System Losses

The Regulated Industries Commission Experience

Presented by: Garvin Alexander
Regulated Industries Commission

Outline of Presentation

- Introduction
- What are system losses
- Issues for regulators to consider
- The RIC's Experience
- Some Engineering and other Solutions
- Conclusions and Recommendations

What are system losses?

- Energy losses occur in the process of supplying electricity to consumers.

- The transmission and distribution losses comprise **technical losses**, **non-technical losses** and **administrative losses**.

Reasons for high technical losses

- Inadequate investment in transmission and distribution, resulting in overloading.
- Lack of planning for extensions of sub-transmission and distribution systems – lengthy circuits.
- Too many stages of power transformation
- Improper load management- sparsely distributed loads over large rural areas
- Inadequate reactive compensation
- Poor quality equipment in industrial applications
- Increased use of information technology equipment worldwide, causing harmonics and other power quality issues

Reasons for high non-technical losses

- Numerous instances of illegal connections
- Meter tampering
- Inability to recover outstanding revenue due to
  - poor billing and collection policies
  - Weak legal system
  - Inappropriate meter reading

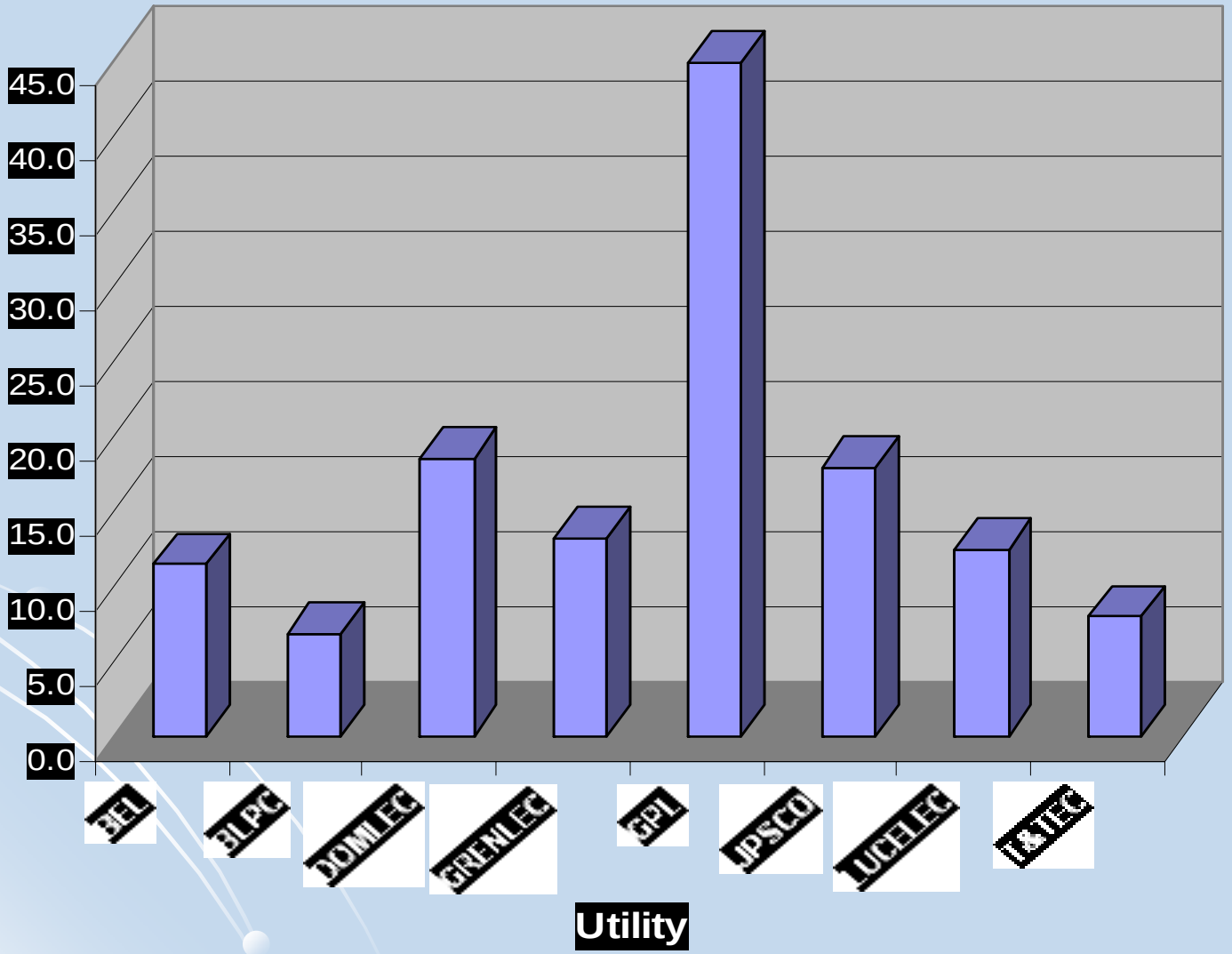
Why should we consider system losses?

