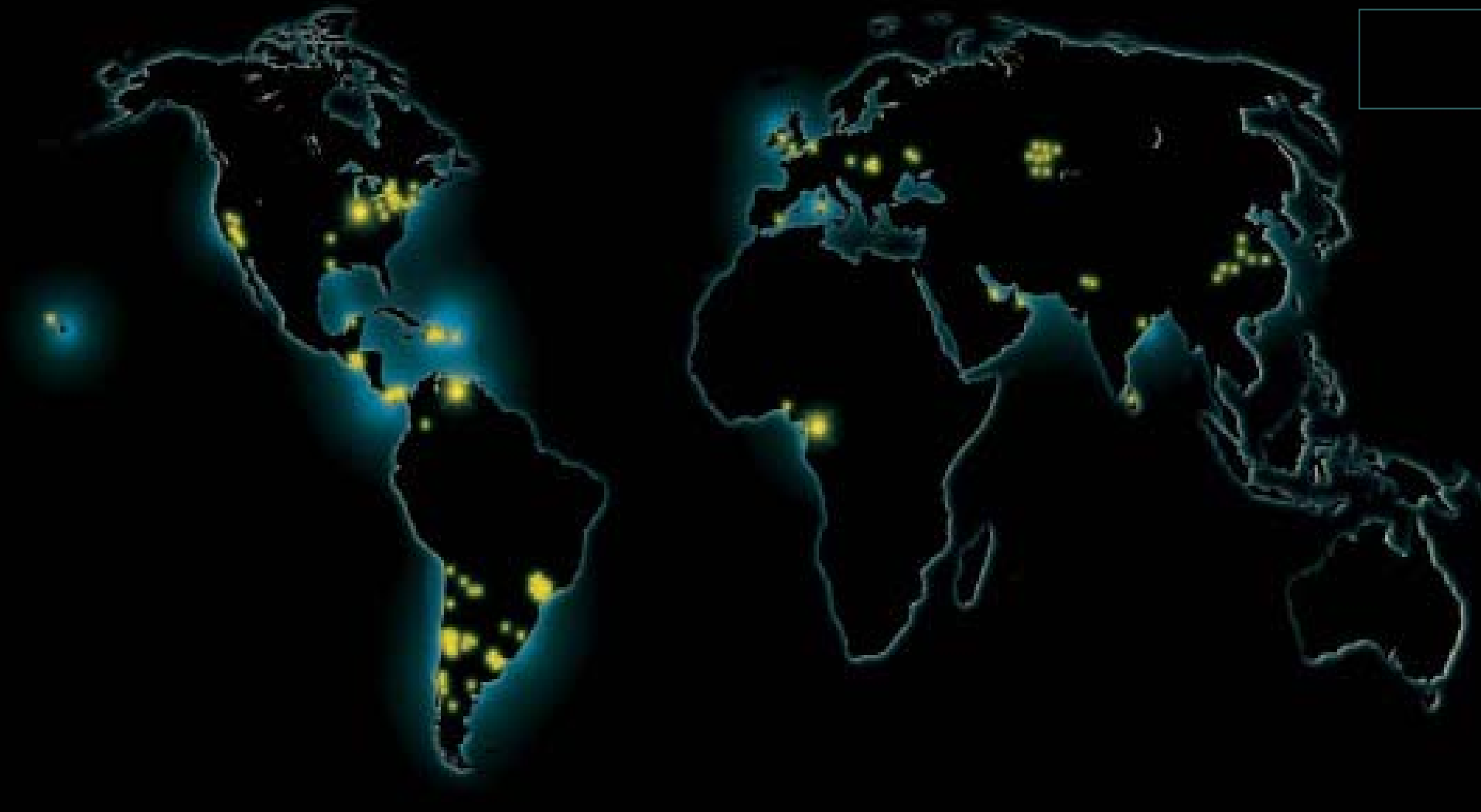
Electric Utility Losses

The Electricity Regulatory Authority of Albania
and
The Indiana Utility Regulatory Commission

Indianapolis Power & Light Company
Al Such
October 6, 2006

AES

Serving 100 million people in 27 countries



Breadth of AES Capabilities

Distribution

Coal-Fired

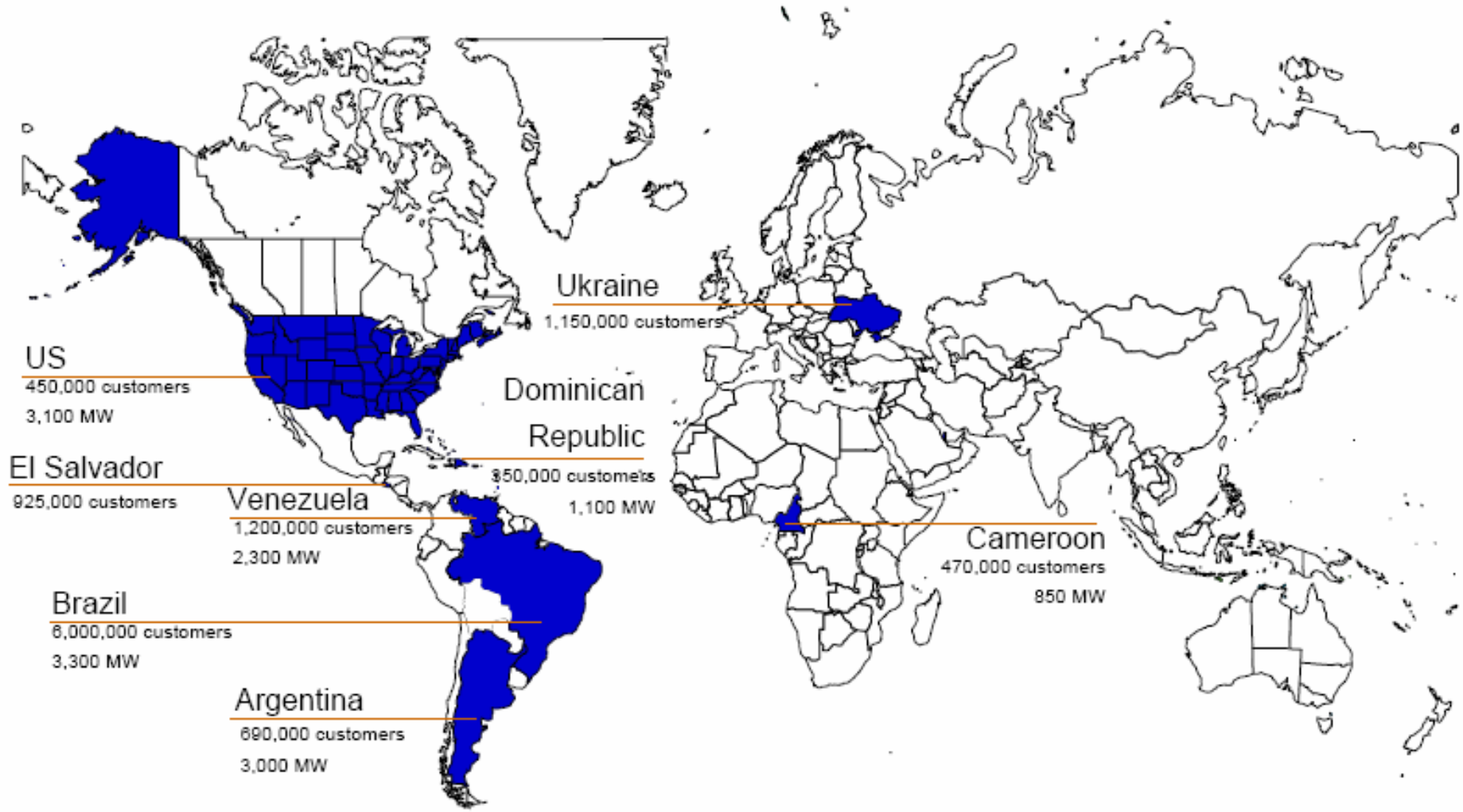
Hydroelectric

Wind Power

LNG

Gas-Fired

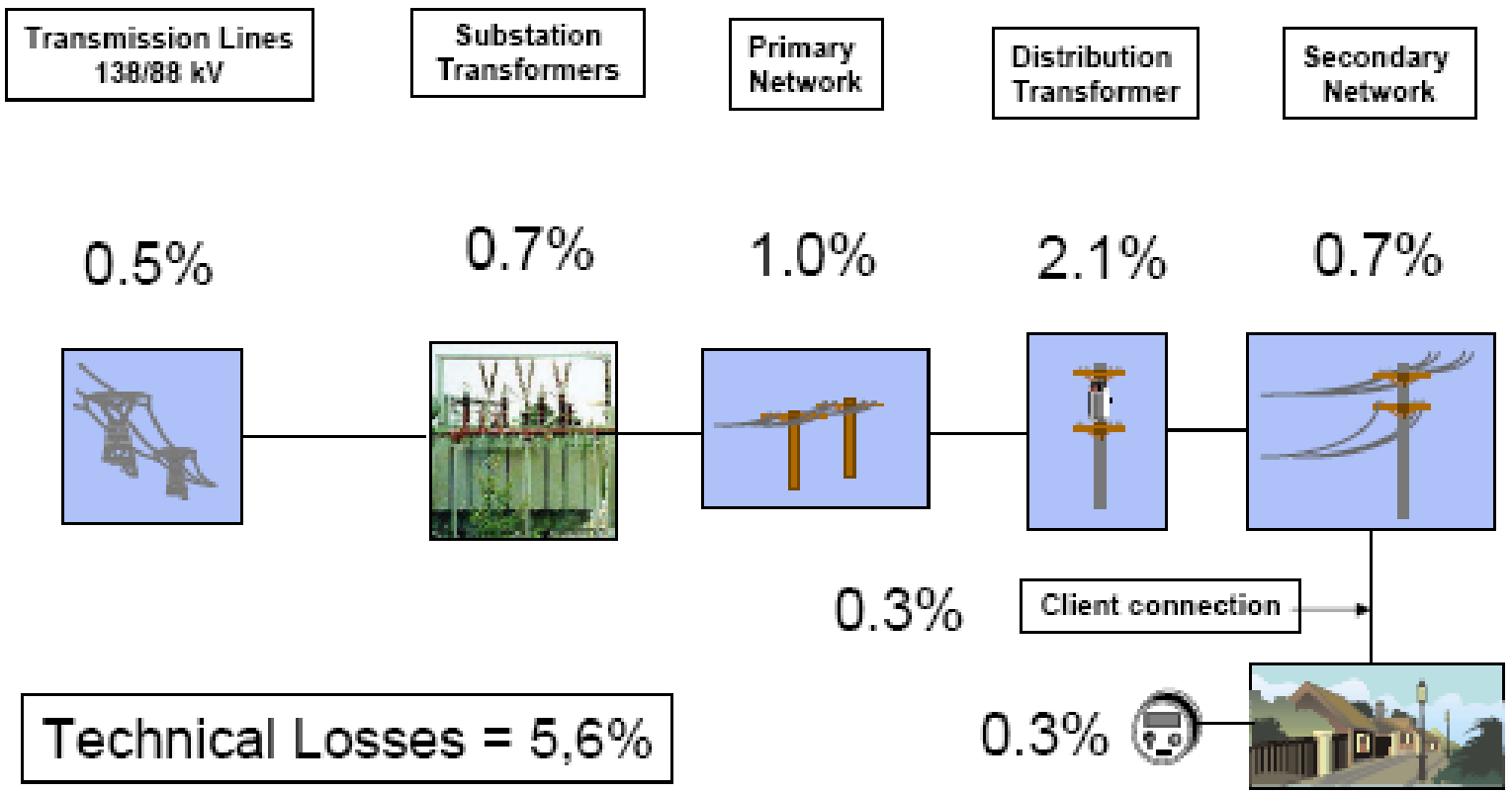
Our Integrated Utilities Group has 13,650 MW and over 11 million customers



Electric Utility Losses

- Technical
  - Those inherent to transport and operation of the electrical system and that represent costs.
  - Can be optimized to a level which the return on investment becomes profitable.
  - I^2R
- Non-technical

