extent of the problem in both developed and undeveloped countries and this Paper shares these findings and provides a brief insight into how other countries tackle the issue.

Approaches range from strong policing and regulatory based incentives or penalties to "outsourcing" the solution by transfer of operating rights offering the potential for large financial profit incentives for utility investors.

The developed countries are often used as a benchmark as having best practice for the managing the issue of non technical losses but certain poorer and less developed countries have adopted different approaches with considerable success.

I. INTRODUCTION

Total Loss comprises three components:-

Technical Loss: The component of distribution network losses that is inherent in the physical delivery of electric energy. It includes conductor loss, transformer core loss, and potential/current coils in metering equipment.

Technical Loss is calculated as the sum of the hourly Load Loss and No-Load (or Fixed) Loss in all distribution equipment, devices and conductors for a specified billing period. It is calculated through three-phase load flow simulations of the distribution system using the appropriate Network and Load Models. Such load flow simulations capture all Technical Losses from the incoming and outgoing delivery points of the unbalanced three-phase distribution network (i.e. from Sub-transmission lines to the service drops of the distribution network customers).

Administrative Loss: Includes the component of distribution network losses that accounts for the electric energy used by the Distribution Utility in the proper operation of the distribution network. Substations, offices, warehouses and workshops, and other essential electrical loads are usually considered as part of the Administrative Loss.

Non-Technical Loss: Includes the component of distribution network losses that is not related to the physical characteristics and functions of the electrical network, and is caused primarily by human error, whether intentional or not. Non-technical losses Includes the electric energy lost due to pilferage, tampering of meters, and erroneous meter reading and/or billing. Losses in metering equipment, including the electrical burdens of instrument Transformers, are usually considered as part of the Technical Loss.

Non-Technical Loss is the residual loss that remains after subtracting the Administrative Loss and Technical Loss from the total distribution network losses1.

The estimation of non-technical losses requires an accurate computation of technical losses and administrative losses. In practice administrative losses are determined by measurement, and thus the accuracy of the estimate for non-technical losses is largely dependent on the accuracy of the estimation of technical losses.

In this paper we explore the experiences of distribution utilities in several countries and conclude by extracting from these experiences the more popular strategies that have been shown to work.

II. COUNTRIES OF INTEREST

The level of non-technical losses varies generally according to the economic conditions of the country.

In countries where GDP per capita is very low it is common to find higher levels of non-technical losses (pilferage). This is perhaps because the cost of electricity is high relative to household income.

There are exceptions to this, however, and in countries such as Indonesia and Thailand, GDP per capita is low but the reported non-technical loss level is also remarkably low. The reason here is most likely due to the fact that poor customers receive subsidized electricity that is affordable in the form of a social tariff. In Venezuela, a move to a social tariff in 2001, resulted in the level of losses falling significantly as electricity became affordable for poor communities.

In some countries electricity supply has become non-regularized due to war or failure by Government to maintain adequate controls on the supply of electricity and pilferage has become endemic with high levels of tolerance within the community.

These varying circumstances mean that it is difficult to identify a specific benchmark for non-technical losses correlated with GDP per capita. On the other hand, the relationship between non-technical losses and the severity of loss mitigation practices is valuable in justifying the approach taken by any utility in their loss mitigation strategy.

PB has collected information regarding practices in countries experiencing high levels of non-technical losses where utilities have tried a wide range of techniques, some of which may be suitable for application in South Africa where they are not

[1] Regulators expect that any electric energy loss in the distribution network that is recovered through anti-pilferage activities would normally be subtracted from the non-technical loss.

already being applied. The countries of interest are ranked in order of Purchasing Price Parity (PPP per capita) as follows:-

Table II-1 Relationship of Distribution Losses to Economic Prosperity

Country	Estimated Losses in 2007	PPP per capita 2007
India	NTL – 20% to 40%	2,700
Philippines	NTL – 3.5% Total losses 10%	3,300
Indonesia	NTL – Unknown Total losses 12%	3,400
Jordan	NTL – 3 to 5% Total Losses – 15%	4,700
Jamaica	NTL -13.2% Total Losses - 23.2%	4,800
China	NTL – 10%	5,300
Thailand	NTL – 0.32% Total Losses – 5.69%	8,000
Brazil	0.5% to 25%	9,370
Turkey	NTL – 6% to 64%	9,400
Lebanon	Unknown	10,400
South Africa	NTL ~ 10%	10,600
Venezuela	NTL - 12.74%	12,800
Russia	Unknown but 10%+	14,600
UK, Australia, United States	NTL between 0.2% to 1%	> 30,000

It will be seen from the case studies that the non-technical loss mitigation practices in the Philippines, Indonesia, Jamaica and Thailand are of particular interest.

III. CASE STUDIES

i. Meralco, Philippines

Meralco is the largest electricity distributor operating in the Philippines and serves around 4 million customers

A large part of Meralco's customer base is either very poor or experiences continued difficulties in paying for their day-to-day living needs. Electricity is an essential commodity to maintain a reasonable standard of living, especially in the urban and semi-urban areas served by Meralco, and this need along with the high cost of electricity leads to high levels of electricity pilferage amongst the poor non-manageable communities that live in these areas. The impact on Meralco has been significant:-

- Growth in consumption is understated due to pilferage;
- Reliability of supply has been impacted because low-paying areas do not contribute sufficient revenue to justify capital improvements (SAIDI is around 17 hours);
- Meralco's public image is poor due to customer's sensitivity to price rises and the perception that the company is only interested in profits even at the expense of the poor;
- Servicemen often have to operate in a hostile and life-threatening environment, especially when having to disconnect non-paying customers; and
- Network infrastructure is damaged or rendered unsafe due to illegal connections.

The extent of the electricity theft problem has had such an impact that the company has been forced to become very innovative in its attempts to reduce non-technical losses. The innovation on the part of Meralco has only been matched by the innovative approaches employed by the pilferers of electricity. High voltage barriers have proven to be no deterrent to determined thieves. Meralco even has evidence of organized crime syndicates providing 'customers' with custom-designed radio controlled switching devices, that connect and disconnect illegal wire taps, on a monthly subscription basis! Meralco has tried and tested many approaches to non-technical loss reduction and has learned from experience what works and what does not work. For this reason Meralco's experience in fighting electricity pilfering should be of interest to other utilities faced with escalating non-technical losses.

III-1 MERALCO Market Segmentation (2007)

	Number	Consumption (MWh)
Residential	3,616,963	8,140,000
Commercial	341,272	7,960,000
Industrial	11,543	6,560,000
Streetlights	4,202	140,000
TOTAL	3,980,980	22,800,000

The Energy Regulatory Commission of the Philippines allows distribution companies to recover electricity losses up to a cap of 9.5 % through rate setting. A separate revenue component is included in electricity accounts to allow for this recovery. This revenue is intended to compensate for both technical and non-technical losses. The Energy Regulatory Commission is styled on a US-model.

Meralco's system loss caps were introduced in 2003 at 15% and reduced to 9.5% in the following year. The cap has remained at 9.5% since 2004 until the present day. The results achieved in 2007 suggest that the cap has been effective in making sure that Meralco has been incentivized to achieve sustained reductions in electricity pilferage.

In 1986, Meralco experienced an all-time high total loss level of 21%. By 2004, Meralco had reduced losses to a level of 11.1%, of which technical losses were estimated at 7.44% and non-technical losses at 3.66%. Nevertheless Meralco had to write off about 1.5% of all electricity purchased. At average generation and transmission charges in 2004, and Meralco's average energy purchase costs, this amounted to a loss of around PhP 1.8 billion per year or $30 million USD per year.

As Meralco had to pay this amount to the generators and the transmission company, it represented a direct reduction in profitability. In 2003 for example, Meralco's net profit margin was 4.1%. If the system losses had been recoverable, this figure would have been 8.8%.

System loss in 2006 was reported at 10.10% and 9.65% in 2007, the first time single digit loss figures had been achieved. This result was largely brought about by increasing the emphasis on improving the timing and quality of the work of apprehending crews. Most of the apprehensions conducted were triggered by the information provided by concerned citizens anonymously through Meralco's website, telephone, and sometimes directly to an email address dedicated to anti-pilferage reports.

Loss Reduction Measures

Meralco categorizes its tactics according to Deterrence, Detection, Apprehension, Monitoring and Recovery.

