EVALUATION OF DISTRIBUTION LOSS FACTORS 2015-2016

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APPENDICES

1 Introduction

The National Electricity Rules require that Distribution Network Service Providers (DNSPs) obtain the approval of the Australian Energy Regulator (AER) as the relevant regulator for Distribution Loss Factors (DLFs) for the DNSP's network. This report nominates the DLFs for Endeavour Energy's electrical distribution network for the 2015/2016 financial year. It also outlines the methodology, assumptions and base data used for the calculation of the loss factors.

The methodology used in this calculation is based on the requirements set out in Endeavour Energy's publication "Methodology for the Determination of Distribution Loss Factors" dated 30 January 2008. In compiling the DLFs, and in line with Section 2.1 of the Report, "actual load and generation data for the most recently completed financial year will be used, in line with NEM Rules clause 3.6.3 (h)(5)." The AER requires that distribution loss factors should be calculated for site-specific major customers, while loss factors for each tier of the network should be provided to calculate the losses attributable to the remainder of the customers.

The methodology used in this report is identical to that used in the submissions since 2008/09.

As required by the Rules, the proposed DLFs are "forward looking" and use both demand and energy forecast data as provided by Endeavour Energy's Forecasting and Finance Sections for the 2015/16 fiscal year.

2 Summary of Results

Network Level[1, 3]	2015/2016		2014/2015		2013/2014	
	Effective Section Loss Factor %	Cumulative Loss Factor %[2]	Effective Section Loss Factor %	Cumulative Loss Factor %[2]	Effective Section Loss Factor %	Cumulative Loss Factor %[2]
132 kV Network	0.34%	0.34%	0.32%	0.32%	0.26%	0.26%
Transmission Substation	0.28%	0.78%	0.28%	0.75%	0.24%	0.60%
Subtransmission Network	0.45%	1.09%	0.47%	1.09%	0.45%	1.13%
Zone Substation	0.40%	1.15%	0.39%	1.13%	0.47%	1.25%
High Voltage Distribution Network	0.69%	1.85%	0.61%	1.75%	0.98%	2.41%
Distribution Substation	2.77%	4.85%	2.69%	4.67%	2.76%	5.70%
Low Voltage Distribution Network	1.09%	6.82%	1.09%	6.65%	1.50%	6.94%

Table 1 - Generic Loss Factors

Notes:

1. All % loss factors quoted in the above table are given as the % of energy delivered at that level of the network, whether to customers at that level, or to lower levels.
2. In this study section loss factors do not add numerically to give cumulative loss factors due to the effects of compounding and network configuration.
3. An allowance for theft losses of 0.5% of total sales has been made.

An examination of the results indicates that the proposed 2015/16 DLFs is marginally higher than what was proposed last year but overall is consistent with recent historical values.

The calculation of the above loss factors is set out in Appendix A. The billed energy data used as the basis of the report is contained in Appendix B.

In addition, and in accordance with the National Electricity Rules, all customers with an average energy consumption of greater than 40GWh and/or 10MW demand have had site specific Loss Factors calculated. Embedded Generators with a peak output of greater than 10MW have also had Loss Factors calculated. The results are summarised in the following tables:

Significant Customers	2015/2016 Loss Factor %	2014/2015 Loss Factor %	2013/2014 Loss Factor %
Customer A	0.35%	0.37%	0.44%
Customer B	0.19%	0.19%	0.21%
Customer C	0.55%	0.43%	0.33%
Customer D	3.85%	3.86%	3.06%
Customer E	0.78%	0.66%	0.70%
Customer F	0.10%	0.07%	0.09%
Customer G	1.23%	0.96%	1.02%
Customer H	-	0.51%	0.51%
Customer I	-	0.39%	0.4%
Customer J	0.69%	0.72%	0.76%
Customer K	1.52%	1.35%	1.21%
Customer L	3.10%	3.28%	2.89%
Customer M	3.10%	3.10%	3.68%
Customer N	1.35%	1.00%	1.01%
Customer O	1.35%	1.08%	1.39%
Customer P	0.61%	0.89%	1.54%
Customer Q	1.34%	1.29%	1.44%
Customer R	2.65%	2.99%	2.97%
Customer S	0.81%	1.48%	1.57%
Customer T	0.86%	-	-
Customer U	0.87%	1.15%	1.67%
Customer V	1.48%	0.96%	-
Customer W	0.82%	0.87%	0.89%
Customer X	0.47%	0.45%	0.47%
Customer Y	-	0.45%	-