Technical Losses



Non-Technical Losses

- External
  - Frauds
  - Illegal connections
  - Meter tampering
- Internal
  - Administrative
  - Defects on installation
  - Data base errors

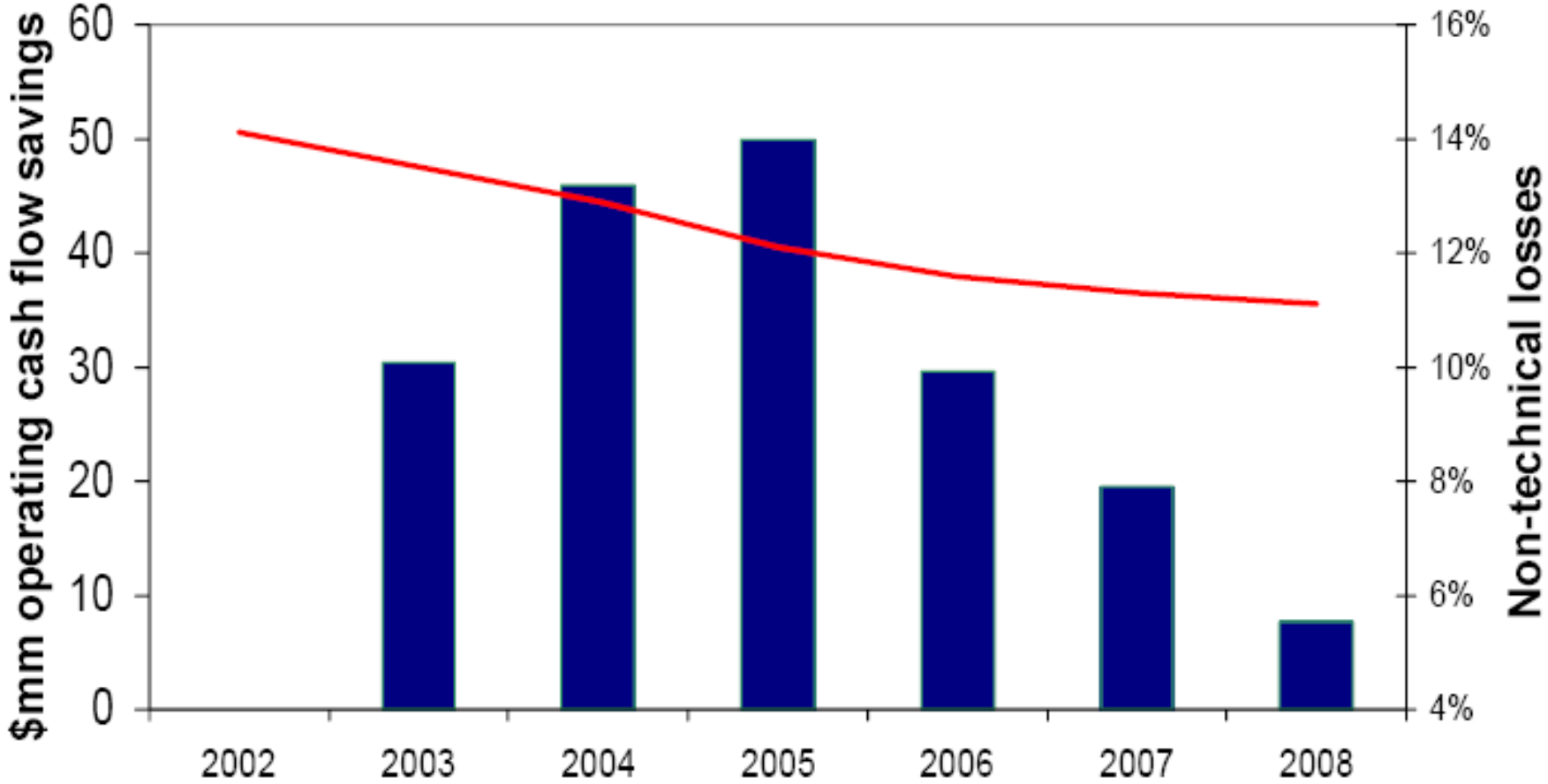
AES
Distribution Business

Approximate Losses (Various Dates)

Company	Country	Customers	Commercial	Technical	Total	Approx. Load GWH
CAESS/CLESA						
DEUSEM/EEO	El Salvador	960,000	1.8%	7.5%	9.3%	3200
Eastern Kazakhstan	Kazakhstan (Mgmt. Only)	280,000				
Semipalatinsk	Kazakhstan (Mgmt. Only)	180,000				
EDC	Venezula	1,000,000	9.6%	7.5%	17.1%	10525
EDE Este	Dominican Republic		7.5%	10.5%	18.0%	3427
EDELAP	Argentina	280,000	7.1%	4.6%	11.7%	2364
EDEN / EDES	Argentina	410,000	3.8%	8.1%	11.9%	2829
Electropaulo	Brazil	5,300,000	7.3%	5.6%	12.9%	36499
Kievoblenergo	Ukraine	818,000			14.9%	3785
Rivneenergo	Ukraine	404,000			"	2216
SONEL	Cameroon	505,000			24.4%	3258
SUL	S. Brazil	1,000,000	0.8%	5.5%	6.3%	7011
IPL	Indianapolis, IN	465,000	0.4%	4.7%	5.1%	16276

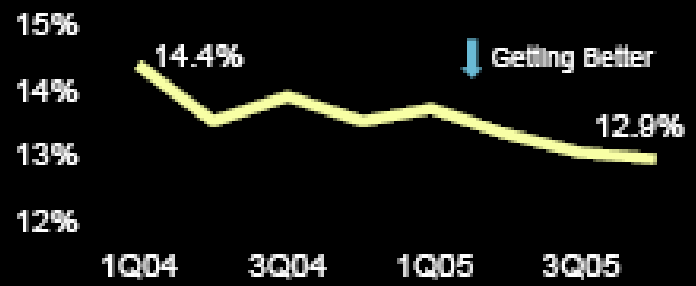
Non-Technical Loss Improvement

(.6% / yr improvement - $30mm annual savings)

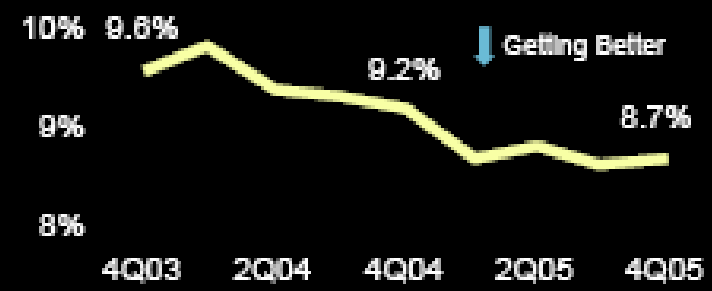


KPI Focus – Utility Losses in Latin America

Eletropaulo – Total Losses (1)



AES El Salvador – Total Losses (2)



(1) Trailing 12 months, excludes rebilled energy.
(2) Trailing 12 months.

In 2005 every AES regulated utility improved year-over-year total loss rates

Eletropaulo, Brazil
- Refocused loss reduction efforts
- Increased number and efficiency of theft inspections
- Results: 10% improvement since beginning of 2004 and normalized 188 MWh in 2005

AES El Salvador
- Improved meter inspections and follow up (replacement and recalibration)
- Improved meter reading practices
- Changed 73,000 obsolete meters in 2004-2005
- Result: 10% improvement since 2003

IPL - Losses

- Commercial Losses
  - .4 %
- Technical
  - 4.7%

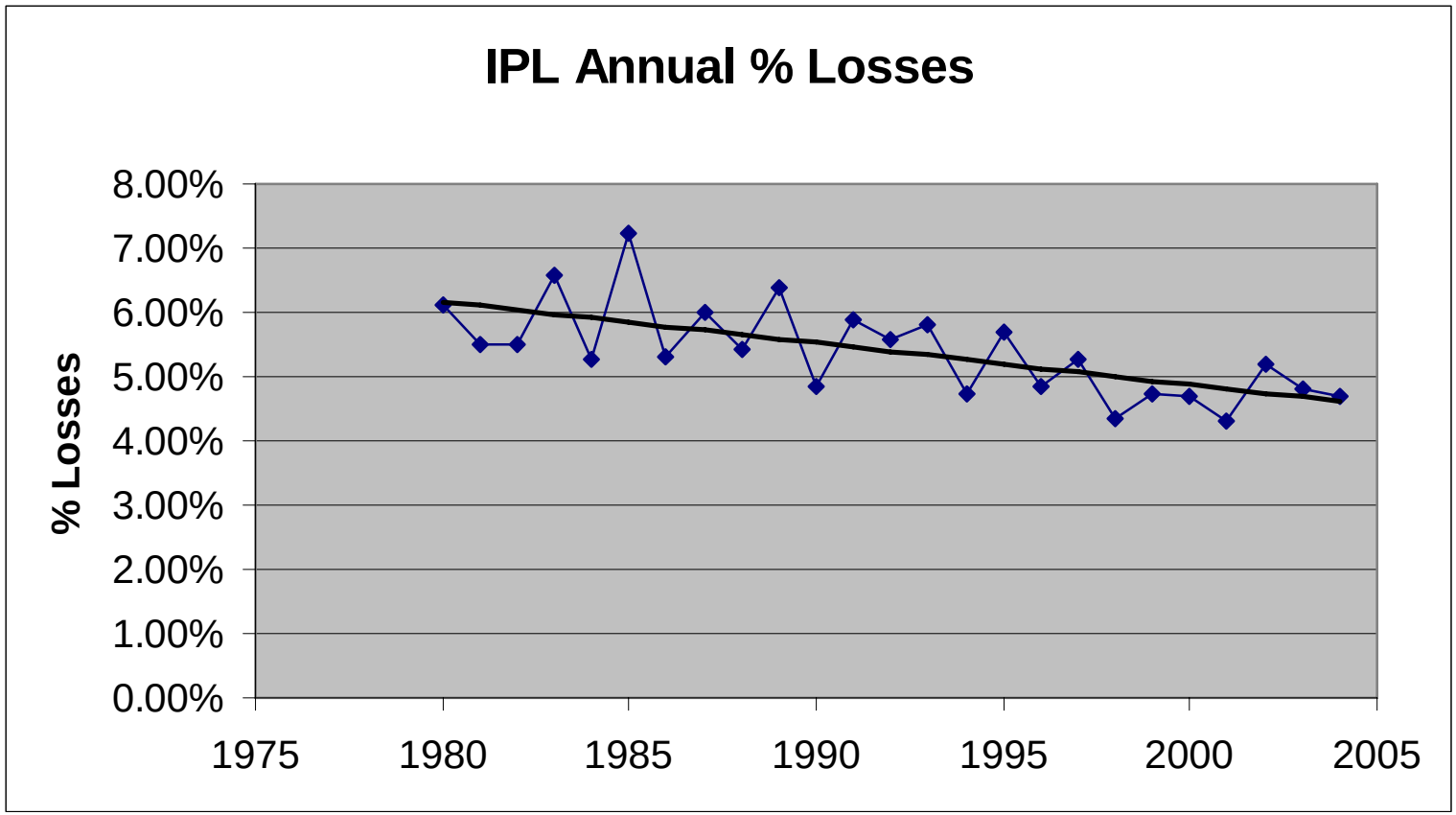
WHAT WORKS FOR IPL

- **Construction Standards**
- **AMR**
- **Governmental - Utility Energy Assistance**
- **Credit Reports**
- **Credit Guidelines – Proper Risk Management**
- **Credit Pilot Program – Educate Customers**
  - **Firm Pay arrangement guidelines consistent with IPL policies**
- **Security Deposits – 2 months**
- **Delinquent bills are assessed late charges (10% of the first $3 and 3% of remaining)**
- **Timely Disconnects for Non-Payment**
- **Disconnect / Reconnect Fees**
- **Tampering Charges- Unauthorized Reconnect $25 – Damaged Meter $37**
- **Monitor Arrears Tracking Reports**
- **Timely Referral to Outside Collection Agencies**
- **Indiana Utility Regulatory Commission (IURC)**