Deterrence programs have centred on surprise off-cycle reading of large customer meters as a check against on-cycle reads, and saturation drives for high loss circuits wherein inspections are carried out at random and on regular basis.

Meralco has been able to reduce the level of non-technical losses by focussing on large customers and on illegal connection 'communities' (close-knit villages).

For the large customer segment Meralco regularly employs the following approaches:-

- Amnesty;
- Off-cycle readings & analysis;
- Random inspection;
- Use of check meters;
- Elevated meters (sometimes with high voltage barriers);
- Metal casings for meters; and
- 24-hour security guards.

For illegal connection 'communities' Meralco has tackled non-technical losses with support from local officials through a Memorandum of Agreement. The MoA recognizes that local area officials have influence over the attitudes of local people and covers a range of activities designed to regularize electricity consumption:-

- A Certificate of Electrical Inspection (CEI) program was facilitated by the city government;
- Local Area officials helped in the handling of delinquent accounts and reporting of illegal connections;
- Local Government and Meralco collaborated in the design and financing of load-side wiring to ensure that customers did not bypass the meter at the point of connection;
- Local Area officials helped Meralco conduct information campaigns designed to educate customers on how to applying for legal electric service, and the impact of pilferage on the community and electricity rates;
- Meralco partnered with government institutions and NGOs to create community-based long-term solutions (e.g. lifeline assistance and short term credit arrangements); and
- The local city government facilitates police assistance in apprehension.

Anonymous Reporting Hotline

Meralco has established a program for curbing electricity pilferage known as Kuryente Watch. Kuryente means 'electric current'.

A cornerstone of Kuryente Watch effort includes a public service educational campaign to make customers aware of the dangers of power pilferage to lives and property. The program is a campaign that encourages customers to legalize their electric connection, and a drive to rally support from citizens and local government units in fighting pilferage.

Kuryente Watch uses television and radio advertising, and signage to promote customer awareness. The campaign uses branding to support customer recall.

Meralco has established a text messaging facility for customers and an email facility (that can also be accessed on their home page) for customers to report suspected pilferage. The email facility is easy to remember - stoptheft@meralco.com.ph

Support from the Law

The legal position of the utility is governed by the Republic Act No. 7832. This Act is known as the "Anti-electricity and Electric Transmission Lines/Materials Pilferage Act of 1994."

The Law:-

- Penalizes the pilferage of electricity and theft of electric power transmission materials;
- Specifies prima facie evidence and the manner/basis of computation of differential bill, surcharge bill, other penalties; and
- Rationalizes system losses by phasing out pilferage losses through introduction of caps.

The penalties are imprisonment from 6 years and 1 day up to 20 years, and/or payment of a fine from PhP10,000 (USD200) up to P20,000 (USD400). The offender must also pay for the corresponding amount of the full cost of the electricity stolen.

In practice Meralco cannot prosecute electricity thieves unless they are caught in the act of placing or removing illegal wire taps. The law provides a protection to the poor. Consequently Meralco has resorted to night patrols and utilizes night vision cameras to take photographs of customers removing illegal taps when the alarm is raised that a Meralco vehicle has entered the village area.

Organization

Meralco has appointed a Senior Executive to head their Revenue Protection Department. This person reports to Meralco's Asset Manager and is accountable for non-technical loss reduction strategies. Management have placed a weighting of 16% on their performance measure for non-technical loss reduction. In their 'performance scorecard', this measure has almost twice the weighting of any other performance target, whether financial-, customer-, process- or people-related.

The Revenue Protection Department is focussed on the detection of tampering of meters and metering installations at large users premises whether by employees/persons/electricians. Their target is 24 cases per annum.

The Operations Sectors (10 sectors) are focussed on prevention of illegal wire taps and domestic meter tampering.

Overall Meralco has reported to the Consultant that 25% of their labour effort is focussed on loss reduction.

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ii. PLN, Indonesia

State Electricity Company, PT PLN, has suffered from moderate levels of T&D system losses. The level of theft is not as high as might be expected from Indonesia's 2007 PPP per capita figure of 3400. This is because there is an affordable social tariff that meets the needs of the poor, and PLN does not connect rural customers until there is sufficient economic strength to ensure that customers can meet the social tariff obligations. The greatest problem faced by PLN is theft in the large user segment.

III-2 PLN T&D Loss Statistics

Year	Total T&D Losses	T Losses	D Losses	Reason for Change
1999	12.22%			
2000	11.65%			
2001	13.52%			
2002	16.54%			Sharp increase due to tariff rise
2003	16.88%			
2004	11.29%	2.33%	8.96%	A reduction of such magnitude suggests a measurem ent error
2005	11.54%			
2006	11.45%			

PLN has focussed on electricity pilferage associated with large consumers with supplies greater than 200kVA. PLN relies on raiding tactics carried out with the support of the metropolitan police.

In 2003, PLN launched an operation in the capital city's industrial areas over a period of two months. The company brought charges against 235 customers, mostly industrial companies, in Jakarta and Tangerang for stealing electricity and inflicting financial losses of up to Rp 11.5 billion (US$1.35 million). A further 287 companies were raided. In this case the operation was a joint effort between PLN and the city police and had the full support of the Government (as owner of PLN).

The thefts were found to be mostly accomplished by slowing down the rotation of the meter or through the placement of a metal strip in the meter to prevent the recording of power usage. The consistency of the methods suggested to PLN that these methods were promoted to large customers by an individual or team with specific knowledge of meter tampering methods. Suspicions fell upon PLN staff, particularly meter readers, who learned the specifics of such methods when trained to detect meter tampering. PLN is particularly wary of the potential for meter readers to promote illegal practices and conducts independent random audits to ensure that meter readers operate within company policy guidelines.

PLN is also promoting anonymous reporting hotlines to fight power theft, and offers rewards for anyone who reports theft. The reward is in the form of cash equal to 3 percent of the total arrears collected from the party charged with theft.

PLN shifted the responsibility for street lighting payment to local Government due to a serious problem with illegal street lighting connections.

Support from the Law

Electricity pilferers face criminal charges under Law No. 20/2002 on electricity, as well as civil law charges.

Article 34 sets out the rights and obligations of customers. Electric power consumers are obligated to "pay the prevailing subscription fees or electric power rate in accordance to the stipulation or agreement".

Article 34 supports PLN in prosecuting offenders, however the courts have been generally reluctant to jail offenders and power theft has been dealt with by fines.

iii. Jamaica Public Service Company

JPS's total system losses in 2007 were 23.2%.

Of this figure, JPS estimates that technical losses are around 10%. This level of non-technical losses is considered by the World Bank to be comparable to that of a number of countries within the development strata in which Jamaica is ranked.

The contributory factors to losses of this nature are many and complex. Jamaica's less than robust social and economic environment over the past two decades have fostered conditions conducive and encouraging to electricity theft. Simultaneously, weak state law enforcement and several deficiencies in JPS's business operations have created opportunities for such losses that have been increasingly exploited.

Contributory factors include:-

(a) Social & economic

- Ten-year economic depression;
- High rate of unemployment;
- Generally high crime rate;
- Weak law enforcement;
- Relatively low penalty/fine for electricity theft; and
- Garrison communities phenomenon.

(b) Business Deficiencies

- Past unavailability of meters resulting in direct connections;
- Collusion by field operatives (company and contractor);
- Weak internal controls over adjustments to accounts;
- Deficient record keeping;
- Weak audit procedures; and
- Improper accounts set-up.

(c) Network access

- Large stretches of un-insulated secondary network offering easy access;
- Unsealed Meters; and
- Exposed, energized terminals when meters are withdrawn from service.

In Jamaica, audits have shown that the non-technical component of system losses is generally due to factors fully within the utility's control. These factors are as follows:-

- Polarity reversal of a current transformer (CT) in a three phase system during installation will result in only 30% of energy consumed being recorded on the customers' meter;
- Improper set up of accounts contribute to significant losses, e.g. a multiplier entered as 60 instead of 600, will result in an account being billed for only one-tenth the actual demand \ consumption; and
- Potential transformers (PT's), current transformers (CT's), and meters which become defective while in service are also major non-technical loss contributors.

An analysis of the Company's non-technical loss profile yields the following:-

III-3 JPSC Non-Technical Loss Causes

Throw-Ups	5.2%
Other theft	0.8%
Defective equipment	3.0%
Incorrect installations	0.3%
Improper account set up	0.2%
	9.5%

Dis-aggregation into the above categories was based on prior analysis of the throw-up phenomenon and statistical data

arising from various audits.