- The level of losses directly affects the sales and power purchases of the utility, and can ultimately result in loss of revenues for the utility.
- Any efficiency gains to be made by the utility must include the aspect of system loss reduction in all areas of losses – technical or commercial.

TABLE 1: Summary of Utility Network Data

Utility/ Country	Avg. Cost per kWh (US D)	Level of system losses (%)	No. of Customers	Annual electricity production (GWh)
BEL (Belize)	0.18	11.5	63,076	308
BL&P (Barbados)	0.17	6.8	107,232	806
GRENLEC (Grenada)	0.225	13.2	40,012	129
GPL (Guyana)	0.25	45.0	126,938	489
JPSCo (Jamaica)	0.137	18.0	532,284	2993
T&TEC (Trinidad & Tobago)	0.021	8.0	350,000	6400

Level of System Losses (%) for Selected Caribbean Utilities



The Cost of Losses

- Transmission and distribution system losses result in considerable financial and environmental costs.
- The cost of these losses is ultimately borne by the utility's consumers.

Table 2. Annual cost of losses by utility

COUNTRY/UTILITY	annual production (GWh)	avg cost/kWh(USD)	level of system lossses (%)	financial cost of losses
BEL	307.5	0.180	11.5	6,365,250.00
BLPC	805.9	0.170	6.8	9,864,216.00
DOMLEC	62.7	0.300	18.6	2,099,196.00
GRENLEC	129.0	0.225	13.2	2,692,008.00
GPL	489.0	0.250	45.0	21,708,000.00
JPSCO	2993.0	0.137	18.0	96,973,200.00
LUCELEC	252.0	0.150	12.5	5,670,000.00
T&TEC	6400.0	0.021	8.0	10,752,000.00
TOTAL				156,123,870.00

How can Caribbean regulators deal with system losses?

- By the implementation of standards
- By the establishment of performance indicators
- By the implementation of incentives for reduction
- By the review of existing legal issues in order to make recommendations for improvement

How can Caribbean regulators deal with system losses?

Regulatory approaches for reducing system losses can be grouped into two broad categories: -

- command and control rules
- incentive based.

- Command and control rules prohibit or discourage the utility from undertaking a specified objectionable practice by the threat of a monetary penalty.
- An incentive based approach attempts to change the behaviour of the service provider through the provision of unambiguous monetary rewards and/or penalties

The RIC’s Experience

Overview of T&TEC

- T&TEC is the transmission and distribution utility
- Approximately 350,000 customers.
- T&TEC's network
  - 1,337 km of transmission mains
  - 10,773 km of distribution overhead mains and underground cable.
  - Transmission takes place at 132 kV, 66 kV and 33 kV
  - Distribution takes place at 12 kV, with some areas in Port of Spain carrying 6.6kV in a mainly underground network.

Overview of T&TEC

- Current level of system losses averages 7.9%
- Distinctive situation – major load close to generating source – low loss levels in that region
- Other areas – long distribution lines, transmission at 33kV for much of the system, submarine cable transmission to Tobago
- Much scope for the reduction of technical losses
- Apparent low level of Non-technical losses

Calculation of System Losses

- Transmission and distribution losses are generally calculated as a percentage of the difference between total energy input to the network and the total energy sold to all customers.
- Some jurisdictions have defined total losses as total energy purchased less the sum of total annual sales of energy and own usage.
- These methods lump technical and non-technical losses together.

Calculation of system losses

- In developing a formula for the calculation of total system losses, the RIC felt that consideration must be given to the non-realisation of revenue for electricity billed by the service provider.
- Hence the RIC believes that the most effective measure of the overall efficiency of the network system is the difference between kWh input into the system and kWh for which payment is collected.