IPL TECHNICAL LOSSES

- Annual Energy Losses
  - By Year
  - By System Component
- Peak Demand Losses
  - Summer
  - Winter
- Energy Losses by Service Type
  - Annual
  - Summer
  - Winter
- Technical Losses – Reduction Activities

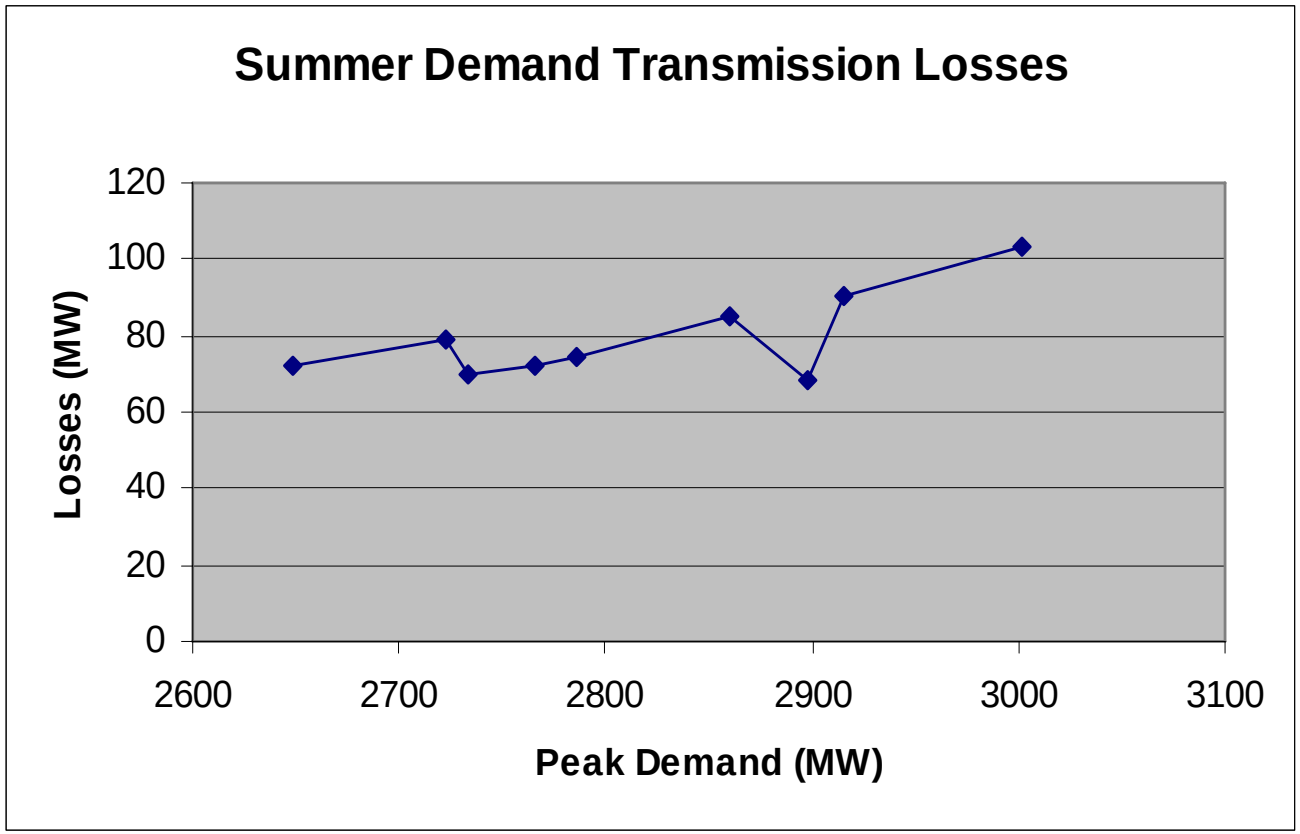
Annual Energy Losses



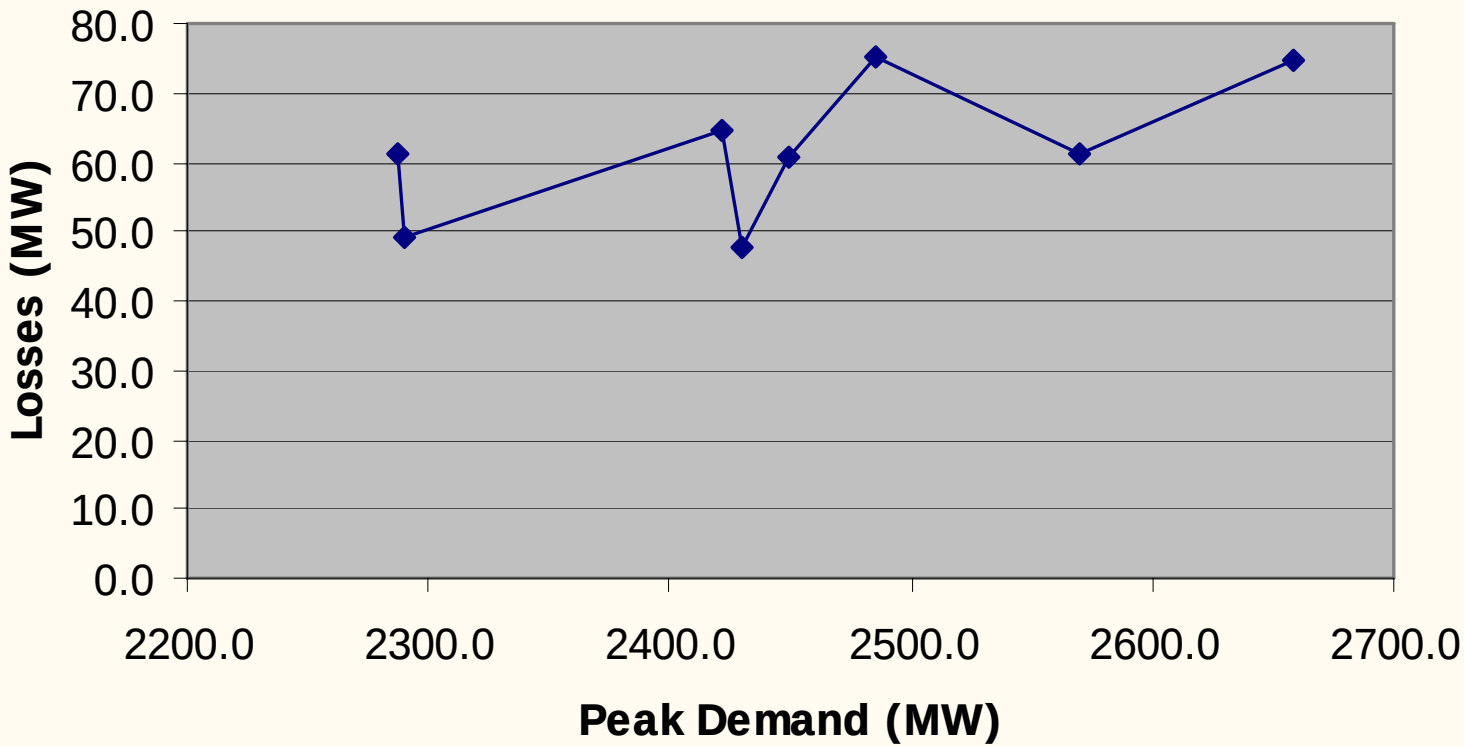
ANNUAL ENERGY LOSSES
(By System Component)

	TOTAL ENERGY LOSS (GWH)		
COMPONENT	1993	1985	1977
GSUs	**39.7**	**30.9**	**43.9**
TRANSMISSION	**142.7**	**133.1**	**101.6**
138 kV TRANSFORMERS	**71.4**	**68.4**	**75.6**
34 kV SUBTRANSMISSION	**12.5**	**15.7**	**16.7**
34 kV TRANSFORMERS	**16.5**	**29.3**	**39.4**
PRIMARY	**158.1**	**117.7**	**61.7**
DISTRIBUTION TRANSFORMERS	**244.6**	**207.1**	**191.5**
SECONDARY	**27.4**	**40.1**	**90.8**
TOTAL	712.9	642.3	621.2
NET SYSTEM LOAD	**13328**	**10264**	**9065**
% ENERGY LOSS	**5.3%**	**6.3%**	**6.9%**

TRANSMISSION LOSSES
(Summer Demand 1995-2002)



TRANSMISSION LOSSES
(Winter Demand 1995-2002)



TECHNICAL LOSSES
(Annual Energy Losses by Service Type)

COMPONENT	CUMMULATIVE LOSSES 1993-94	1989-90	1984-85
TRANSMISSION	**1.39%**	**1.78%**	**1.60%**
TRANSMISSION SUBSTATION	**2.06%**	**2.46%**	**2.50%**
SUBTRANSMISSION	**2.48%**	**2.78%**	**2.80%**
SUBTRANSMISSION SUBSTATION	**3.40%**	**3.83%**	**3.90%**
PRIMARY	**3.60%**	**3.66%**	**4.20%**
SECONDARY	**6.89%**	**6.88%**	**8.50%**

TECHNICAL LOSSES
(Summer Demand Losses by Service Type)

COMPONENT	CUMMULATIVE LOSSES 1993	1989	1984
TRANSMISSION	**2.06%**	**2.71%**	**2.00%**
TRANSMISSION SUBSTATION	**2.74%**	**3.37%**	**2.80%**
SUBTRANSMISSION	**3.36%**	**3.87%**	**3.30%**
SUBTRANSMISSION SUBSTATION	**4.10%**	**4.79%**	**4.20%**
PRIMARY	**5.43%**	**5.33%**	**5.10%**
SECONDARY	**8.48%**	**8.34%**	**8.40%**

TECHNICAL LOSSES
(Winter Demand Losses by Service Type)

COMPONENT	CUMMULATIVE LOSSES 1993-94	1989-90	1984-85
TRANSMISSION	**2.01%**	**2.38%**	**2.10%**
TRANSMISSION SUBSTATION	**2.56%**	**2.92%**	**2.70%**
SUBTRANSMISSION	**3.52%**	**3.76%**	**3.30%**
SUBTRANSMISSION SUBSTATION	**4.14%**	**4.63%**	**4.20%**
PRIMARY	**5.09%**	**5.43%**	**5.00%**
SECONDARY	**8.34%**	**8.53%**	**8.40%**

REDUCTION ACTIVITIES

- **Transformer Losses**
  - **Purchasing practice**
    - Transformer specifications include cost of losses.
    - Manufacturer quotes guaranteed loss.
    - Determine total owing costs.
  - **Cost of Losses**
    - Determine capitalized cost of core losses
      - Demand charge
        - T&D capacity cost
      - Energy charge
        - PV of Off-Peak Market Price * Core Loss Factor
    - Determine capitalized cost of copper losses
      - Demand charge
        - T&D capacity cost * Peak Responsibility Factor
      - Energy charge
        - PV of Peak Market Price * Copper Loss Factor

REDUCTION ACTIVITIES CONT'

- **Voltage regulation**
  - **Losses are indirectly reduced through voltage regulation efforts.**
    - Generation – VAR control
    - Transmission
      - 138 kV 100 MVAR Capacitor bank - .5MW reduction
      - Seasonal auto-transformer tap changes
      - 34 kV capacitor bank control
    - Distribution
      - ULTC
      - 13.8 kV Capacitor banks
        - Future - locate using CYME load flow study.