Table 2 - Location Specific Loss Factors for Customers >40GWh pa Consumption and/or Maximum Demand >10MW

The DLFs for the major embedded generators are as shown below. The methodology for the calculation of these DLFs is based on the difference in losses in the network between the conditions where the generator is operating and not operating over an annual cycle, relative to the energy sent out by the generator over the same period.

Generation >10MW	2015/2016 Loss Factor %	2014/2015 Loss Factor %	2013/2014 Loss Factor
Generator A	0.25%	-0.19%	-0.10%
Generator B	1.15%	0.78%	0.82%
Generator C	0.51%	0.24%	0.28%
Generator D	-0.06%	-0.06%	-0.04%

Table 3 – Location Specific Loss Factors for Embedded Generators >10MW

3 Reconciliation of Forecast and Actual Losses

In accordance with Rules requirements, a reconciliation of forecast and actual losses has been carried out. This involved taking the complete billing data set for 2013/14 and comparing the losses incurred with those estimated by the calculations carried out in 2012/13. A summary comparison between the actual losses as calculated from the billing data and the losses predicted by calculation is shown in Table 4 below.

Details of this calculation for the 2013/14 year are contained in Appendix B.

Financial Year	Forecast Loss kWh	Actual Loss kWh	Difference kWh	Energy Distributed kWh	Forecast error as % of Energy Distributed
2006/07	1,062,802,864	922,867,190	139,935,674	17,457,605,133	0.80%
2007/08	944,468,857	907,912,261	36,556,596	17,410,946,298	0.21%
2008/09	1,073,392,460	988,987,754	84,404,707	17,363,078,492	0.49%
2009/10	836,833,750	742,886,372	93,947,378	17,514,300,287	0.54%
2010/11	891,864,721	774,135,147	117,729,574	17,431,698,650	0.68%
2011/12	845,522,227	831,903,329	13,648,898	16,393,244,332	0.08%
2012/13	740,442,654	620,376,827	120,065,827	16,693,856,384	0.75%
2013/14	662,109,404	644,181,958	17,927,446	16,281,133,055	0.11%

Table 4 – Reconciliation of Forecast to Actual Losses

Note that financial year 2013/14 is the last complete set of available billing data.

4 Overall Methodology

This submission presents loss factors that can be applied to customers' metered energy to recover upstream network losses. In general, loss factors have been calculated for each hierarchical level (or tier) of Endeavour Energy's network to apply across the entire Endeavour Energy franchise area.

Energy loss in the supply network falls into two categories. The first is series losses which are dependent on the load being supplied, and the second is shunt losses which are independent of the load, and are confined to the transformers on the network. Both series losses and shunt losses have been determined and included in this study.

For site specific (SS) or general tariff customers (TC) connected to zone substations, or higher voltage levels, the loss factor calculations have been achieved by calculating the losses attributable to the customer within each hierarchical tier of the network using 15 minute metering data. From the resulting series of load flow solutions, the DLF for the site specific or tariff customers can then be determined from the sum of the series and shunt network losses attributable to that customer, divided by the energy consumed by that customer.

The series losses are calculated by incorporating the 15 minute metering data from the previous financial year into the load flow routine. This metering data is scaled such that the peak demand matches the forward looking forecast demand for the relevant customer. However, in recent years, energy consumption has been in decline at a faster rate than demand at most locations. Therefore, scaling the metering data by the peak demand alone does not produce network loads representative of the coming year. Hence, the forecast metering data is also normalised in order to obtain a load flow energy consumption that matches the forecast energy demand.