Calculation of system losses

- System Losses =

$$1 - \frac{\text{Units billed}}{\text{Units purchased}} \times \frac{\text{Collection (\$)}}{\text{Billing (\$)}}$$

Monitoring and verification

- T&TEC will be required to submit quarterly reports on the system loss values as calculated using the above formula.

- The RIC intends to monitor and verify annually, T&TEC's compliance.

Designing an Incentive Framework

- Without any regulatory intervention, there would be little incentive for the service provider to reduce losses to an optimal level.
- The incentive should be sufficiently strong, but neither too strong nor too weak, to encourage the service provider to reduce losses.

Designing an Incentive Framework

- Factors to consider:
  - whether the scheme should be input- or output-based
  - at what time should the incentive be applied
  - what level of sharing, if any, should be introduced
  - what is a reasonable efficiency level of losses. Should this be based on history or an efficient level based on yardstick competition

Designing an Incentive Framework

- The RIC has
  - researched a number of output-based and input-based schemes
  - considered the advantages and disadvantages of each
  - structured an appropriate incentive scheme for the first rate review period for T&TEC.

- The RIC has favoured a less formal output based mechanism for the treatment of system losses.

RIC's Proposed Incentive Scheme

- A target system loss level (6.75%) is prescribed at the beginning of the regulatory control period for the entire period.
- If actual total system loss is less than the prescribed target figure, T&TEC would be allowed to keep the entire difference, with a cap of 90%, as an incentive.
- If the actual loss level achieved is higher than the prescribed target, then T&TEC bears the entire difference as a penalty, without any safety net.
- Any sharing of efficiency gains will be kept for the entire regulatory period of five years – Efficiency carryover mechanism

Possible strategies for T&TEC

- Possible strategies to reduce T&TEC's system losses
  - the installation of low-loss equipment on the distribution system
  - upgrading the sub transmission voltage from 33 kV to 66 kV
  - installing capacitor banks at strategic locations on distribution feeders.

Other Methods of Reduction

- Improved technologies such as
  - HVDC transmission
  - high strength composite overhead conductors,
  - power transformers and underground cables that use high temperature superconductors
  - high efficiency conventional transformers
  - Decentralised energy* - to be expanded upon

Decentralised energy

- World Alliance for Decentralised Energy (WADE) defines Decentralised Energy (DE) as the high efficiency production of electricity near the point of use, irrespective of size of technology.
- It is more efficient to generate electricity near to where it is needed, since large amounts of energy are wasted as heat, carrying power along high voltage ac electric lines.

Decentralised energy

- According to WADE, in developing countries, T&D losses average 13.4% per year.
- DE could be a reasonable alternative to the provision of centralised power in remote or sparsely populated villages.

Disadvantages of Centralised Generation

- The use of central electrical generation systems require extensive and costly T&D systems and which are prone to high losses.
- Other drawbacks of centralised power include:
  - Central power generation plus the required new T & D require twice the capital outlay as DE generation at or near the users.
  - Central power plants are substantially less efficient.
  - The central power model is more vulnerable to system disruption or destruction.

Decentralised energy – An example

- An example of the possible application of DE is the installation of electricity generation by gas turbine driven generators in the island of Tobago. This will: -
  - eliminate losses over the 2 x 43.75 km of submarine cable from Toco in Trinidad to Milford Bay in Tobago.
  - increase reliability and voltage quality, which should result in less damage to equipment on the island.
  - create the ability to export power back to Trinidad.
  - improve efficiency by having a source of generation close to where it is needed.

Relevance and Feasibility

- The relevance of each of the aforementioned methods should be assessed in terms of the country's network characteristics.

- Size of network, voltage levels, load distribution, dispersion of customers and cost of implementation are some of the important factors/ characteristics to be considered.

Conclusion & Recommendations

- Given the importance of the reduction of system losses to Caribbean utilities, appropriate incentive mechanisms should be implemented by regulators to encourage the utilities to embark on feasible measures to reduce system losses.
- Caribbean utilities should be incentivised to make use of new technologies that have already been developed.

Conclusions & Recommendations

- There is need to change in areas such as
  - procurement policies
  - legal statutes to allow technologies such as distributed generation and renewable energy.

Conclusion & Recommendations

- In its rate determination exercise for T&TEC, the RIC has designed an appropriate incentive scheme that seeks to encourage the utility to reduce the total system losses on the T&D network.
- It is hoped that the incentive is sufficiently strong to encourage the service provider to make the necessary investment.

The End