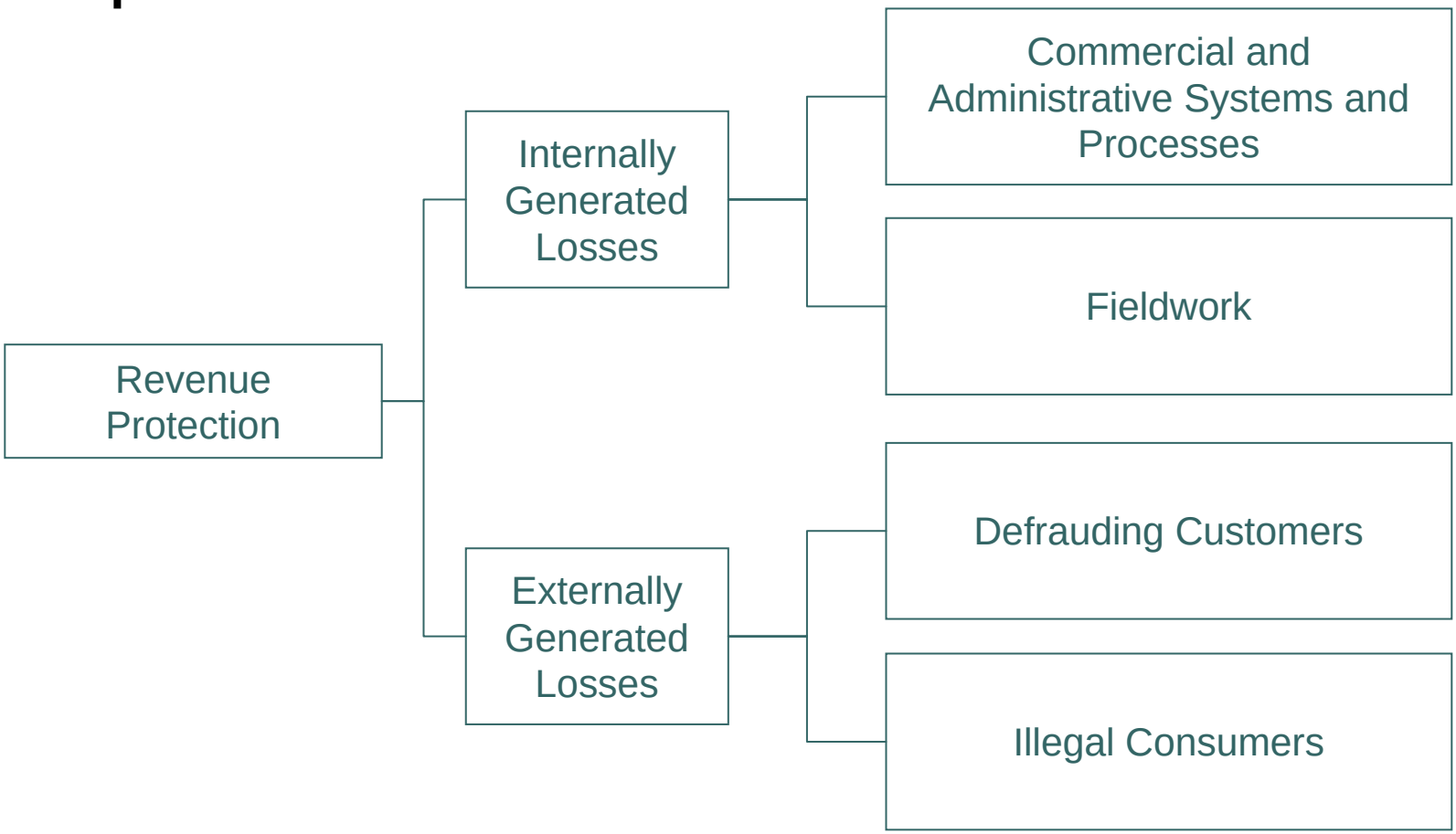
REDUCTION ACTIVITIES CONT'

- **Conversion of 4.1 kV to 13.8 kV**
  - **Beginning in 1973, IPL began a conversion from 4.1kV to 13.8 kV to eliminate an antiquated and overloaded distribution system.**
- **Balancing Distribution Circuits**
  - **Losses are indirectly reduced by balancing three phase circuits.**
- **Distribution Circuit Configuration**
  - **Reconfiguring primary circuits for optimum voltage and load operation indirectly reduces losses.**
    - Manual
    - Future – CYME

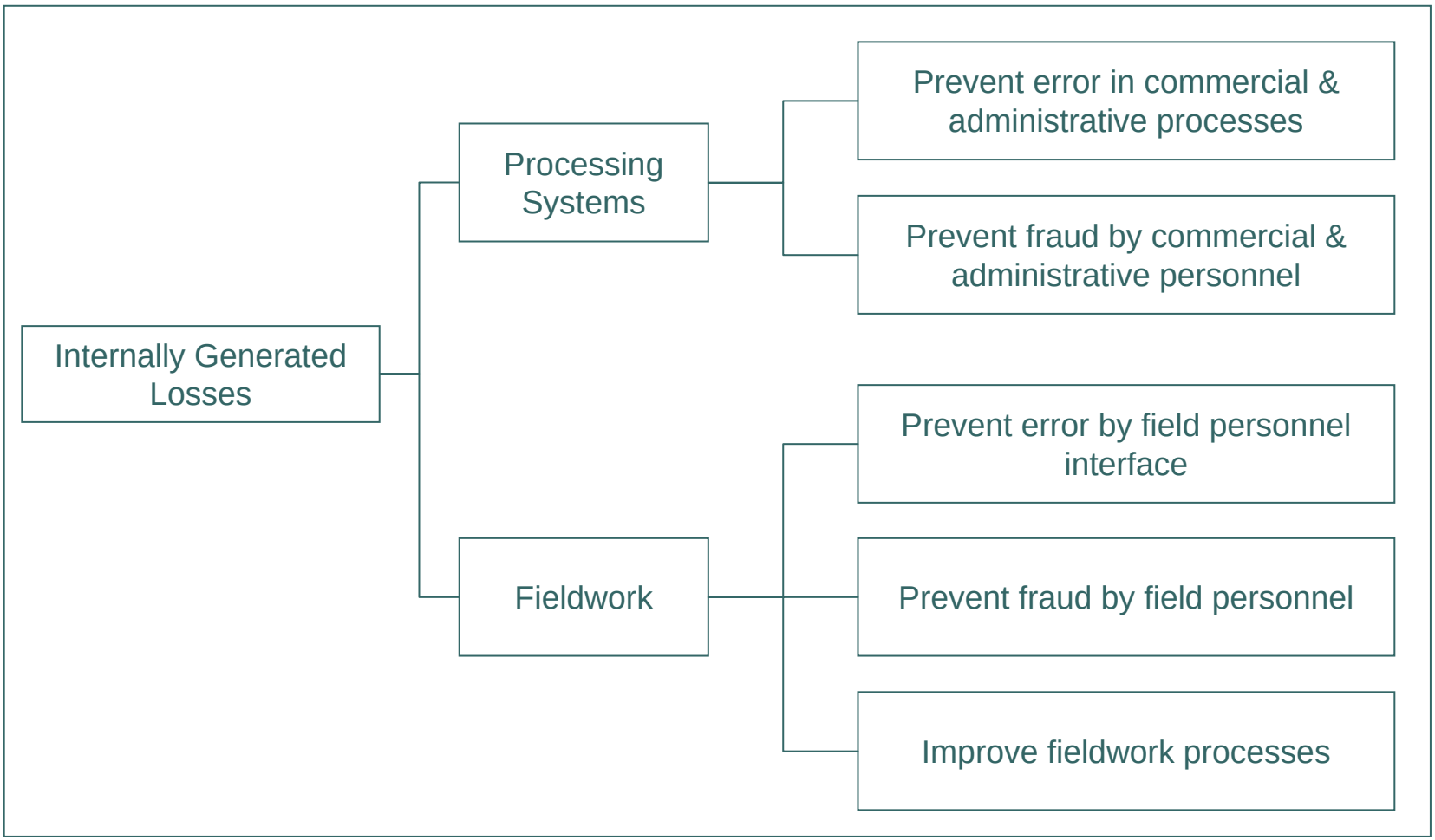
REDUCTION ACTIVITIES CONT'

- **Tariffs**
  - **Industrial rates structured to encourage customers to smooth demand.**
  - **Industrial rates include power factor correction incentives**