For each metering interval, one load flow solution is obtained to determine the total network losses and the accumulated network losses within each hierarchical tier. During the course of the financial year, there are 35040 individual 15 minute metering data points. Therefore, the loss factor *LF* for TC or SS customer *K* is given by:

$$LF = \frac{\sum_{N=1}^{35040} Losses(K)_{Series} + \sum_{N=1}^{35040} Losses(K)_{Shunt}}{\sum_{N=1}^{35040} Energy(K)}$$

where:

N	=	the 15 minute metering interval
LF	=	the loss factor for the customer
$Losses(K)_{Series}$	=	the total series losses attributable to the customer
$Losses(K)_{Shunt}$	=	the total shunt losses attributable to the customer
Energy(K)	=	the energy consumed by the customer during the interval *N*.

The proportion of the series network losses which are attributable to the customer is calculated through linear estimation of the load flow solution at each of the 15 minute time intervals.

Similarly, the proportion of the shunt network losses which are attributable to each customer is calculated in accordance with the relative load placed on that transformer by the customer. Within substations, transformer no-load losses have been calculated from manufacturer's data where available as:

$$\text{Shunt Energy losses (kWh)} = \text{shunt losses (kW)} \times 8760 \text{ hours}$$

For example, if one transformer supplied both a 20 GWh pa of network load and a 10 GWh pa customer with a location specific loss factor, the transformer shunt losses would be allocated 2/3 to the network "pool" and 1/3 to the 10 GWh customer.

For customers supplied from 11/22kV distribution feeders, the additional distribution series losses are calculated using a LLF for each zone substation. In this case, the distribution series losses are defined as:

$$\text{Series Energy Losses (kWh)} = \text{peak losses (kW)} \times 8760 \text{ hours} \times \text{LLF}$$

The peak distribution losses were modelled in the DINIS load flow package using location specific demand forecasts for the 2015/2016 year. The LLF is the ratio between the instantaneous losses incurred at peak load and the average instantaneous losses over a year. It is based on the square of the load and can be expressed as follows:

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

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

In accordance with the National Electricity Rules, site specific loss factors have been calculated for those customers whose demand is in excess of 10MW, and/or whose consumption is greater than 40GWh per annum. The calculations use data specific to each customer's load profile and the assets used to supply them. The losses and energy allocated to the significant customers are then removed from the generic pool. The remaining losses and energy are used to determine the general network loss factors by calculating the pool of losses incurred within a particular level of the network and dividing them by the total energy delivered by that level.

It should be noted that the overall network DLFs take account of the effect of all other embedded generation on the network. Metering data for each of these sites has been included in the previous load flow calculations.

Embedded generators which generate at a peak of >10MW have also been allocated a site specific DLF. As stated previously, the methodology centres on the difference in network losses between the conditions where the generator operating and not operating over an annual cycle. The loss factor for generator *G* is then equal to:

$$LF_G = \frac{\sum_{N=1}^{35040} \left(L_{GEN\_OUT} - L_{GEN\_IN} \right)}{\sum_{N=1}^{35040} E_G}$$

where: LF_G = the loss factor for the generator
L_{GEN_IN} = the total network losses when the generator is modelled in service, in accordance with the generation profile for the last financial year
L_{GEN_OUT} = the total network losses when the generator output is set to zero during the metering interval *N*.
E_G = the energy sent out by the generator during the metering interval *N*

In summary, the calculation methodologies are presented in the table below. Additional detail on the calculations for each of the tiers of the network is presented in sections 5 to 11 of this submission.