The company pursued a "carrot and stick" strategy in its effort to control and reduce commercial losses. These initiatives were organized in three primary areas:-

- Removal of illegal connections (throw ups);
- Tightening of internal controls (including audits of large accounts); and
- Conversion of illegal users to legitimate consumers.

In 1999, JPSC established an integrated Loss Reduction Division (comprising up to 72 persons) in an effort to reduce system losses from the then prevailing level. In spite of the Division's diligent efforts, the anticipated reduction in losses was not realised.

A further re-organisation of the loss reduction effort was implemented at the beginning of 2002 following privatisation of the company. The primary objective of the re-organisation was to place greater emphasis on the removal of throw ups, the greater part of the overall problem, and, at the same time, again make core business units more accountable for activities closely aligned with their respective activities.

(i) Removal of throw-ups

Illegal "throw-ups" (wires thrown up and hooked onto the company's open, low voltage, secondary conductors) remain the most visible, obvious and public manifestation of non-technical losses. They were also the most prevalent form of electricity theft. In terms of individual energy use this mode of electricity theft ranks a distant second to other more sophisticated versions of illicit abstraction, such as meter bypasses by commercial enterprises and large residential customers in its impact on energy losses. Nevertheless, as can be seen from the analysis, cumulatively throw-ups account for the lion's share of non-technical losses and the company has historically placed great emphasis on this mode of electricity theft in its system loss reduction initiatives.

In excess of 30,000 illegal connections were removed from the system allowing for a theoretical, monthly reduction of 4,500,000 kWh of monthly electricity production.

This figure was derived from past efforts which identified and quantified the extent of non-technical losses within inner city "garrison" communities. Master meters were installed at the entrance of several of these communities that were devoid of any legitimate consumer. The number of "throw-ups" within the communities being used to steal electricity was counted yielding an average consumption of just more than 100 kWh per month per "throw- up".

(ii) Tightening of internal controls

One of the clear weaknesses identified in an early management audit consequent on the change of ownership of JPS was its poor internal controls. This presented abundant potential for revenue leakage. Such leakage would be most readily obvious, verifiable and of greatest revenue impact in the large customer rate categories. Audit of these accounts was therefore considered an effective strategy for loss reduction.

The effort resulted in more than 90,000 accounts investigated and close to 30,000 defects corrected yielding more than 2,000,000 kWh of incremental, monthly billing.

(iii) Gentle persuasion

The third axis of the Company's strategy was a campaign to convert illegal consumers into customers. This it attempted to do through a community outreach programme working in conjunction with local political leaders. Inner-city communities, and in particular those identified as "garrison" communities were offered assistance in regularizing their electricity supply in exchange for a minimum number of residents signing on. In an effort to reduce losses, recover some revenue from these consumers, and transition to the normal applicable residential rates a flat rate tariff was introduced in several communities. The flat rate was set at an effective level approximately one-half that of the normal residential rate.

While this effort succeeded in legitimising about 1,600 consumers, it was not particularly successful as only a handful of these consumers consistently honoured their commitments.

Given the extremely volatile nature of many of these communities, the normal enforcement mechanism (disconnection of delinquent accounts) could not be routinely employed, thus weakening the "stick" element of the strategy.

The 2002 organisation refinements were aimed at ensuring past deficiencies were more aggressively addressed.

Audits

Audit of large (R50, R40 and select R20) accounts were assigned to the Internal Audit Department. Their mandate was to ensure all R50 and R40 accounts were audited within three (3) months of being set up and annually thereafter. The purpose was to identify and correct record keeping deficiencies (incorrect billing multipliers), meter defects, etc.

Audit of R20 accounts was to be accomplished every five (5) years. Audits were meant to not only ensure meters accurately recorded energy consumed but also that correct potential and current transformer data were used for billing.

Progressive audits of R20 installations and audits of select apartment complexes, comparing cumulative, billed energy consumption to consumption recorded by a temporary master meter aided in detecting concealed by-passes yielding further system loss reductions.

These audits identified a number of issues that had not been previously noted. In several instances, defects issued for correction had not been acted upon due to a deficiency in the communication protocol.

Meters

The meter ordering and supply process was improved avoiding the need to temporarily connect customers without a meter.

Improvement in the meter control process, particularly at customer service centres, was implemented to minimize the risk of meters being withdrawn from stock and installed without proper authorisation. Particular attention was given to the timely return of meters to the Meter Department after withdrawal from service.

A large number of installed meters were unsealed. Most disconnections by the Company were performed by contractors but they were not previously entrusted with disconnection seals. The Customer Service Department undertook to issue seals to contractors and ensure such issues were strictly accounted for.

Projects were undertaken by the Customer Service Department to ensure all in service meters were 'legitimised'. In the first project, withdrawal of each meter, inspection of meter socket internals for shunts and meter testing prior to reinstallation and resealing was undertaken. The process was aborted without being concluded due to the extreme length of time taken. In the second project meters were simply re-sealed. The sealing of meters without inspection risked the possibility of some by-passes being 'legitimised' behind a company seal but JPS decided that leaving meters unsealed facilitated meter removal and re-installation without detection with far greater potential for theft losses. The Customer Service Department rigorously reviewed field inspections and

corrections to advancing meters reflecting significant (>100 kWh) monthly consumption etc.

Persistence & Prosecution

While just less than half of the non-technical loss component of system losses was due to the conditions mentioned above, the remainder was due to approximately 150,000 highly visible 'throw-ups' providing service to structures primarily within informal, inner city communities.

Because of a perception of lack of consequences associated with this practice, the phenomenon infiltrated many formal middle-income communities. A much higher profile was given to the removal of the throw ups. Several of the raids received coverage by both the electronic and print media. Arrest and imprisonment of persons responsible, were pursued to remove the perception of lack of consequences. Additionally, in past times, areas were likely to escape being raided more than once a year. Individuals therefore restored throw-ups shortly after a raid with little chance of being disturbed for another year. The focus was changed to not only arrest and prosecute individuals for theft, but to also conduct repeated raids into areas to remove the feeling of comfort. The logic for this approach was based on an expectation that the stigma associated with the risk of arrest, fines, imprisonment, etc, would cause individuals involved in more sophisticated means of pilfering of electrical energy to desist.

Several individuals, including commercial customers, were arrested, convicted and fined under this new thrust.

In some areas the “throw-up” phenomenon appeared largely due to less than satisfactory socio-economic conditions. In others the problem appeared to be primarily due to prevailing attitudes of lawlessness.

In addition to continued vigilance and enforcement of the measures outlined earlier, one of the primary strategies pursued by the company was to forge a broader coalition of forces for a renewed thrust at reducing commercial losses. At the centre of this renewed effort was an acknowledgement that many of the factors driving the growth of non-technical losses were outside the ability of the Company to control or influence. JPS therefore initiated a multi-sector, multi-prong approach canvassing support from the regulator, civic society, the political directorate, Commerce Chamber and the media.

Specific initiatives included:-

- Enhanced collaboration between the Company's senior management and a number of senior government officials, viz Minister of National Security, Attorney General, and Opposition Leader to secure support of the political leadership for the Company's effort to reduce, if not eliminate, this aspect of lawlessness which is presently prevalent in the country;
- The Securing of a Parliamentary commitment to introducing tougher penalties for electricity theft in new electricity laws being drafted; and
- Closer ties were forged with law enforcement agencies to ensure adequate security protection was available to afford safe passage into and out of garrison communities to address theft problems. This measure alone was estimated to reduce total system losses by up to 2.0% (from 18.6% to 16.5%).

JPS continued to be affected by increases in world oil prices, which resulted in an overall 20% increase in the cost of fuel purchased by JPS during 2006, with very little expectation of a reduction in the near future. The increases in fuel costs had a negative impact on energy sales and directly contributed to an increase in the company’s electrical losses, as more customers turned to electricity theft.

The gains in 2005 were effectively wiped out with the total system losses moving from 21.2% on average in 2005 to 22.9% in 2006. JPS once again intensified its efforts to reduce the theft of electricity. JPS carried out 138 arrests, audited 13,000 accounts; removed over 7,000 throw-ups; and recovered approximately 9GWh or J$100.5 M in retroactive and forward billing. The company also implemented an Amnesty Program which offered illegal users a 30-day grace period within which they could regularize their accounts with the company. This program resulted in the addition of approximately 5,000 accounts to the system.