AES Revenue Protection
Non – Technical Losses



Internal Losses

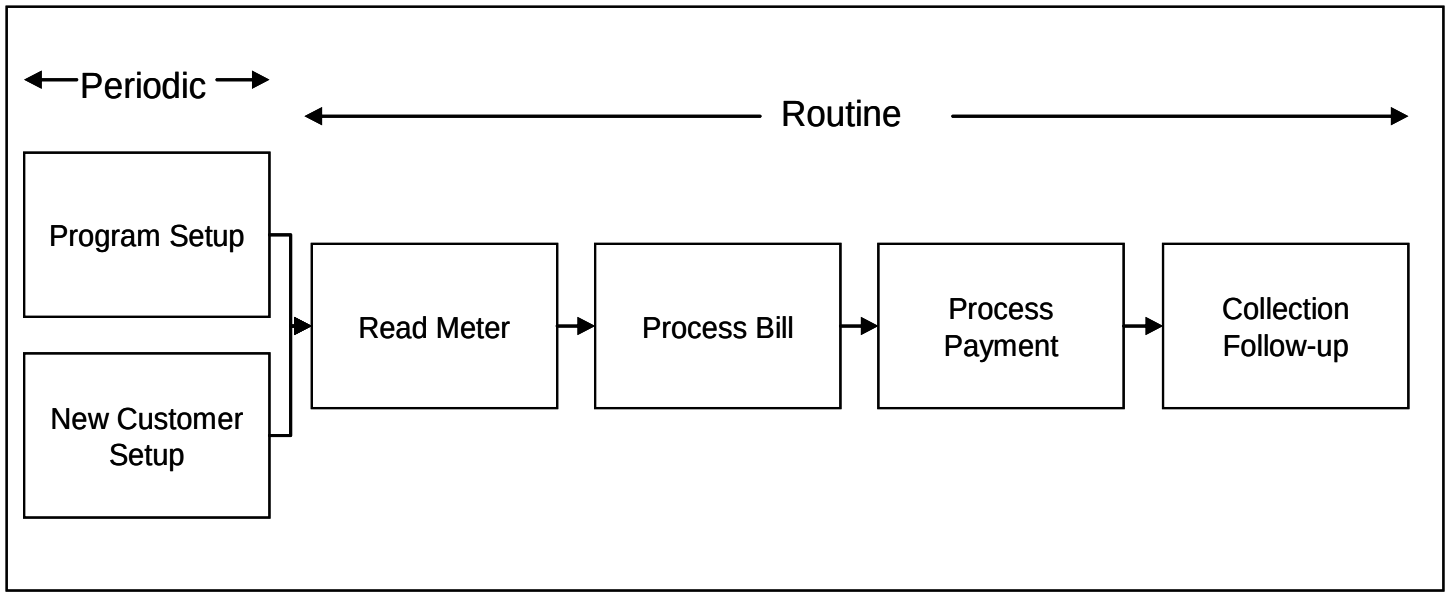


Internal Losses - Administrative

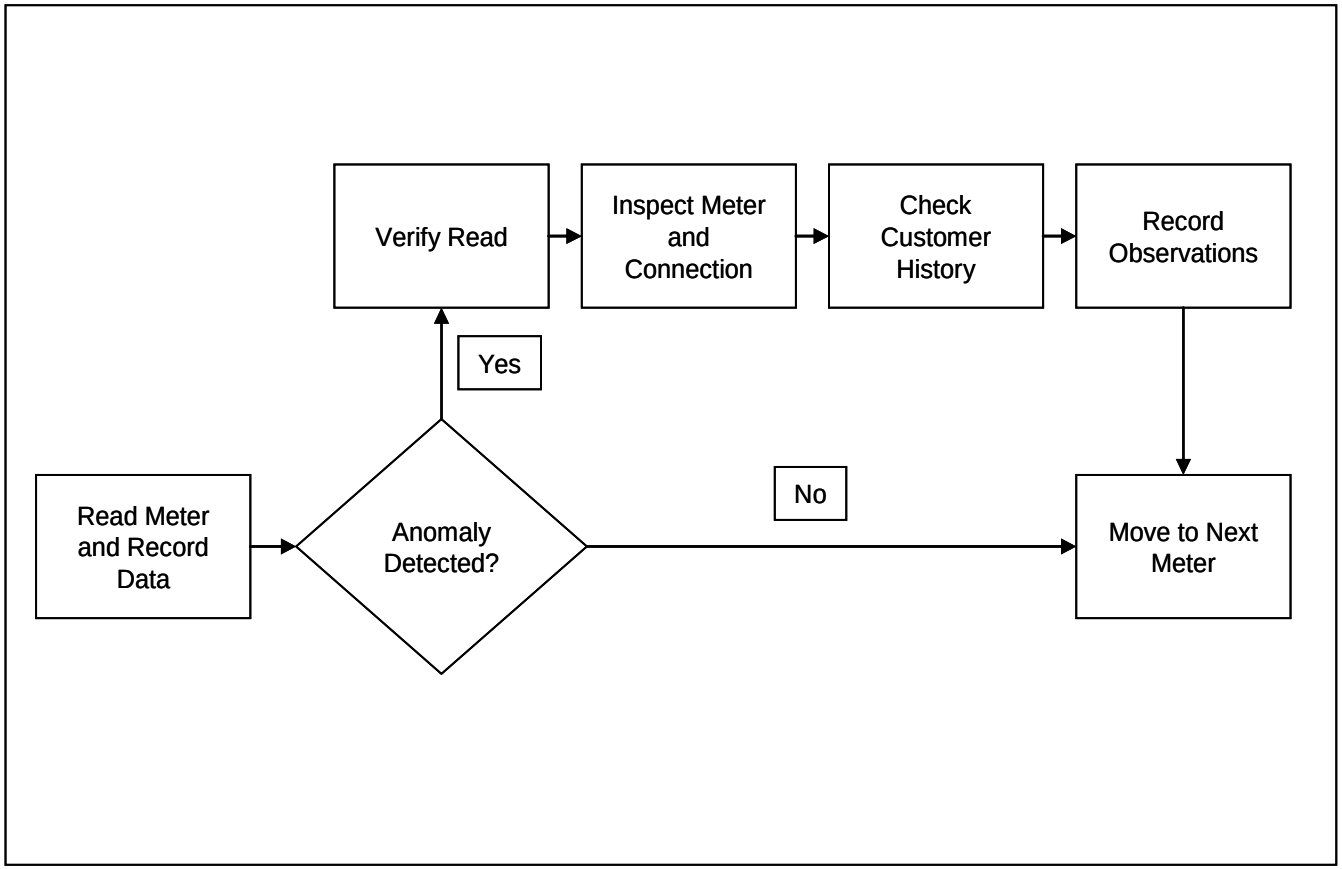
Internal Controls are the key to preventing commercial and administrative process and system errors and fraud

Commercial and Administrative Loss Reduction Strategies		
Activity	Action	Objective
Revenue Audit	Perform a comprehensive revenue audit to identify error points and inadequate internal controls in commercial and administrative practices including meter reading, billing and collection and customer maintenance activities	Identifies process weaknesses, and inadequate internal controls which may result in revenue leakages through error or fraud
Data Input and Validation Controls during Meter Reading	Using electronic meter recording devices to identify anomalous usage patters caused by data recording error, meter malfunction and/or customer fraud during the meter reading process	Identifies potential error and fraud at the earliest point in the process, allows meter reader to inspect meter and electrical equipment for tampering or malfunction. Electronic devices reduces data entry errors and data input errors in the billing and collection system
Data Input, Validation, Process And Output Controls During The Billing Process	Use software to identify anomalous usage patters caused by data recording error, meter malfunction, customer fraud and or tariff application error during the billing process	Performs more sophisticated customer usage pattern analysis, confirms and reviews meter readers observations, creates work order for inspection of customer premises suspected of potential fraud or meter malfunction. Maintains comprehensive data base of customer usage and payment record. May act as the first point of error checking for paper based meter reading systems

Commercial and Administrative Revenue Management Process



Validation and Error Controls During Meter Reading

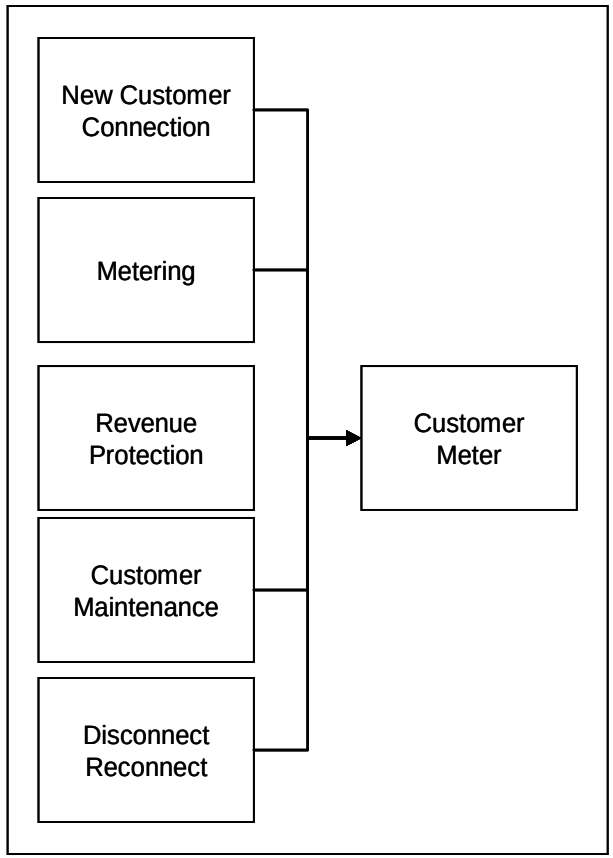


Meter Reading

- AMR
- Handheld Manual Entry Meter Reading Devices
- Paper Based Records

Internal Losses - Fieldwork

- Field work refers to the management of personnel who perform activities at the customer interface.

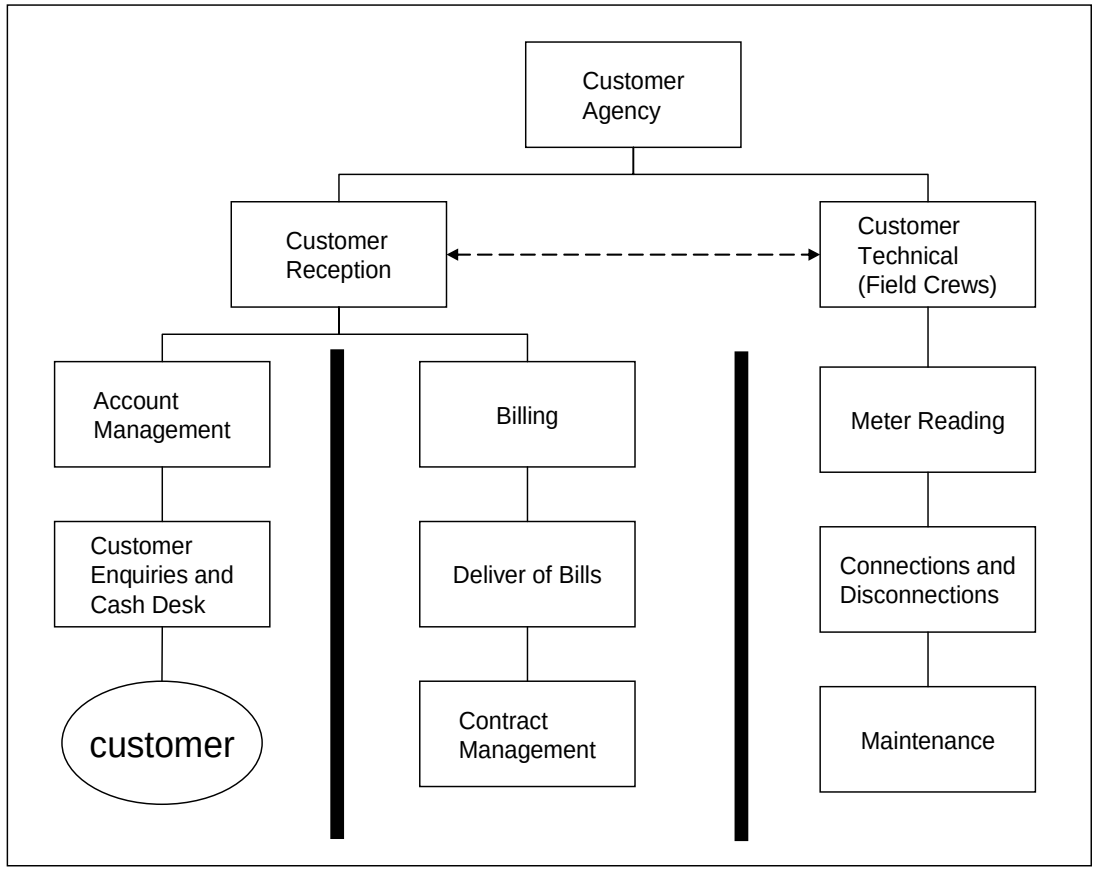


Internal Losses - Fieldwork

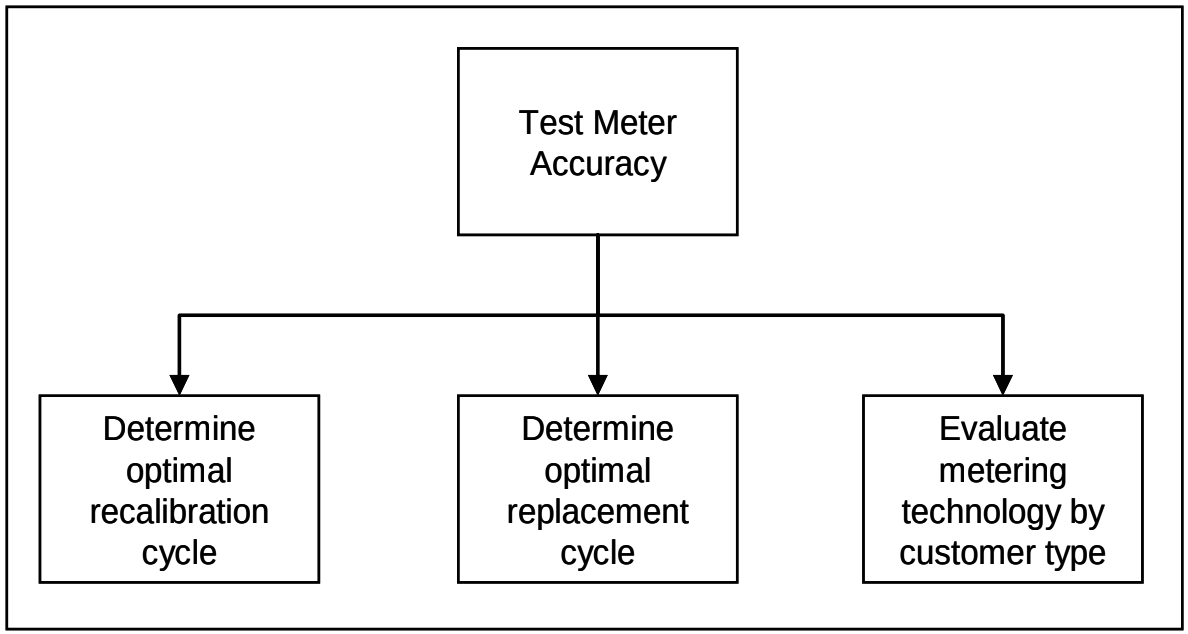
Workforce organization, process improvement and meter management are key to preventing fieldwork errors and fraud

Fieldwork Loss Reduction and Improvement Strategies		
Activity	Action	Objective
Review of Field Practices	Perform a comprehensive review of field practices to identify error points and inadequate internal controls. This review may be performed as part of the Revenue Audit or as part of a Work Management initiative	Identifies process weaknesses, and inadequate internal controls in field practices which may result in revenue leakages through error or fraud
Work Management Process Improvement	Using work management techniques, undertake systematic process improvement initiatives on all field practices to increase labor productivity	Increases the amount of fieldwork performed directed towards revenue protection activities
Meter Management	Review meter database, recalibration, replacement and testing policy and practices. Evaluate meter technology. This may be part of a Revenue Audit or as a stand alone Meter Management initiative.	Determines losses resulting from problems in metering electricity usage. Identifies threshold amount for investment in improved meter maintenance or new meter technology