Network Element	Voltage Level	Series Loss	Transformer	
			Series Loss	Shunt Loss
Transmission Network	132kV	Summation of 15 minute load flow solutions using normalised metering data.		
Transmission Substation	132/66/33kV		Summation of 15 minute load flow solutions using normalised metering data, in conjunction with manufacturer's data.	Use of manufacturer's data (fixed losses for each type of transformer)
Sub Transmission Network	66kV, 33kV	Summation of 15 minute load flow solutions using normalised metering data.		
Zone Substation	132/11kV, 132/22kV, 66/11kV, 33/11kV		Summation of 15 minute load flow solutions using normalised metering data, in conjunction with manufacturer's data.	Use of manufacturer's data (fixed losses for each type of transformer)
HV Network	22kV, 11kV	Use of load flow at peak with LLF calculated on metering data where available (or SCADA data)		
Distribution Substation	22/0.415kV, 11/0.415kV		Use of load flow at peak with manufacturer's generic data on impedance and typical LLF for distribution transformers.	Use of generic manufacturer's data (fixed losses for each type of transformer)
LV Network	415/240V	No calculations performed. Residual energy from above, based on billing data, apportioned to LV network.		

Table 5 – Summary of Network Loss Allocation Methodologies

4.1 Energy Transferred

The loss factors calculated in this report are to be applied to customers' metered energy. Therefore, the kWh energy losses at any level of the network must be expressed as a percentage of the energy **delivered at that level** of the network, irrespective of whether it is delivered to customers at that level or to customers at lower levels of the network. In a simple hierarchical network this is a matter of starting with the energy supplied from the BSP and progressively subtracting loads and losses at each level.

Endeavour Energy's network is more complicated due to the following factors:

- In some cases, 132/11kV Zone Substations bypass Transmission Substations and the 33/66kV subtransmission network
- A number of 66kV subtransmission feeders and 66/11kV zone substations are connected directly to BSP's thus bypassing transmission substations, and
- Endeavour Energy has a significant quantity of embedded generation connected at 132, 66 and 33kV.

These factors have been taken into account in the calculation of the energy delivered at each level of the network and hence in the percentage loss factors.

4.2 Accumulation of Loss Factors

Due to the complicated nature of the network noted above, it has not been possible to simply add successive loss factors to arrive at an overall loss factor. Rather, account must be taken of the different paths by which the energy may reach the user.

Consequently, the resulting cumulative loss factors are derived by dividing the network losses attributable to only the tariff customers, within each level of the network, by the energy delivered to that same level of the network.

The applicable proportion of network losses is calculated using the linear estimation of each load flow solution, as described previously. Similarly, the delivered energy is derived through a subtraction of the loads and losses at each level, as described in Section 4.1.

4.3 Treatment of Theft

This study has identified theft as a separate line item and has taken a value of 0.5% of total sales (as recommended by the former DLF Working Group) and applied this to the calculations. It has been assumed that all theft occurs at low voltage and the overall theft apportionment is therefore allocated to the low voltage network. Consequently, this equates to 1.1% of low voltage sales (see Appendix A).

4.4 Site Specific DLFs

In addition, a total of 22 site specific DLFs have been calculated. Site specific DLFs for embedded generators >10MW have also been calculated.

General comments driving changes to DLFs are summarised below:

- Care has been taken to ensure that the transmission network has been modelled in the configuration that is most representative of the way in which the system is generally operated in practice.
- Load flow models for the 2015/16 year were executed with the network configured according to current capital program commitments.
- Substantial effort has been put in to returning out-of-service or failed capacitors at Transmission Substations to service and to installing capacitor banks on the 11kV busbar at Zone and Transmission Substations. Consequently, a level of static reactive support has been modelled in the load flow calculations. However, the magnitude of this support is less than the maximum available. Instead, the status of each capacitor has been estimated by considering the time weighted average reactive support at each location.

The DLFs for the major embedded generators have been calculated.

5 132kV Lines

Endeavour Energy's 132kV network supplies transmission substations, 132/11kV zone substations and 132kV customers. Forecast load data from the 2013/14 year was used to determine the 15 minute average line losses using a load flow calculation. This data was normalised to account for both the forecast 2015/16 peak demand and the forecast energy consumption from the network.

The 132kV line losses were then accrued from the load flow calculations conducted for each 15 minute metering interval. In the case of site specific 132kV customers, the 132kV line losses attributable to that customer were calculated from a linear estimation of the load flow solution, at each time interval.

6 Transmission Substations

Transformer series losses were calculated by applying the forecast 2015/16 load data to the network load flow model. The transformer losses were then accrued from those obtained in each 15 minute metering interval.