The company implemented a Losses Stand – Down initiative. The program included sealing and barrel locking meters, repairing open circuits, replacing defective wires and auditing meters which showed zero readings and other irregular activity.

As part of efforts to get the public involved in the fight against electricity theft, JPS also introduced a new all-media campaign that successfully highlighted the legal consequences of stealing electricity while increasing the public’s awareness of the safety implications of this illegal practice.

The investigations and analyses were undertaken during the year, as well as the introduction of a Customer/Feeder Mapping project, which set the stage for a more intense loss reduction programme in 2007.

In 2007, JPS started to see some tangible results. Despite the continuing upward trend in world oil prices, which inevitably meant that customers paid more for electricity, JPS saw that the growth of electricity theft, had slowed, thereby reversing the trend of the previous five years. Overall, losses for 2007 went up marginally by 0.07% from 22.9% in 2006 to 23.2% in 2007. This result compared favorably to an average increase of 1% annually during the previous five years.

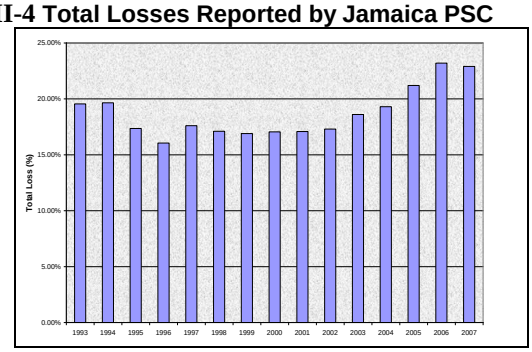
During the year, the Company achieved notable successes with the discovery of several outstanding cases of theft among large business customers. This was the direct result of a concerted effort to focus more resources on the detection of theft and other anomalies among large customers, even as the Company continued to focus on theft among residential users.

In 2007, JPS made 34 arrests, audited 15,000 accounts, removed over 25,000 throw-ups and recovered approximately 49GWh or J$494 million in retro-active and forward billing.

In the last quarter of 2007, the company introduced an Advanced Metering Infrastructure (AMI) program for priority commercial customers. This program significantly improved the company’s ability to monitor customer consumption on the backbone grid on a real time basis, thereby significantly improving JPS’ ability to detect non-technical losses. The first phase of the programme started in April 2008, while the second phase is planned for completion by April 2010.

Despite the considerable efforts made by JPS over many years, the company maintains that electricity theft is a matter that requires national attention from all stakeholders – the Government, the police, social welfare groups, community leaders, influential members of the society, and religious organizations. The company positioning is that the stealing electricity is a criminal act that cannot be tolerated and has significant impacts on all honest stakeholders.

III-4 Total Losses Reported by Jamaica PSC



iv. Russia & Eastern Europe

The problem of non-technical losses is known to be significant in Russia and Eastern Europe. The problem is reported to be most acute amongst industrial customers in Russia and at the domestic level in Eastern Europe; however the problem exists at all levels in both countries.

It is reported that the utility companies in these areas resort to 'communal' metering whereby customers are allocated a share of the total bill according to individual customer metering. Should an individual pilfer electricity it will result in the remaining members of the 'community' paying more than their fair share of the 'communal' electricity bill. The utility publishes the payment allocated to each household so that the community can determine whether the allocation is equitable. Communal metering results in pressure on individuals to shoulder their responsibility as neighbours are less likely to be deceived by pilfering than utility staff. The utility company is indifferent if theft occurs beyond the point of the communal metering and the responsibility falls with community leaders or community support groups.

v. Electricity de Caracas, Venezuela

La Electricidad de Caracas (EDC) is an integrated utility, electricity and light provider in the Caracas metropolitan area, Vargas and Miranda and part of Aragua and Yaracuy states of Venezuela, with a population of about six million.

The company was acquired by AES in 2000, but was subsequently nationalised by the Government of Venezuela.

It is estimated that over half the population in the metropolitan area of Caracas lives in barrios (shantytowns). Most of these barrios are located on hills above the city. Few of their residents have a legal title to their property, which meant in the past that they could not get connected to the electricity grid. EDC had installed electrical lines in the barrios at the order of the municipal authorities, but as many people could not formally access the electricity, they started connecting illegally to the street lamps.

This soon resulted in a sharp increase in EDC's financial costs, exacerbated by the fast population growth of the barrios.

In 2000, the year AES acquired EDC (hereafter AES-EDC), non-technical losses attributed to electricity theft were estimated at 12% of energy produced, rising as high as 18% in 2004.

This level of losses was considered high even by developing country standards. In 2005, electricity losses represented some US$ 35 million in lost revenue. At the same time the number of accidents due to unsecured illegal electric connections increased steadily. It therefore became crucial for AES-EDC to find a remedy to this situation.

In 2003, AES-EDC launched the Barrio Eléctrico (Electric Shantytown) to turn illegal consumers of electricity into customers. This management initiative was conceived as an intervention favouring interaction among the community, the government and the company, with community empowerment at the core. Through the initiative, the company aimed to:-

- Reduce non-technical losses attributed to electricity theft thereby restoring the financial situation of the company;
- Convert illegally connected consumers into paying customers;
- Increasing reliability and security of electrical connections; and
- Improve quality of life of the concession area neighbourhoods.

Addressing the question of turning illegal consumers of electricity into customers required AES-EDC to undertake a learning process that involved organizational changes and abandoning old attitudes towards low-income consumers. The company's conservative management style and engineering focus had made it shun away from customers lacking property titles and it did not leave room for innovation in product service. Energy was supplied to areas of the city whose urban development had been approved by the municipal authorities, and was only extended to unplanned communities when those authorities commissioned the installation of the power lines. For a customer to arrange for the installation of a meter on his home to obtain electricity, he had to go to the company's offices, present a property or lease title, request the service and make a deposit.

The organizational change within the company started from the bottom up: the electricians and field crews confronted the situation in the barrios on a daily basis, where they were known as "cable cutters" because all they did was untangle illegal connections. The company's management realized that employees in lower levels had family or knew people in the barrios and understood life in those places much better, so it organized management meetings at all hierarchical levels to bring together executive managers and low- and mid-level employees. This spurred the change in organizational culture that was the prerequisite to start thinking about customer relationships in poor areas.

Operationally, the company radically changed its approach to power installation, billing and collection procedures, and it recruited a team of 20 social workers to build up a relationship with the communities in the barrios. The company soon learned that low-income consumers actually wanted a better supply of electricity and reliable street lighting to reduce crime. After initial hostility to the concept of paying for electricity, communities soon realized the benefits of stable power supply that would be gained from it.

After interventions in some barrios and as a result of initial interactions between community people and company relationship staff, the company developed an integrated solution consisting of the following initiatives:-

- Installation and consolidation of electricity roundtables (Mesas Electricas);
- Improvement of the public lighting system;
- Installation and maintenance of pre-paid meters;
- Installation and maintenance of collective meters;
- Creation and consolidation of electrical cooperatives (Coopeléctricas);
- Establishment of authorized community commercial agents; and
- Training of community leaders: leadership courses.

A pilot project was launched in 2003 in Barrio La Morán, a low-income community populated in the 1980s in the hillsides

of Caracas with some 1,200 dwellings housing approximately 20,000 people. Previously, support to La Morán had come from church-organizations. But the barrio had no sewage system or running water. Nor did it have roads wide enough for vehicles. Access to the terraces where dwellings were located was by foot. The barrio was known for its community leadership, and the company managed to overcome its bad reputation as "cable cutters" through the initial organization of "electricity roundtables". The role of the social workers the company hired was the key to building up a relationship with the communities. After the goal of the pilot project was explained, 300 of the 1,200 dwellings were selected for a six-month follow-up, and they were assigned a rate of less than US$ 1.50 for the first 200 kWh used. In 2004, AES-EDC decided to introduce a pre-paid power card similar to the type used to pay for mobile phone services. First, it had to persuade community members that it was worth paying for electricity rather than stealing it. Then it had to remove the illegal wires that linked each dwelling or workshop to a lamp post and replace it with meters in each of the 300 households. And the company needed to obtain authorization for the pre-payment system and tariff approval from the regulatory authorities, which was never obtained.