Internal Losses:
Separation of Duties and Responsibilities

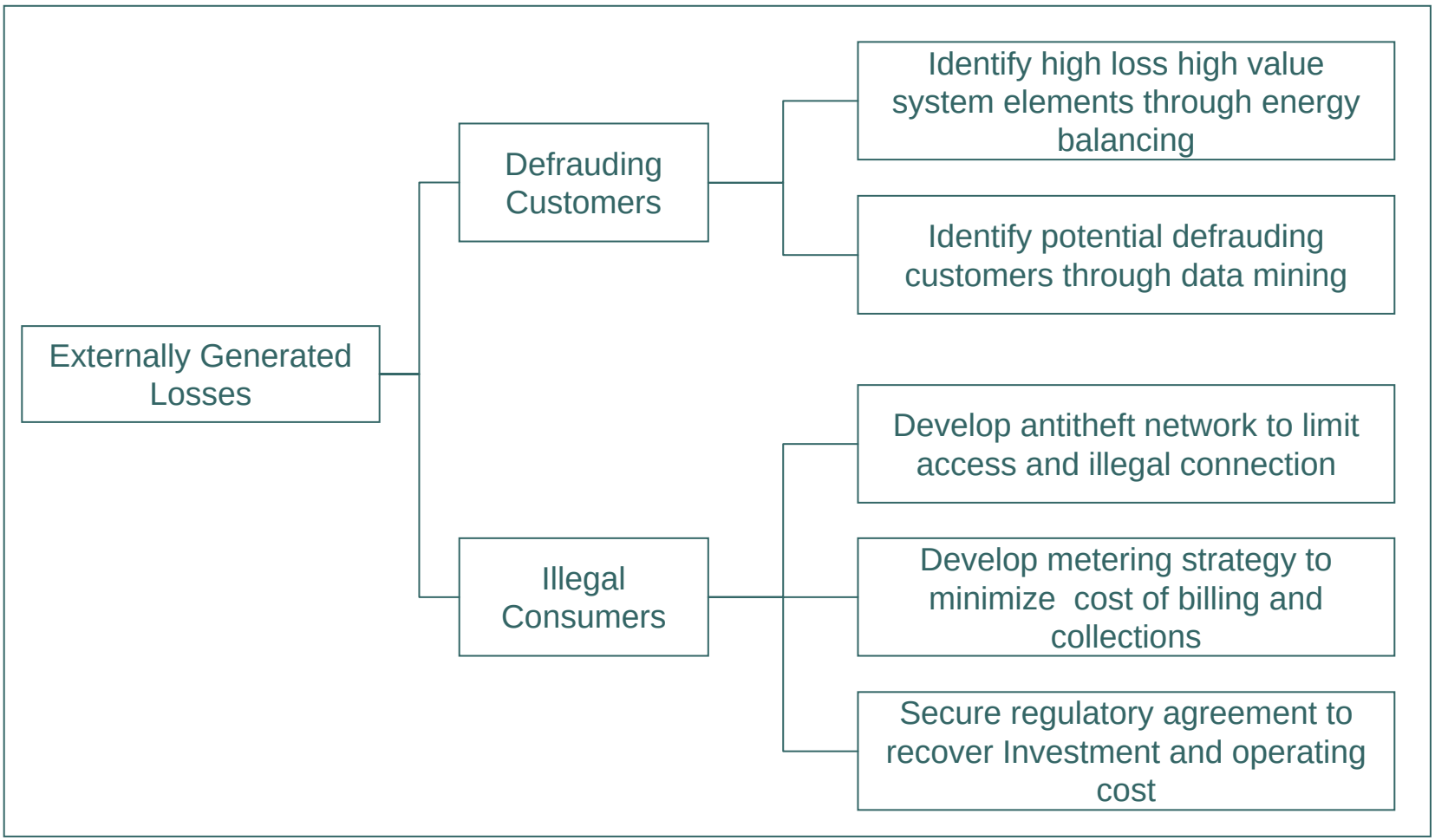


Internal Losses
Meter Testing Objectives



External Losses

The detection and prevention of externally generated losses relies on information, network and metering technology



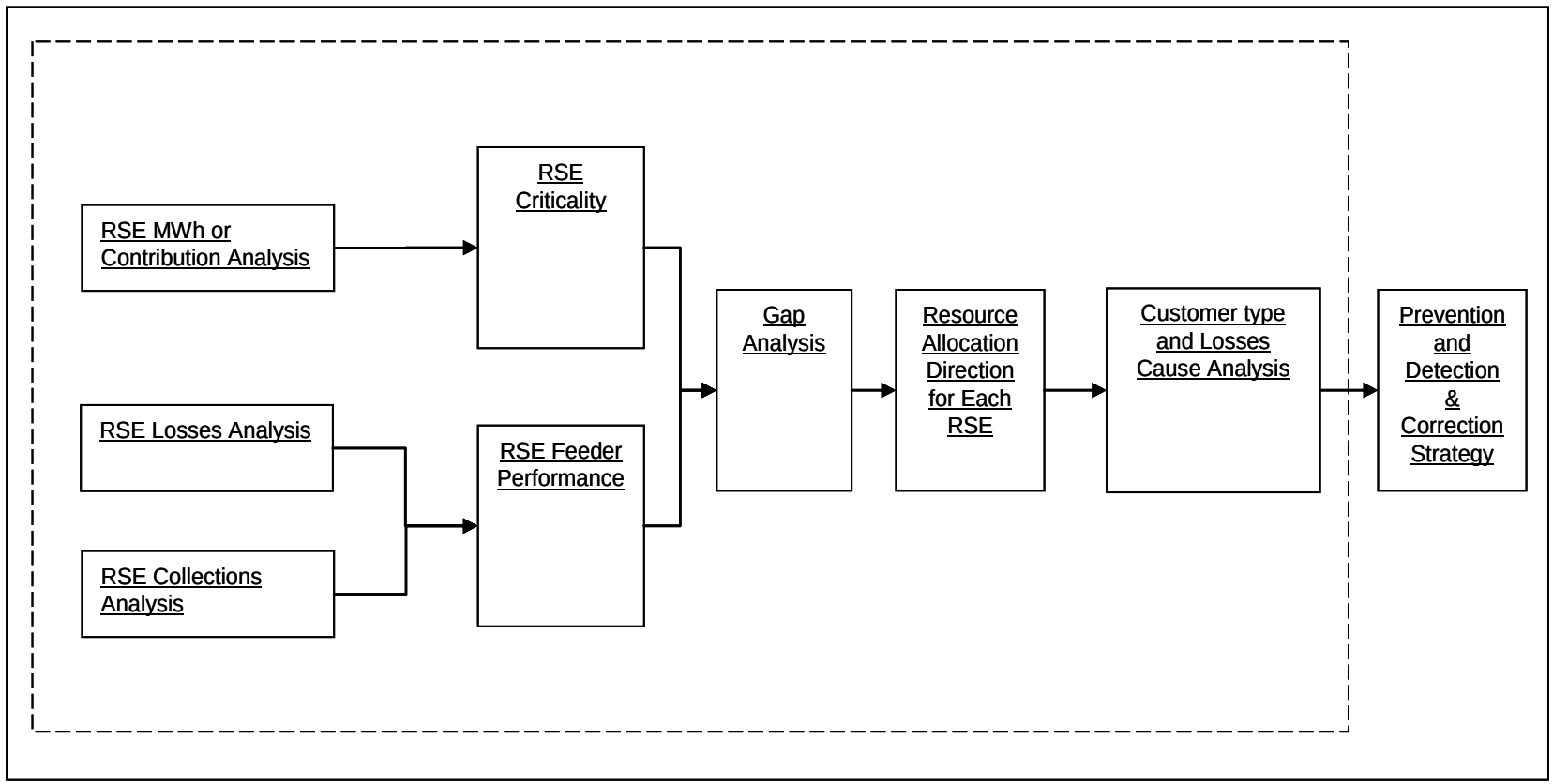
Defrauding Customers

Defrauding Customer Loss Reduction Strategies		
Activity	Action	Objective
Energy Balancing	Perform losses measurement calculations by Relevant System Element (RSE), (typically region, substation or feeder) to identify high loss RSEs. Perform Asset Management analysis including Pareto to identify high loss high value targets.	Identifies location of high loss high value RSEs to focus loss reduction tactic and maximize MWh recovery for a given level of effort
Identifying potential defrauding customers during Meter Reading and Billing)	Using electronic meter recording devices to identify anomalous usage patters caused by customer fraud during the meter reading and billing process	Identifies potential fraud during the meter reading or billing process, allows meter reader to inspect meter and electrical equipment for tampering. The billing process may confirm anomalies detected during meter reading and creates work order for inspection of customer premises suspected of potential fraud. The billing process also maintains comprehensive data base of customer usage and payment record. May act as the first point of fraud detection for paper based meter reading systems
Interrogation of Customer Databases	Combining billing and collection, customer and losses data bases and using query software to develop sophisticated customer profiles and usage patterns to identify potential defrauding customers	Provides precise targets for fraud inspections and creates a learning loop which increases the “hit” rate of inspections and the level of MWh recovered per inspection

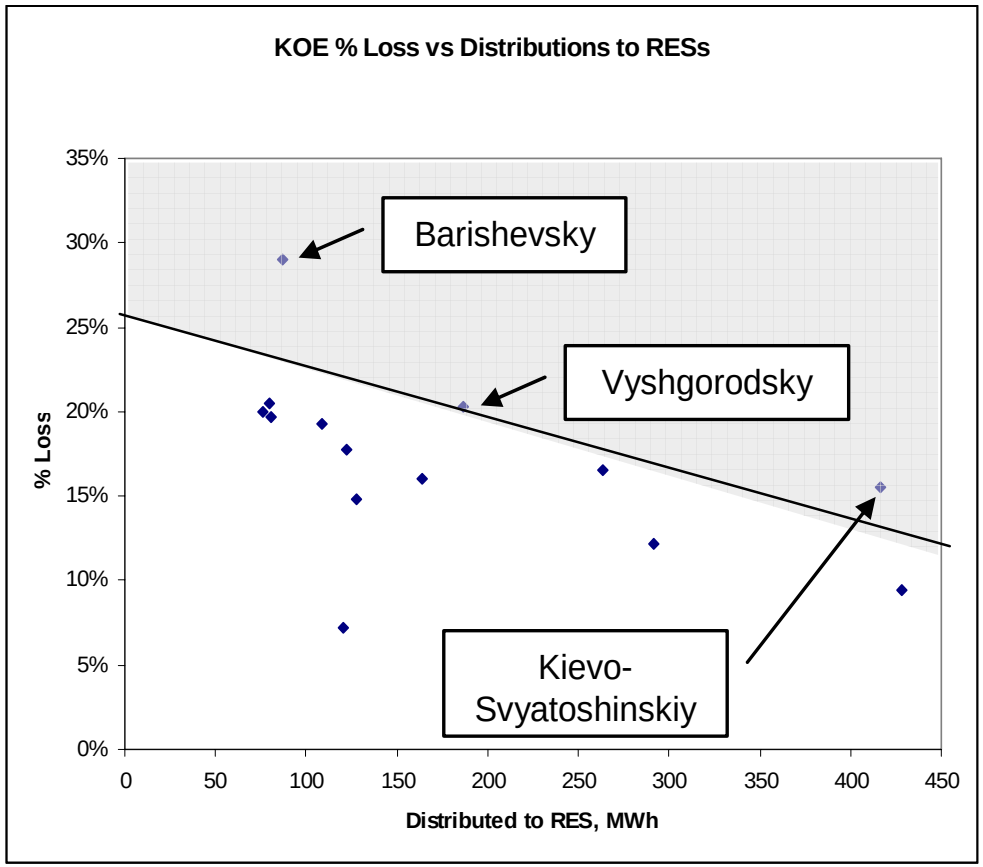
Energy Balancing

Item	**Network Information and Technology for Revenue Management**
1	**Relevant System Elements:** defining feeders/circuits or substations as unit of measure
2	**Connectivity Mapping:** mapping customers to RSEs
3	**Billing:** aggregating customer billing by RSE
4	**Collections:** recording collections rate by RSE
5	**Metering:** installing meters to measure energy injected into the RSE
6	**Energy Transfer:** process to record transfer of energy between RSE
7	**Criticality:** ranking RSEs by MWh, or Contribution Margin

