WEL's Distribution Loss Factors

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Introduction

During the process of distributing electricity between the Point of Supply (POS) and the individual consumer a small proportion of the electricity is lost. There are two components to these losses

> Those losses due to the inherent operation of an electricity network, called "***Technical Losses"***
>
> And those attributable to metering errors, incorrect meter installation, billing errors, theft, and unread meters, which are called "**Non Technical Losses"**

Definitions

Loss ratio: is the ratio of electricity consumed between the POS and the end user with respect to the energy injected into the network at the POS. It is defined as:

Loss ratio = Energy Losses/Energy Input

Note, the loss ratio is expressed in terms of energy, not in terms of power. Energy is found by integrating power usage over time.

A loss factor: expressed as a multiplier, is used to estimate the difference between quantities injected into a network at a POS and the sum of metered quantities at the meters of consumers accumulated over a period of time.

Loss factor = 1/(1-Loss ratio)

WEL's Obligation

WEL networks Limited, as an electricity distributor, is required by the Electricity Information Disclosure Requirements (2004) to disclose the loss factors that apply to WEL's networks and is also required by Part E of the Electricity Governance Rules 2003 (Rules) to supply loss factors for the reconciliation process to the reconciliation manager via the Registry. Also in accordance with Part E of the Electricity Governance Rules 2003 (Rules), WEL has an obligation to calculate and publish loss factors for each network through which WEL distributes electricity.

Technical Loss Factor Calculation Methodology

1. Background

As explained in the introduction Technical losses represent the electricity entering the network that is dissipated during the delivery to end users' installations. There are two main components to this loss:

a. a fixed component that arises from the standing losses of the network transformers; and
b. a variable component that arises from the heating effects of the resistance in the network components.

The major source of technical losses is the variable part, as this is proportional to the square of the current flowing in a component.

2. Limitations

The ideal way of establishing losses is to have high quality synchronized metering at both the input and output points of a network. This would provide the most accurate network loss figure, however it would still be subject to metering errors. In practice a distribution system does not have such metering and thus alternative ways of determining technical losses must be used.

3. Approach

WEL has segmented its network into three levels between the POS and the end user:

- 33kV sub-transmission system including the 33/11kV zone substation transformers
- 11kV feeder network
- 400/230 volt distribution network (including the 11kV/400-230volt transformers)

The loss ratio for each of these was derived in turn:-

33kV Sub-transmission

The loss ratio for this level of the network was determined by three different approaches:

A calculation based upon a typical mix of overhead and underground circuits to produce a weighted average loss based on the recorded line and cable lengths under typical loadings.

A comparison was done of the known load through the POS with a calculated load flowing out of the transformers. Voltage, current and power factor data on the individual transformers was taken from the WEL SCADA system and was based on a typical winter loading.

A computer based network analysis of the 33kv system was also carried out based on a typical winter loading.

A composite of these three figures was used to develop a value for 33kV losses.

11kV Feeder Network

The losses in the 11kV network were calculated using a model extracted from the mapping and record system and run in a power system analysis tool. The calculations were carried out using the system peak load.

400/230 volt distribution network (including the 11kV/400-230volt transformers)

WEL determined the losses for the LV network by analyzing a typical subdivision. This was cross checked against a series of measurements taken at the subdivision. This loss ratio was then assumed for the entire low voltage network. (There is no model of the entire low voltage network currently available.)

11kV to 400 v transformer losses

To allow the accurate determination of loss factors for customer fed directly from the 11kV network a figure for transformer losses for those customers metered at low voltage needed to be assessed. For this published transformer loss curves were used to determine a realistic loss factor based upon typical loadings.

Generation Loss factor

Under part E of the Electricity Governance Rules there is a requirement to calculate an individual loss factor for all embedded generators in excess of 10MW. The approach taken has been to model network losses with and without the generator running and use this difference in the losses to derive a loss factor for the generator. When the generator has the effect of reducing network losses the loss factor is greater than 1 and when the effect is to increase losses the loss factor is less than 1.

Percentage Loss Ratios

From this exercise a loss ratio for each component of the network was derived

33kv sub-transmission system	0.81%
11kV feeder network	1.9%
11kV to 400v transformer losses	1.3%
400/230 volt distribution network	2.8%

Technical Loss Factors

The above loss ratios were then used to derive a technical loss factor for each voltage level of the network and for each or WEL Networks embedded networks.

The loss factors for embedded networks increase as houses are built and start to consume electricity. When they are first built and largely vacant the transformer losses

predominate. As more houses are built, the losses increase to that of general low voltage network figure.

Non Technical Loss Factor Calculation Methodology

Non Technical Losses are the difference between the energy entering the network and the energy leaving the network adjusted for technical losses.

Non Technical Losses = Total Energy In – (Technical Loss Factor x Metered Energy)

The Total Energy In was determined from the Transpower billing data plus the billing data provided for Embedded Generators adjusted for generation loss factor.

Metered energy was obtained from normalized billing information by supply point provided by energy retailers, where available. If this was not available retailer billing information was utilized (5% by volume).

These data were obtained for the period 1 May 2006 to 30 April 2008.

From this the total amount of Non Technical Losses (kWh) were derived. This energy was then allocated to each voltage level on a volume weighted basis. By this means a non technical loss ratio for each network component was derived.

33kv sub-transmission system	1.001
11kV feeder network	1.001
11kV to 400v transformer losses	1.001
400/230 volt distribution network	1.001

Published Loss Factor

The loss factor used for reconciliation purposes (Reconciliation Loss Factor) is calculated for each loss category by multiplying the Technical Loss Factor by the Non Technical Loss Factor.

Reconciliation Loss Factor = Non Technical Loss Factor x Technical Loss Factor

The Loss Factors applicable to the WEL Networks from 1 April 2009 are outlined below.

WEL's published Loss Factors

Loss code	Loss factor consumption	Loss Factor Generation	Description
530	1.057		Waikato Low Voltage
531	1.009		Waikato 33 kV
532	1.028		Waikato 11 KV HV metering
533	1.041		Waikato 11 KV LV metering
534	1.028	1.030	Te Rapa Co-generation
535	1.024		Kirkdale (Manukau)
537	1.020		Half Moon Bay (Pakuranga)
538	1.028		Oaklands (Cambridge)
539	1.020		Flagship (Manukau)
540	1.020		Wharewaka (Taupo)
541	1.024		Jeffs Rd Dannemora (Manukau)
542	1.020		Parawera (Taupo)
543	1.020		Aotea (Wellington)
545	1.020		Hulme Place (Henderson)
546	1.020		Ryan Place (Manukau)
548	1.020		Southgate Wellsford
549	1.020		Brick Street (Manukau)
550	1.020		The Strand (Wainuiomata)
551	1.020		Belfast (Christchurch)
552	1.020		Silverwood (Whitby)
IMTMTG	1.028		Mangatahi Interconnect

- Loss factors 535 and above are technical losses only, the Electricity Commission is at present reviewing the application of loss factors to Embedded networks and these will be adjusted in line with these directives once they are published

Demonstration for the accuracy of the loss calculation for 1 Apr 2007 on WEL Traditional Networks

	Volume entering Network (GWh)	Volume used by Network (GWh)	Losses (GWh)	Loss Ratio
Actual Volumes for 1 Apr 2007 to 31 Mar 2008	**1,200.9**	**1,142.5**	58.3	4.86%
Forecast Volumes based on Loss Ratio set for 1 Apr 2007	1,209.0	**1,142.5**	66.5	**5.50%**
Variance	-8.2	0.0	-8.2	-0.68%

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