After its initial success based on the relationship between both parties in La Morán, the company went on to remove the tangled network of illegal cables in other barrios. On its first visit to a barrio at the outskirts of the city, the company team was received by residents with pistols in hand. Thanks to the intervention of community leaders and the expertise of social workers in interacting with the inhabitants, the goal of the visit was explained.

The team learned that the more distant huts were receiving less power and had to ration electricity, limiting the number of television sets that could be operated during the broadcast times of the most popular soap operas. With the removal of the illegal cable tangles, the service became more reliable and the repair costs of appliances damaged by power surges decreased. Customers with meters now had the opportunity to operate electrical equipment that required a stable electricity supply.

For the poorest consumers who could not afford an individual connection, the company installed collective meters, for which groups of people were made responsible collectively.

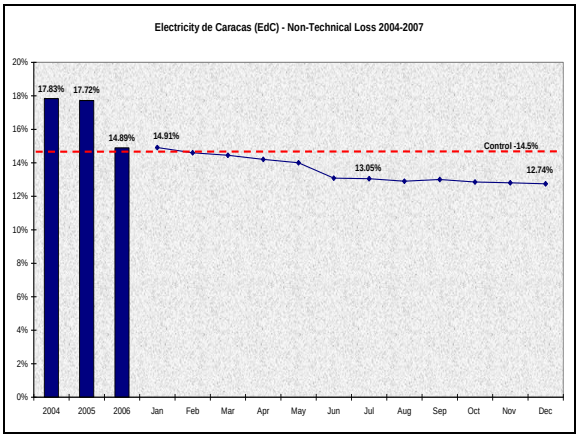
Thanks to community leaders, the company was able to identify residents who would assume responsibility for each collective meter. The company empowered such residents to coordinate the payment of bills and disconnect those who did not pay. The company also allowed certain payment delays for the poorest customers with irregular incomes before proceeding to disconnect lines. Also, to incorporate new customers in some barrios, the company installed individual meters with limited electricity.

Through its Barrio Eléctrico initiative AES-EDC managed to build up a positive reputation in communities once hostile to its personnel. It reduced the numbers of barrio residents considering free electric power as their right.

In commercial terms, electrical losses due to electricity theft decreased from around 18% in 2004 to around 15% in 2006, which represented a saving of around $6 million. Further gains were recorded during 2007 with the non-technical loss level falling to a national record of 12.74%.

Furthermore, communities that had previously helped themselves to free electricity became paying customers, potentially broadening the company's market in the future. In 2006, formal electric service user coverage was increased by 110,000 to 460,000. Electricity roundtables (176) were established, 300 pre-paid meters were installed benefiting 1,200 people, 233 collective meters were installed benefiting more than 11,000 people, two electrical cooperatives were established with some 8,400 clients incorporated, and 22 authorized communities commercial agents collected about US$ 15,000 per month, and 257 community leaders were trained in 16 communities and 12 institutions.

III-5 Electricity de Caracas Reported Non-Technical Losses



The initiative had further social benefits, including the removal of dangerous conditions from a lack of street lighting in many communities. Accidents related to the misuse of electrical installations decreased. Crucially, barrio residents who formerly had no access to the banking system were now eligible, since a utility bill with name and address was accepted to open a bank account. Huts that had been covered with cable tangles were cleaned and freshly painted. And the improvement of relations with the company also left communities more empowered.

AES-EDC found that communities had perceived it as a distant company, creating an attitude that electricity pilfering by poor communities did not have the attention of the company. AES-EDC realized that they needed to become more visible presence by bringing the community and the company together. The company identified the needs of poor consumers and created service offerings of greater flexibility. The poorest dwellings were provided with collective meters, and trusted residents became payment coordinators. Barrio residents were not required to present a property title, an identification document was sufficient to qualify for connection to the power grid.

After its first initiative in Caracas, AES implemented this model in Brazil. AES consider that the first and most important step is to understand the particular necessities of local communities as well as the reasons why illegal connections are made and why some areas are not served. AES considers that the use of social workers and of the company's field crews of electricians is crucial for the company to become a close and active partner of these communities.

vi. Other Latin American Countries

The Argentine and Chilean Governments included technical loss-reduction targets in the concession agreements for newly privatized distribution companies. In contrast, the Brazilian Government did not establish loss-reduction targets for newly privatized distribution companies. The distribution companies were allowed to pass through the full quantity of power

purchased. In early 2003, for the second, multi-year tariff period of two distribution companies, the Brazilian Regulator established loss-reduction targets rather than just accepting the full quantity of power purchases.

vii. India

The non-technical losses of Indian State Electricity Boards are estimated to be as high as 40% - 50%.

Historically, families in India's poorest neighbourhoods could only receive electricity if the household proved legal residency and guaranteed that it could cover the cost of distribution. But very few poor households could prove ownership and even fewer could raise the upfront costs of connecting to a grid. About 40 percent of homes in poor neighbourhoods have illegal power connections, but the supply is unreliable and costs twice as much as a legal connection. The estimate of 40% energy losses is based on the count of illegal connections in such neighbourhoods.

Law:-

In July 2000 the state government amended the Indian Electricity Act of 1910 to make electricity theft a cognizable offence and impose stringent penalties. A separate law, unprecedented in India, provided for mandatory imprisonment and penalties for offenders, allowed constitution of special courts and tribunals for speedy trial, and recognized collusion by utility staff as a criminal offence.

Advance preparations ensured that the Government was able to constitute special courts and appellate tribunals as soon as the new law came into force. The utility service areas were divided into 24 “circles” coinciding with the state’s 24 administrative districts. A special court and police station were established in each circle to ensure rapid detection and prosecution of electricity theft. And the state police and anticorruption units of other Government Departments were directed to support utility employees in inspections to control theft.

In addition, consultations were held with labour unions about the proposed legal provisions for making collusion by utility staff a criminal offence. Assurance that old cases would be excluded under the new law helped secure the unions’ consent to punitive action against staff caught colluding in theft. Disciplinary action was taken against 218 employees and criminal cases launched against 87 employees involved in stealing electricity and misappropriating funds and materials. In the first three years after the law’s enactment the authorities pursued more than 150,000 cases, compared with 9,200 in the previous 10 years, and arrested more than 2,000 defaulting customers.

The Government’s political resolve to combat theft was tested when some politically powerful people (including a member of the legislature) were charged with electricity theft. The cases went forward, and the proof that even the most powerful were subject to the new law, and that utility officials would be protected from interference, generated broad support amongst the public as well as utility employees.

The Electricity Act 2003 gave full freedom to vigilance engineers in detecting power theft, confiscating machineries, papers, document related to production etc. and permitted utilities to frame their own rules. However the effectiveness of this law has been reduced as the States have not created matching legislation to empower the State Electricity Boards.

Theft Control Program:-

The Government also initiated institutional changes in the utilities. Their anticorruption department was strengthened by promoting its head from an advisory to an executive position on the board, and the organizational structure was modified to strengthen the department’s coordination with other departments. In addition, the anticorruption department’s procedures were made simple and transparent. Inspecting officers provide an inspection report with an identification number to customers on the spot and carry numbered receipts so they can accept payments of fines. Police stations provide public notification of all theft cases. A tracking system followed the progress from inspection to payment of fine or prosecution. More than 2,000 inspection teams were deployed throughout the state to launch the theft control drive.

The Government launched a communication program through media ads, posters, and videos, and a public outreach program through visits by special teams and regular public meetings with utility managers. The outreach campaign deployed about 600 teams to conduct town hall meetings in all settlements with more than 200 residents. The teams informed people about the proposed new law and the penalties for electricity theft and gave everyone the opportunity to obtain an authorized connection on the spot after paying a connection fee. They also explained the utilities’ deteriorating financial situation and the effect of electricity theft on their costs and tariffs.

In the initial phase the theft control program focused on high-value customers. Dedicated feeders were constructed to supply large industrial customers, which were also provided high quality, tamper-proof electronic meters, and protective boxes were installed on transformers.

Meter reading instruments were provided to inspection teams to download monthly data, allowing analysis to identify customers whose monthly consumption varied by more than 2 percent. Irregularities in metering and billing were found for about 15 percent of the 23,000 industrial connections—and 10 percent of the 36,000 commercial connections—inspected in 2001. In many cases it was determined that the electricity theft was not for direct monetary gain. In certain industries, the excise duty, sales tax, etc. was determined based on the actual consumption of energy. In order to evade these expenses, some companies pilfered energy.