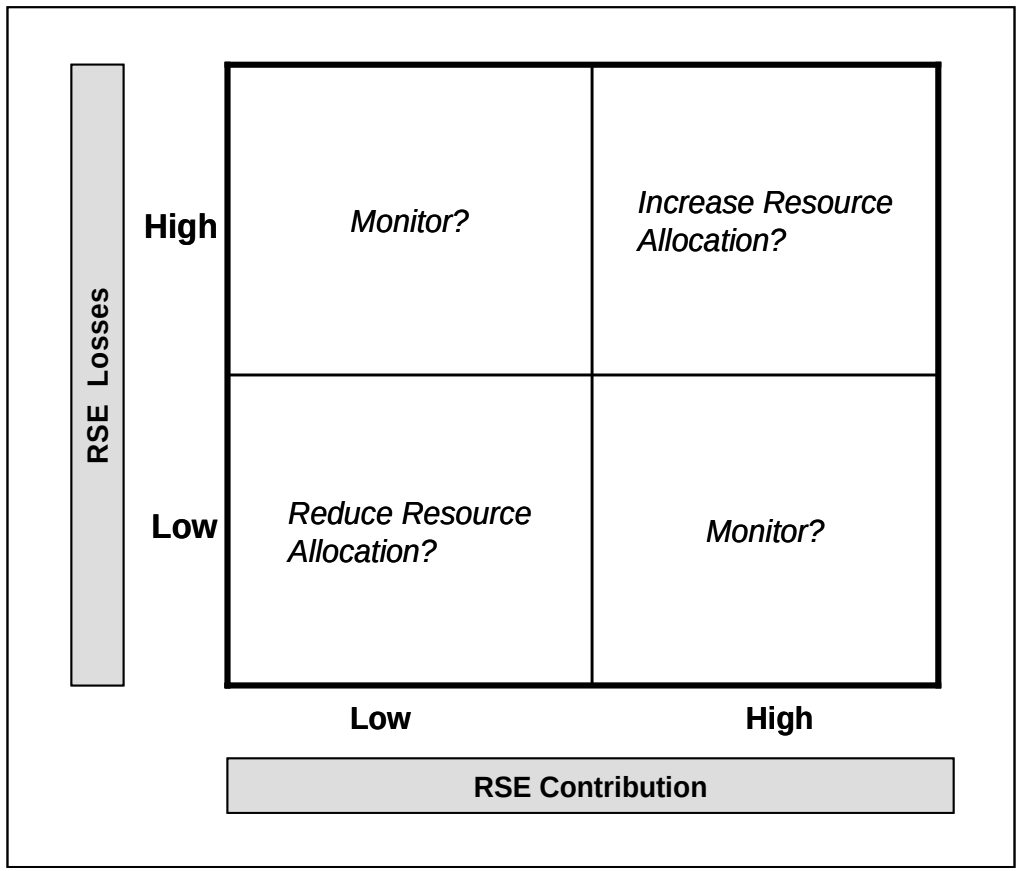
Energy Balancing



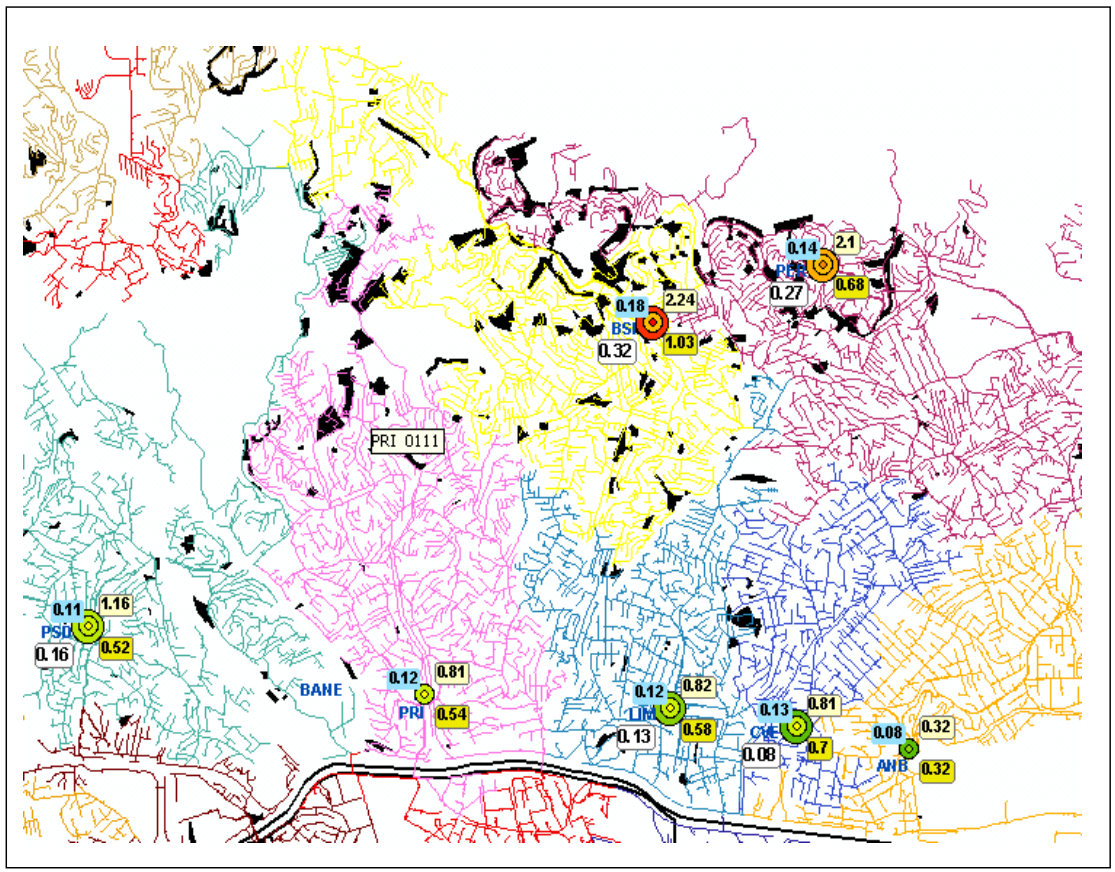
Energy Balancing Gap Analysis



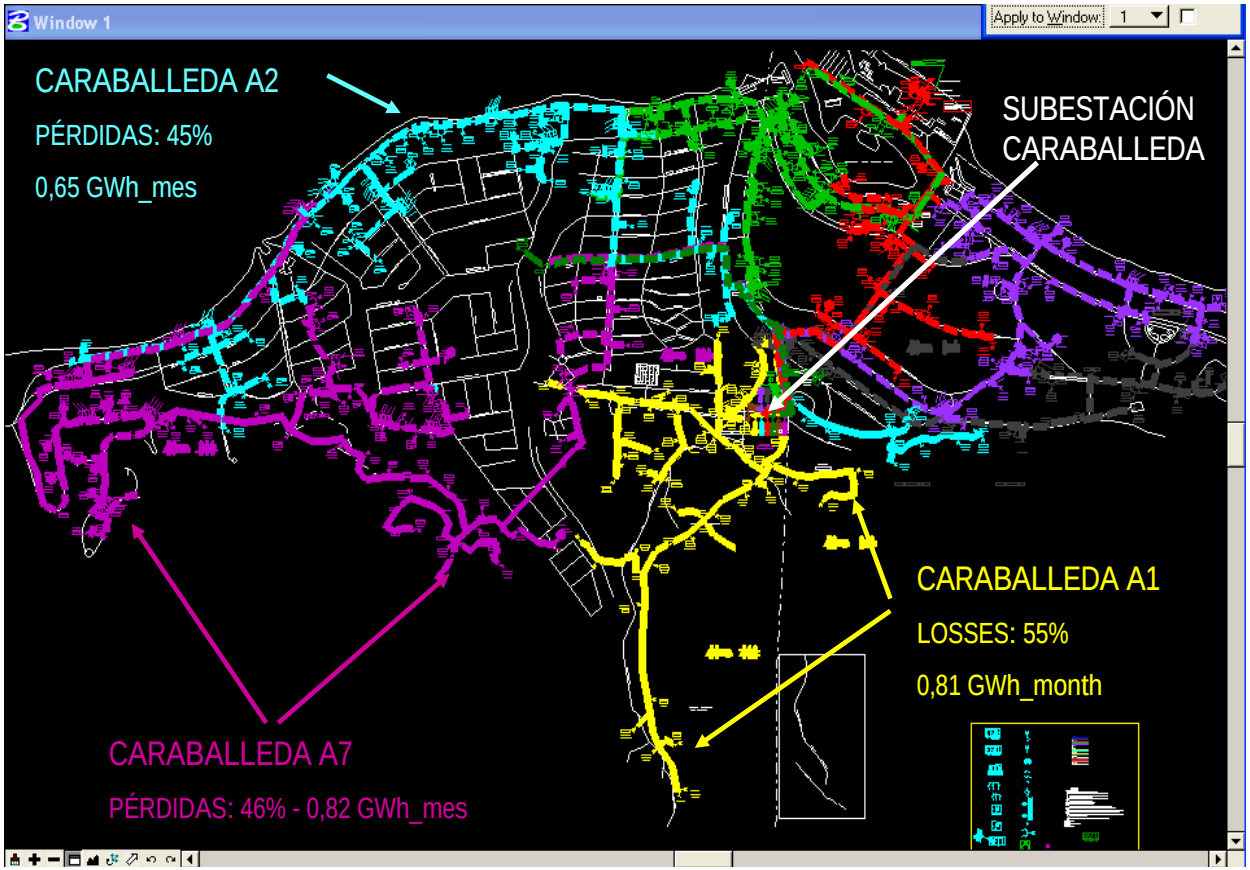
Energy Balancing Gap Analysis



Energy Balancing
Loss Analysis - Substations



Energy Balancing
Loss Analysis – Feeder Circuits



Meter Reading and Billing System

- On an ongoing basis the meter reader is the first point of contact with potential defrauding customers. Meter readers should, therefore, be an integral part in the prevention of losses. Meter readers themselves have limited capacity to conduct fraud inspections. Time constraints and lack of training allow them to detect only the most obvious frauds; however mobile data terminals (handheld data recording devices) enable detection of both malfunctioning meters and some forms of customer fraud.

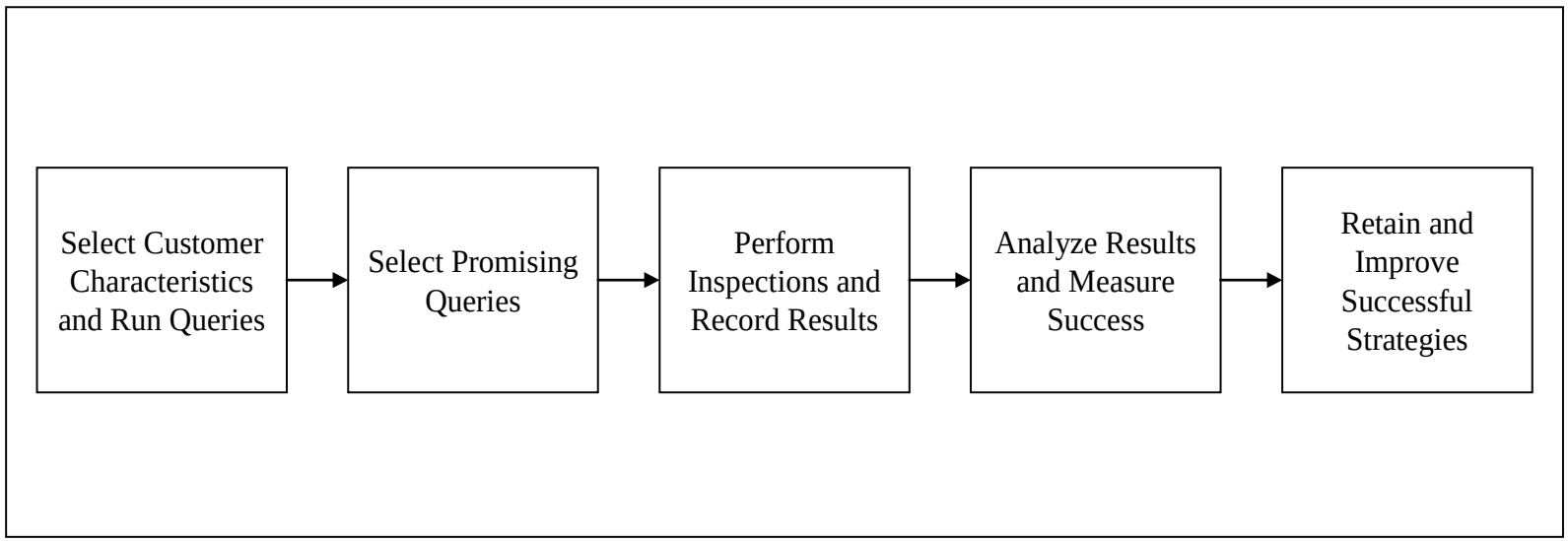
Meter Reading Process

- A formalized process of meter reading should be developed to incorporate error checking and losses and fraud detection. For example, the meter reader should:
  - Locate the client's address and the meter to be read.
  - If the meter cannot be located, record an anomaly on the terminal using the appropriate anomaly code
  - If the meter can be located, verify the condition of the meter, including evidence of tampering, direct connection and safety infractions. Any suspected fraud should also be entered on the mobile data terminal
  - Before reading, validate the tariff via information included in the mobile terminal
  - Confirm that the meter's identification number conforms to the identification number contained in the terminal
  - Record and verify the meter reading on the mobile data terminal
  - If the terminal emits an alarm, verify the reading and renter the data on the terminal. The alarm should sound if:
    - the consumption is outside the normal range for the customer's usage profile,
    - significant increase or decrease in consumption over the previous read or average of a number of previous months
    - there is zero consumption
  - Record all unread meters and all meters that could not be located.
  - The terminal should reconstruct a reading route for all unread and un-located meters.
  - Submit the mobile data terminals to billing staff

Interrogation of Databases

- Data mining, as with energy balancing described above, is concerned with energy theft detection. Like working with mobile data terminals, data interrogation may be regarded as a work identification sub-process of Fraud Inspection Work Management. In the case of energy balancing, high value, high loss *locations* are identified, so that loss reduction efforts may be geographically focused. Data mining is a complementary approach, in which potential defrauding *customers* are identified. Data mining is more of a laser-strike than a blitz.

Data Interrogation Process

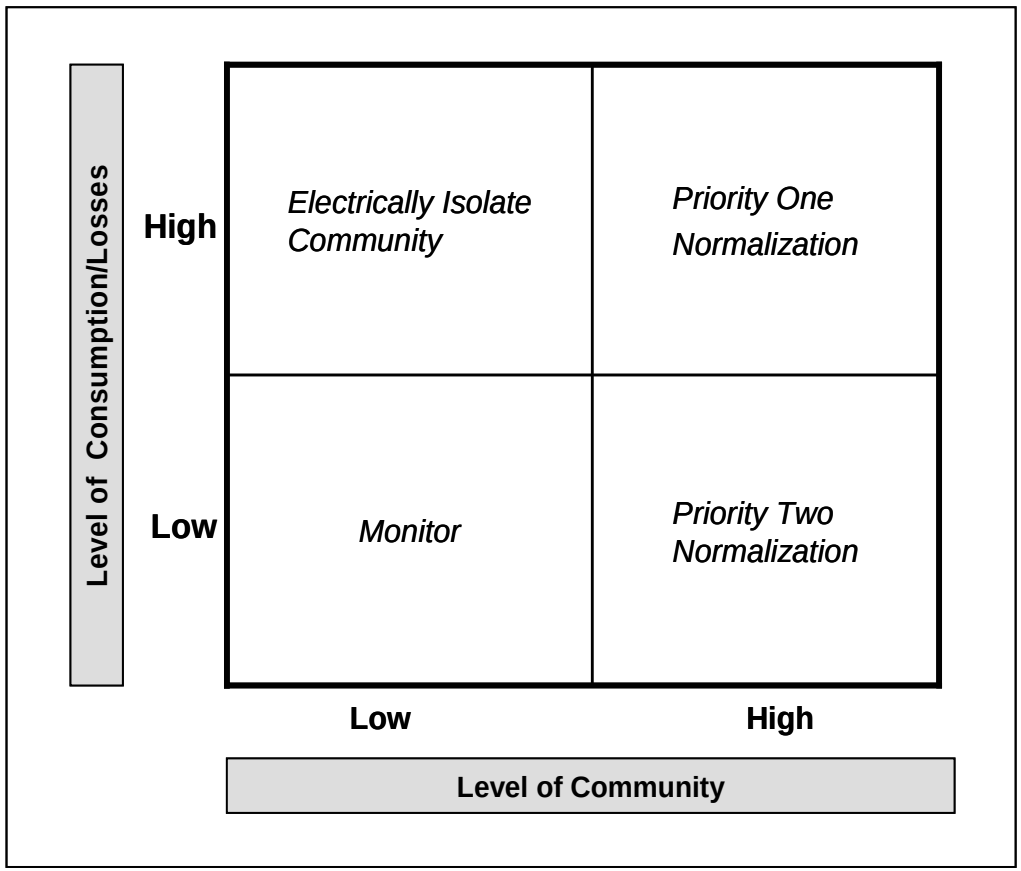


Illegal Consumers Loss Reduction Strategies

Activity	Action	Objective
Antitheft Technology	Develop antitheft technology on the low voltage network to limit access and restrict illegal hookups on low voltage lines	Reduces the opportunity for illegal hookups
Metering Technology	Develop metering strategy including, community metering with load limiters and no meters at the customer premises. Low cost meters at the customer premises and in some cases e.g. commercial operations, install "split" prepaid meters in high risk neighborhoods. Split meters record energy consumption at the connection point and in the customers residence	Reduces the cost of providing electricity for each customer, limits the load and therefore losses generated by the community, reduces meter reading and bill processing costs and collection costs if payments are collected from a single source Split meters provide an opportunity to compare consumption paid for at the customer's meter with consumption recorded at the connection point to detect error or fraud. Reduces bad debt
Government Negotiations	Negotiate with the regulator to cover investment and operating costs in the tariff and/or with national, state and municipal government to offer subsidies for low income neighborhoods and individual consumers	To recover investment and operating costs and/or to reduce the cost of electricity for low income customers and reduce the incentive to illegally connect to the network

Illegal Consumers Loss Reduction Strategies

Tactic	Action(s)	Objective
Perform Community and Loss Analyses	Identify, investigate and categorize illegal communities according to their level of community development. Measure, sample and estimate losses for each community. Perform a community development losses analysis (similar to the asset management analysis)	To identify communities with a high level of community development and high losses. To focus normalization efforts on these communities, which have the greatest opportunity for successful transformation and value capture
Develop Commercial Approach	•Negotiate with regulator and/or federal, provincial and municipal government agencies for a direct subsidy for illegal communities /customers •Failing that, negotiate for a social (reduced) tariff for low income communities/customers •Failing that, negotiate for prepayment, flat rate tariff and limited consumption schemes •Negotiate with the regulator etc. and community leadership for the "community as customer" model and design a billing and collection process appropriate for the community and form of subsidy •Failing that, develop a Cost effective "individual as customer" process appropriate for the community and form of subsidy and with adequate antitheft technology.	To develop a sustainable payment policy and customer focused connection process for customers with limited ability to pay; decrease costs of the normalization process.
Develop Investment Approach	•Develop a technical plan for the least cost approach to network structure and method of connection •Develop a business plan to evaluate and determine economic benefit to AES •Develop a project plan to efficiently manage construction of new network	To develop a normalization program which reflects the social and physical conditions of the community which will provide the expected return to AES
Monitor And Manage Illegal Consumer Until They Are Paying Customer	Develop education programs to teach energy conservation to newly normalized communities and/or individual customers. Develop database and monitor and manage newly connected customers for changes in energy consumption and past due payments	To carefully manage high risk customers and to manage the transition from illegal consumer to paying customer


Level of Consumption/Losses
High
Low
Electrically Isolate Community
Priority One Normalization
Monitor
Priority Two Normalization
Low
High
Level of Community

Illegal Consumers Metering Technologies

Solution	Results/Comments
Pre-paid metering - to avoid bad debt	**EEE-** A prepayment pilot on 5,000 customers was conducted in 1997. The pilot was terminated because of the high cost of selling credit cards at the call center. Other solutions are under investigation **DDD -** A prepayment pilot on 1,700 customers in rural zone is underway
Remote metering - Allows meter reading in areas with access problems	**AAA** – A remote metering pilot is being implemented in Argentina
Remote metering and disconnection - Allows meter reading and remote disconnection in areas with safety problem for AES employees or contractors. Electronic meters disconnection relays are installed on the pole	**EEE –** A remote metering and disconnection pilot with 450 costumers was implemented in July 2005. The costumers receive metered energy.

Illegal Consumers Anti-Theft Technologies

Solution	Results/Comments
Protective Barriers on Posts - Impedes access to insulators for illegal hookups and theft of materials	Pilot project in process.
Extra High Poles - Reduces access to cables and boxes for illegal connections. Regular low voltage pole height is 7.5 m, whereas an extra high pole is 10 or 11 m.	Found to be a good solution because it's very difficult for customers to access the connection points.
Anti Fraud Boxes - Impedes access to boxes for illegal hookups **Termocontraibles** - Protect the secondary cables and boxes against illegal connections. And avoids the need to change to coaxial or twisted cables	Combining anti fraud boxes and thermocontraibles has had good results in preventing illegal connections in urban zones In addition the boxes organize connections, enable charge balancing, facilitate the disconnection of customers and eliminate hot points caused by loosening screw connections on the LV lines.
Coaxial Cable - Impedes illegal connections on the secondary network and taps.	**EEE** – Coaxial cables are used for normalizing all illegal connections. No problems have been encountered with this technology. **AAA –** This solution has been satisfactory. It is particularly useful in cases where illegal connections are installed inside walls. No problems have been encountered with this technology
Twisted Cables – Impedes illegal connections on the secondary network	**EEE** – Twisted cables have been installed on all secondary networks. There have been no new illegal connections on this type of cable. Some problems have been experienced with connections at the boxes and at cable ends. **AAA** – Twisted cable have been installed on the major part of the secondary network. The cable configuration and the XLPE hard covering has made it much more difficult to illegally connect. Illegal connections continue to happen on other parts of the secondary network where twisted cables have not yet been installed.

Illegal Consumers Anti-Theft Technologies

Anti Fraud Grid – It consists of a MT grid, supported in posts, in symmetrical and/or asymmetric disposition, according to air space availability, with low tension in triplex cable and neuter remote, in section of 35 to 40 meters. One phase transformers, up to 75 KVA of power and three phase ones for greater punctual loads, protected by the side of mid and low tension with operating fuses with pole. Derivation of customers' cables from non-metallic boxes, supported in the post or in the side on the LV cable, with connection to the grid in concentric cable of three threads. This construction can be combined with the installation of auto-protected transformers, which operate their protections before overloads and limit the quantity of energy that is lost product of the illegal connections not planned mainly in zones of border with P. R. A.	The construction of a pilot project is in process
Low voltage brackets - steel bracket that separate the cable from the pole. The brackets are often 1 meter in length making the cable difficult to reach for illegal connection	**AAA** – This solution has had varied success. In some cases it has prevented illegal connection, however in other cases; ladders have been used to access the cables.
Distribution box – a polycarbonate box located at mid span where the concentric cable connects Locating the boxed at mid span is a significant obstacle to illegal connections.	**AAA** – This solution has been very successful at preventing illegal customers however, the location of the box makes it more difficult to connect, cut and reconnect customers.
Load Limiter oLimits energy consumption by limiting current to the maximum level defined by the utility oProtect transformers against overload oEnables the implementation of fixed tariff systems with consumption limits oAvoids the need for meters at individual premises oEnables load management by dropping load during periods of high demand oOffers selectivity for protection devices oResets automatically seconds after opening due to excess in threshold	**AAA** – This solution is very unpopular in the low income neighborhoods. Equipment has been vandalized, and operations and maintenance crews have been prevented from accessing equipment for repair resulting in the deterioration in the quality of service in these communities.

Thank You

*fahlehmeen**deh**reet*

*meeroo**pahf**sheem*