In the case of residential customers, inspections focused on 11-kilovolt feeders with high line losses and on 114 towns accounting for 53 percent of consumption and 60 percent of revenue.

Delhi Vidyut Board:-

On July 1, 2002, the Delhi government sold a 51 percent equity interest in each of three new distribution companies that had been created out of DVB, the state-owned enterprise that had served the metropolitan area. At the time of privatization, DVB was a sick enterprise. It had technical and commercial losses of more than 50 percent and receivables of more US$400 million. Consumers were unhappy with the DVB’s quality of service and the endemic corruption. For several years the Delhi government had been forced to prop up DVB with annual subsidies of US$200 to 300 million through loans that no one expected would be repaid.

The negotiated sale to BSES and Tata Power, two private Indian companies, was the first major distribution privatization after several failed efforts elsewhere in India.

When it appeared that the government’s efforts to privatize would fall victim to regulatory uncertainty, the Delhi government decided to issue a “policy directive” to the Regulator. The directive required the Regulator to accept realistic initial values for technical and commercial losses, and to adjust tariffs based on the loss improvement trajectory

proposed by the bidders and accepted by the Government.

Andra Pradesh Electricity Board:-

In 1999, the Chief Minister of the Indian state of Andhra Pradesh, decided that it would be impossible to privatize the state's power enterprises unless power theft was reduced. With the active encouragement of the Chief Minister, a strict Anti-Theft Law (the first of its kind in India) was passed by the state legislature and went into effect on July 1, 2000. The new law provided for:-

- A minimum mandatory punishment of 3 to 60 months imprisonment for the theft of electricity;
- Mandatory financial penalties ranging from a minimum of US$120 to a maximum of US$1, 200;
- Residents convicted of stealing electricity would be prohibited from receiving electricity for two years; and
- The establishment of special courts and tribunals to quickly try cases under the new law.

Before the law went into effect, AP citizens were given the opportunity to pay back bills and to "regularize" their status (i.e. to become legal customers if they were illegally connected or their request for legal service had not been processed). In a state of about 75 million people, about 1.9 million applications were received for "regularization." Once the grace period ended, the law was vigorously enforced. From July 2000 to April 2002, more than 2800 people were arrested for stealing electricity (including 87 utility staff and two members of the Legislative Assembly). Over an 18-month period, billings for electricity increased by 34 percent and revenues increase by 44 percent (while average tariffs increased by 15 percent). Nevertheless, the state-owned power enterprise still experienced major deficits because even with the increase in collections, a large number of agricultural and domestic consumers continue to be supplied electricity without metering and under tariffs that recovered only a small fraction of the cost to serve them.

In a random sample of Indian electricity consumers, about 30 percent reported paying bribes to employees of power enterprises. Usually, the bribes were paid to linesmen, meter readers and billing employees. This is probably an underestimate for two reasons. First, the survey was limited to individuals and therefore does not capture bribes paid by corporations. Second, it probably fails to capture consumer initiated corruption.

The total losses of the Andra Pradesh Electricity Board, losses were measured at 38% in 1999 and following the changes to the law were reduced to around 26% by 2003.

West Bengal Electricity Board:-

West Bengal, in common with much of India, has a large electricity theft problem.

The Board has introduced a program to replace LV reticulation with a high voltage network comprising long feeders and smaller transformers serving 2 or 3 customers each. These transformers are metered at the pole and customers are informed that any illegal taps taken off their service line will be recorded as part of their metered consumption. West Bengal reports that this approach has been highly successful in reducing electricity theft[2].They have also fitted permanent LV metering to 90% of their distribution transformers to allow assessment of the actual non-technical losses. These meters give 3 phase power readings on a half hourly basis which are collected by VHF transmission. The data provides information on overloads, line loading balance, and supports the identification of losses as the distribution substation demand can be readily compared to the metered demand.

viii. Turkey

Non-technical losses are generally lowest in the developed and urbanized districts, several of which have been privatized as part of the Government's ongoing program.

Non-technical losses in 20 Turkish regions were as shown below[3] in 2007: -

III-6 - NTL in Turkey for 2007

REGIONS	NTL %	Customers 2007 (m)
DQCLE EDAL.	64,7%	0,97
VANGÖLÜ EDAL.	56,2%	0,39
ARAS EDAL.	29,4%	0,70
ÇORUH EDAL	12,0%	0,97
FIRAT EDAL	11,0%	0,65
ÇAMLIBEL EDAL	8,8%	0,72
TOROSLAR EDAL	9,8%	2,51
MERAM EDAL	7,9%	1,48
BASKENT EDAL	8,7%	2,95
AKDENQZ EDAL	9,3%	1,40
GEDQZ EDAL	8,6%	2,29
ULUDA` EDAL	7,3%	2,21
TRAKYA EDAL	7,9%	0,74
AYEDAL	9,4%	1,98
SAKARYA EDAL	6,2%	1,27
OSMANGAZQ EDAL	6,3%	1,24
BO`AZQÇQ EDAL	12,5%	3,72
MENDERES EDAL	7,0%	1,44
GÖKSU EDAL	8,0%	0,47
YELQLIRMAK EDAL	9,1%	1,44
Average	**14,8%**	**29,52**

Initiatives to improve the situation commenced in 1996 but attempts to "privatise" the problem have stalled repeatedly for legal and political reasons. In addition, although the non technical losses are due to all of the "conventional" reasons, including untidy low voltage networks, unsupportive legal systems, meter tampering, poor billing systems etc little progress has been achieved in reducing NTL's due to a lack of institutional strength and poor management of the state owned utilities.

The Republic of Turkey's Privatization Administration ("PA") initiated the privatization of Turkey's electricity distribution utility, Turkiye Elektrik Dagitim Anonim Sirketi ("TEDAS") in 2003. TEDAS is a Turkish State-owned joint-stock company engaged in the distribution and retail sale of electricity and provision of retail services to final customers. With approximately 29.5 million customers, 126 billion kWh of electricity sales and 98% market share in electricity distribution across Turkey in 2007, TEDAS and its distribution companies together form one of the largest organizations in the country.

Privatization of distribution companies will be executed using a Transfer of Operating Rights ("TOR") backed by a Share Sale model ("TSS model"). According to this model, the investor will be the sole owner of the shares of the distribution

[2] This approach means higher numbers of transformers with attendant technical losses. West Bengal has chosen to optimize non-technical losses even if their method results in higher technical losses.

[3] Privatization of Turkey's Electricity Distribution - Industry Republic of Turkey Prime Ministry Privatization Administration

company and will be the unique licensee for the distribution of electricity in the designated region without retaining the ownership of distribution network assets and other items that are essential for the operation of distribution assets. The ownership of these distribution assets will remain with TEDAS. The investor, through its shares in the distribution company, however, will be granted the right to operate the distribution assets by a Transfer of Operating Rights Agreement ("TOR Agreement") with TEDAS.

Under the envisaged market structure, privatized electricity distribution companies will operate as regional monopolies with distribution licenses granted by Energy Markets Regulatory Authority ("EMRA"). As part of ongoing liberalization efforts in the energy sector, Turkey's distribution network was divided into 21 distribution regions based on geographical proximity, managerial structure, energy demand and other technical/financial factors. After the inclusion of TEDAS in the privatization program, a separate distribution company was established by the PA in each one of the 20 distribution regions owned by TEDAS. The geographical coverage of the distribution regions are provided in the following map. Menderes EDAS has been excluded from the privatization program in 2008. The only distribution region operated by a partially private company is Kayseri (Region #18), whose operating rights were transferred to KCETAS in 1990.

According to the general principles as stated in the Electricity Market Strategy Paper1, Turkish Electricity Market has gone through a process of vast restructuring in core activities ranging from generation to distribution. Accordingly, a new tariff structure has been developed inline with the new structural requirements in mind.

The main purpose of the market liberalization is to achieve lower tariffs by increasing overall system efficiency. Accordingly, the tariffs are calculated as "cost-reflective" based on pre-determined operating and loss/theft improvement targets.

The first tariff implementation period (or transition period) has been set as the period from 2006 to 2010 to serve as the transitory period to fully cost based tariff structure after 2010. EMRA has already approved the end user tariffs and revenue requirements of each distribution company for the transition period. Revenue requirements cover the projected expenses for providing distribution and retail services and provide an allowance for the target level of technical and non-technical losses. The end-user tariffs for the period after 2010 will be determined by the distribution companies in accordance with the Electricity Market Tariffs Communiqué and the related regulations again in a cost-reflective fashion and will be subject to the Regulator's approval.

It remains to be seen whether this combination of privatisation incentives and tariff targets (with loss reductions phased over time0 will succeed in reducing NTLs. Indeed, the financial incentives will more than compensate the private investors for their efforts.

ix. Provincial Electricity Authority, Thailand

PEA determines the total system losses by subtracting the energy generated and purchased (system input) with the energy sold and provided to some consumers without charge (system output). PEA energy input in 2001 was 53,034 GWh or 53 million MWh. The total losses reported in 2001 amounted to about 2.5 billion kWh, or approximately 5.69%.

PEA undertakes inspections of meter and discovered incidents of meter violation – a key indicator of non-technical losses – between October 2000 and June 2001, amounted to a total of 130 violations for high-voltage meters, and 2167 cases for low-voltage meters. The total number of violations was very small compared to PEA's installed population of 11,400,000 meters.

III-7 PEA, Thailand HV Customer Violation Statistics

High Voltage Consumers (8 months of data)		
Violation Type	**Cases Found**	**%**
Tampering with terminal seals	69	54.3%
Tampering with meter seals	30	23.6%
Breaking control wires	12	9.4%
Shorting control wires	5	3.9%
Breaking the voltage taps	5	3.9%
Direct connections to grid	3	2.4%
Switching control wires	3	2.4%
Tampering with the meter	2	1.6%
Total	**127**	

According to PEA estimates, the 127 high-voltage meter violations found between October 2000 and June 2001 resulted in the recovery of 4,904MWh lost.

III-8 PEA, Thailand LV Customer Violations

Low Voltage Consumers (8 months of data)		
Violation Type	**Cases Found**	**%**
Direct connections to grid	677	31.2%
Using alternative neutral lines	541	25.0%
Phase-to-phase connections	270	12.5%
Meter tampering/ breaking meter seals	270	12.5%
Other	409	18.9%
Total	**2,167**	

PEA estimated the total losses recovered due to electricity theft at 8,000,000 kWh. This means that electricity theft found only accounted for about 0.32% of the total system losses or about 0.018% of the system's total energy input.

PEA has guidelines and policies for dealing with electricity theft, as shown in Table III-9 below. Table III-10 shows the inspection schedules for the group responsible for inspecting high-voltage (115 KV, 69 KV, 24 KV, and 12 KV) and low-voltage (loads with 380 V line-to-line) meters. The quantity of 220 V meters is too great to make a dedicated inspection effort, so the inspection workload for those meters goes to the unit-readers who are also trained to detect improprieties. Table II-1 shows the regular schedule for reporting and deadlines for analysing the data on electricity theft collected in the field.

III-9 PEA Policies for Billing Customers who Perpetrate Electricity Theft

Billing Services	Target Timeframes
Billing for fines, revised rates, and meter depreciation for large consumers	Within 7 office days of receiving results from the Evidence Department, the fines are sent out. Revised rates and depreciation bills are sent out within 15 office days.
Billing for fines, revised rates, and meter depreciation for small consumers	The revised rates and fines are both sent out within 7 days of the reports of damaged meters. If the fines and bills in items 1 & 2 do not elicit any response from the consumer within 3 months, the case is summarized and sent

Billing Services	Target Timeframes
	on to the legal department of the respective district office.

III-10 PEA Audit / Inspection

Audit / Inspection	Goal / Schedule (Inspection Cycle and % Inspected per annum)
PEA operations: • Reports for routine meter checks • Reports for meters with past violations and suspicious business groups • Major consumers with recent meter installation/changes • Results from checking large consumers with irregularities • Results from checking meters with zero unit reading • Results from fine and revised rates collections for large and small consumers	Reports of results in items 1 a) through 1 f) are to be submitted to the district offices for each month within the 7th of the following month.
Results reports for each district, combined with reports from item 1) above.	Every meter-checking activity results and results from fines/revised rates for each month is to be summarized and reported to the deputy head of each district. The deputy heads of districts then follow up and make necessary changes in operations and a report is submitted for each month to the Electricity Economy Department by the 15th of the following month.

The total amount of estimated recovered loss due to electricity theft in the period between October 2000 and June 2001, about 8 million kWh, is very small compared to the total losses of the system. The total losses of the PEA system is characterized by subtracting the energy generated and purchased (system input) with the energy sold and provided to some consumers without charge (system output), and the total losses amounts to about 2.5 billion kWh, approximately 5.69% of the system input. This means that the electricity theft found only accounts for about 0.32% of the system losses, or about 0.018% of the system's energy input.

x. EDL, Lebanon

In the post-war period, Electricity of Lebanon (EDL) was facing the consequences of a war that extended over approximately 17 years. Technical and non-technical losses were abnormally high and considered to be well above acceptable international standards.

EDL was experiencing difficulties in revenue collection management and in detecting illegal wire tapping. The company decided to develop their GIS systems (ESRI platform) and to use it to track collections and losses. The system depends on an energy map that supports real time capture of energy-related data.

Energy data is supplied from the meter reading database at each level of the distribution network, allowing for a reconciliation of energy-in and energy-out. The tool is reported to be effective in the management of collections, technical and non-technical losses as reports can be generated on monthly basis at any point in the distribution network.

xi. Guyana Power & Light, Guyana

Guyana Power and Light (GPL) reports the level of total distribution losses at almost 40 percent of the energy generated, well above the 13.5% cap set by regulatory authorities. The losses arise from a failure to enforce collection of bills, and to eradicate theft and corruption in under-billing of the service.

III-11 GPL Sources of Non-Technical Losses

Source of Non-Technical Losses	%
Electricity theft	11.0%
Defective meters	11.3%
Billing system errors	6.5%
Total	29.0%

The objective of GPL is to reduce total losses to 15.4% by the year 2010, made up of 10.3% technical losses and 5.1% non-technical losses.

GPL's strategy relies mainly on the threat of prosecution and removal of illegal connections as the level of non-technical losses is considered as extreme and there are elements of lawlessness within the community.

xii. Others

In more developed countries, the cost of electricity as a % of household income is relatively low. This leads to lower levels of electricity pilfering.

United States

The International Utilities Revenue Protection Association reports non-technical losses to be as high as 4%. This figure appears to be rather high for a developed country and may reflect a political agenda on the part of the IURPA.

Australia & New Zealand

Non-technical losses in Australia and New Zealand are reportedly low.

In 2006, Energy Australia reported a non-technical loss figure of 0.19% based on a rigorous measurement programme that assessed losses throughout their network.

Energy Australia conducted a major study into system losses which yielded a non-technical loss figure of 0.03% in 2005 and 0.19% in 2006, against total system losses of 5.01% and 5.23% respectively.

Energy Australia relies on a consistent flow of reports from staff and the public giving rise to investigation. Energy Australia uses approximately 150 compact recording instruments (theft monitors). These are installed in the street to check the meter readings at premises under investigation. In 2007, this process was expedited by taking special meter readings at such premises, allowing many checks to be completed in a matter of weeks rather than a full 3-monthly billing cycle.

In New Zealand, non-technical losses are considered to be between 0.3% and 1%.

United Kingdom

In the UK, utilities have reported non-technical losses to be in the region of 0.2% and 1%, i.e. comparable to the levels observed in Australia and New Zealand.

The United Kingdom Revenue Protection Association (UKRPA) responded to an Ofgem consultation (22 March 2003) with an estimate of 1 to 1.5%.

IV. SUMMARY OF NTL LOSS REDUCTION METHODS

The themes that emerge from a comparison of the practices employed in non-technical loss reduction around the world are as follows:-

xiii. Measurement & Estimation

All utilities measures 'top down' losses as the difference between purchased energy and energy sold. Energy Australia's study of losses provides an argument in favour of measuring losses on a 3-year rolling basis to remove seasonal variations.

All estimates of non-technical losses are based on the accuracy of the calculation of technical losses (assuming that administrative losses are accurately known) subtracted from an estimate of total system losses.

Some utilities measure energy sent out at intermediate points in the distribution network, e.g. at 33kV and 11kV substations and / or distribution feeders, and reconcile the energy against consumption recorded by electricity meters that are downstream from the meter location. The most common practice is to install metering at large substations on the high or medium voltage side.

xiv. Deterrence

Resource Allocation - Large users account for a high proportion of the revenue lost through theft, and revenue protection resources are allocated on the basis of revenue lost.

Large User Inspections – Inspections are made on random but frequent basis in order to create perception in the minds of large users that there is a high risk they will caught if they resort to electricity pilferage

Large User Off-Cycle Meter Reading – Off-cycle meter reading is undertaken on random basis to create a perception that temporary meter tampering (between normal cyclic meter readings) is a high risk activity

Community Programs - Pilferage tends to occur in close knit 'communities' where illegal behaviour becomes established as a cultural norm. This problem cannot be tackled by law enforcement alone as such attempts tend to draw the community closer together. Furthermore there is a general Government and community backlash against punishing poor communities. If the problem is dealt with by local officials and employees, who understand and have influence in the community, then a change in the attitudes of the community is more likely.

High loss circuits - High loss circuits are identified and targeted for inspections on a 'saturation' basis.

Billing Exceptions - Where billing exceptions suggest electricity pilferage is a possibility, the utility contacts the customer (by Call Centre outbound call is efficient) to ensure that the customer is aware that the utility is vigilant; this creates a perception within the community that there is a high risk of being caught if a customer engages in illegal pilferage.

Anonymous Reporting - Utilities provide opportunities for customers to report pilferage anonymously, through a hotline, and through an email link on the company's home page. It is important to emphasize that the identity of a person making such a report will remain anonymous. A relatively large number of pilferage cases are reported by disgruntled employees or during domestic arguments.

Pre-payment metering - has successfully reduced losses as in general these meters are more difficult to "tamper".

Communal Metering – Communities are metered at a single remote location (where tampering is difficult) and all customers are billed based on a consumption determined by pro-rating using their individual meter reading. This acts to deter offenders through direct community pressure.

Fines and Imprisonment – The law in some countries is not always prescriptive regarding the fine that a court can apply.

In the case of criminal prosecution, when charges are pressed and the police are involved, fines and jail terms may be determined by the court. Jail terms are usually a last resort that applies when the party found guilty cannot pay the fine.

When the amount of revenue loss is high, the utility pursues the customer in court and uses media connections to make sure that the details of the offences are reported in the press.

In the USA the law provides for strong penalties for electricity or gas theft. The grading and punishment is shown below: -

IV-1 Grading of Electricity Theft & Punishment, United States

Theft Amount USD	Maximum Fine USD	Max Prison Term
Greater than $2,000	Felony of the 3rd Degree with maximum fine of $15,000	7 years
Greater than $200 but less than $2,000	Misdemeanor of the 1st Degree with a maximum fine of $10,000	5 years
Greater than $50 but less than $200	Misdemeanor of the 2nd Degree with a maximum fine of $5,000	2 years
Greater than $50	Misdemeanor of the 3rd Degree with a maximum fine of $2,500	1 year

xv. Detection

It is common to find that dedicated employees are deployed in order to check large user metering and metering installations on a random but regular basis whenever electricity pilferage is having a significant impact on revenue. These staff are usually organized and trained under the aegis of a Revenue Protection Department. It is important that this "Department" reports at the highest level in the utility.

Meter reading staff may also be trained to detect the most obvious cases of meter tampering and illegal connections, but this is not observed as a best practice or even a widespread practice. In some countries such as the United States, Australia and New Zealand, the use of outsourcing has worked against this practice. American Electric Power (AEP) is one exception where meter readers are trained to detect meter tampering by the Revenue Protection Department. In developing and developed countries there are concerns regarding corrupt behaviour on the part of meter readers. In most cases meter readers are rotated to ensure that they do not develop close relationships with customers. (Internal auditors are sometimes used to check on meter readers – one

telltale sign is a meter reader who prefers not to take time off for fear that one of his 'customers' will inadvertently tip off the stand-in meter reader to any arrangement that is in place).

Detection of illegal connections in particular, and household meter tampering, is also dealt with by operations employees. The rationale for this approach is that these employees usually have links to the local community and social welfare groups. Once again there is a risk that employees may be tempted to make arrangements with domestic customers but this is less likely when these employees move about in teams.

Some utilities measure and provide incentives against employee performance through the use of kWh recovery targets or by the count of cases detected.

xvi. Apprehension

Apprehension of customers who pilfer usually involves the support of the police who conduct joint raids on customer's premises with the utility.

The law enforces the rights of the utility with respect to access for the purpose of inspection of wiring and metering installations and the utility takes advantage of their powers to protect their commercial interests.

xvii. Monitoring

Monitoring is undertaken through summation reconciliation of Grid metering, communal metering and metering at customers premises. Check or temporary metering is used to detect electricity pilferage.

Another important source of monitoring data comes from the billing and collection system. However it is not generally reported by utilities that low consumption or sudden reductions in consumption provide reliable indications of electricity pilferage. Utilities monitor meter advances and meter readers are used to report obvious signs of occupancy and / or electricity use in premises that have been disconnected.

xviii. Recovery

Recovery involves the customer paying for stolen electricity along with a fine commensurate with the amount of electricity stolen (as discussed under deterrence). It is also generally seen that a utility is able to recover the full costs of repairing meters, wiring, etc. The energy is estimated based on the customer's end use profile and the period of time over which it is believed that the energy has been stolen. The time period is usually determined from the historical billing pattern.

The current policy of the ERC is to allow JEPCO to recover the amount of the stolen energy + a 25% penalty + the cost of repairing meters, wiring etc. JEPCO estimates the amount of energy stolen in a consistent manner to that observed elsewhere.

xix. Utility Positioning

Utility positioning on non-technical losses is largely a function of the regulatory drivers and to some extent on ownership, i.e. Government versus investor-owned.

Where caps are applied to non-technical losses, it is evident that utilities focus effort on managing losses within the cap. In other cases, particularly where utilities are Government-owned, higher levels of non-technical losses are tolerated. In general however, there is a relationship observed between the level of losses and the manner in which the utility positions itself. The term positioning is meant to describe the attitude that the utility presents to external stakeholders.

For the most part utilities resort to legal means to recover lost revenue from commercial or industrial customers who engage in pilfering. The community is generally supportive of the utility prosecuting business owners willing to engage in electricity pilfering.

At the small consumer level however, utilities position according to the severity of the losses problem.

When non-technical losses *exceed 15%*, utilities send messages to the community that theft will not be tolerated and the full force of the law will be applied. The utility uses media coverage to highlight successful prosecutions, and offers rewards for information leading to prosecution.

The utility positions itself as an 'electric' police force.

When non-technical losses are *between 8 to 15%*, utilities send less stern messages to the community regarding theft and are more inclined towards developing joint solutions that meet the needs of disadvantaged groups. Prosecution remains an option, but emphasis is placed on cooperation between the utility and community.

The utility positions itself as socially responsible (assisting the disadvantaged while protecting the rights of honest customers) – a 'firm but fair' positioning.

When non-technical losses are *between 2 and 8%*, utilities act to recover losses and apply fines but do not take electricity pilferers to court unless they offend repeatedly.

The utility positions itself as vigilant and ready to take action to recover its losses and penalize offenders directly (at least on the first or second occasion after which the utility may resort to legal action).

When non-technical losses are *less than 2%*, the utility remains vigilant and acts on information of theft reported by the public.

The utility positions itself as neutral (there is little in the way of communication regarding theft). Electricity pilfering remains below the line as a low key issue.

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VIII BIOGRAPHIES

With a transmission and distribution utility background **Ron Millard** has extensive experience in the management of power utilities including technical, financial and human resource management. Ron has also been responsible for the project management of distribution, transmission and power generation projects in several countries.

Since joining PB Power Ron has project managed transmission and distribution projects and has been actively involved in providing strategic advice and support to the utility industry. This includes asset management, capital forecasting and regulatory advice to electricity utilities and regulators. He has been team leader on several due diligence exercises for distribution and transmission business acquisitions and prior to returning to South Africa in 2002 was Operations Manager based in the Melbourne office of PB Power.

Michael Emmerton has a detailed knowledge of contemporary best practices in the development and management of infrastructure. He is highly experienced in facilitating change for competitive advantage and value release.

Michael's core experience was gained in a management capacity with leading electricity businesses in Australia and Hong Kong, and through consulting to infrastructure owners/managers, regulators and Governments throughout the SE Asian Region, including New Zealand and Australia and in the Middle East and Africa.