Actual shunt losses were used for over half of the transmission substations. The average shunt losses for the known transformers, as a percentage of rating, were applied to the remainder.

7 Subtransmission Lines

The subtransmission line series losses were also calculated by applying the forecast 2015/16 load data to the network load flow model. The line series losses were then accrued from those obtained at this level of the network in each 15 minute metering interval.

8 Zone Substations

As in the case of transmission substations, the transformer series losses were calculated by applying the forecast 2015/16 load data to the network load flow model. The transformer losses were then accrued from the losses in each metering interval.

Nameplate shunt losses were used for the majority of zone substations. The average shunt losses for the known transformers, as a percentage of rating, were applied to the remainder.

9 Medium Voltage Lines (11kV, 22kV)

The medium voltage peak distribution line losses for the whole distribution network were modelled by applying the forecast 2015/16 peak demands to the DINIS load flow model for each of the Zone Substation networks. The losses for each Zone Substation network were then calculated using the 2013/14 LLF for that zone substation, applied to the peak line losses of feeders supplied from the particular substation.

In cases where a site specific customer was supplied by a medium voltage distribution feeder, the losses attributable to the general tariff customers were first determined by calculating the LLF, while excluding the site specific customer from the load flow model. The calculation was then repeated using the site specific customer's own LLF and a load flow model which excluded the general tariff customers.

10 Distribution Substations

Losses incurred within distribution substations were assessed by using an average load and generic transformer characteristics due to the large number of distribution transformers in the Endeavour Energy network (>30,000). The numbers of each size of transformer were determined from Endeavour Energy's Asset Database (Ellipse) as at January 2015.

Transformers of 100kVA or greater are generally fitted with Maximum Demand Indicators (MDIs) and so maximum loadings can be monitored. The latest MDI reading for each individual transformer was used to determine an average utilisation for each transformer category, or rating. For those transformers with no corresponding MDI data, a lower utilisation of 50% was assumed.

Transformer full load loss values ranged from 1.5% of rating for the smallest transformers down to 0.9% for the largest. Shunt losses ranged from 0.5% of rating for smaller units down to 0.25% for the larger ones. A LLF ranging from 0.21 to 0.23 has also been used for the distribution transformers as this is representative of the average LLF for the whole of the Endeavour Energy network.

The detailed loss evaluation for distribution substations is contained in Appendix C.

11 Low Voltage Lines

Due to the lack of load information and modelling data it is not possible to model LV network losses directly. Instead, losses were assessed using an assessment of energy purchases less energy sales, theft and other losses.

To determine LV network losses, total losses were first calculated by subtracting energy purchases from energy sales. All other calculated network losses, including theft, were then subtracted from total losses to give the LV network losses.

12 Location Specific Loss Factors

Location specific loss factors were calculated for a total of 22 significant customer connection points. The factors were calculated using the same methodology as the general loss calculations; using forecast load data for the 2015/16 year to determine the 15 minute average line losses using a load flow calculation.

In most cases the major customers shared upstream network assets with other general Endeavour Energy Network customers. As noted previously, the energy losses for these shared assets were calculated and allocated to the loads in proportion to the energy delivered to each load by each asset through a linear estimate of the load flow solution at each metering interval. The location specific loss factors were then calculated using the total energy losses attributable to a particular load divided by the energy delivered to that load. These quantities were then subtracted from the overall network pool, which was used to calculate the general Loss Factors.

Appendix A – Calculation of Loss Factors

Network Level	Average Power Supplied by each Network Tier (MW)	Average Power Supplied by each Network Tier (kWh)	Cum. Loss (kWh)	Residual Losses (kWh)	Section Loss Factor %	Cum. Loss Factor %
Total System load (from BSP's)	1271.9	**11,141,890,856**				
less site specific customers		3,121,208,271				
less losses allocated to site specific customers	4.2	37,184,784				
Energy available to general pool		7,983,497,802				
less 66kV direct connections bypass	160.6	1,407,045,955				
Energy available to 132kV network		**6,576,451,847**				
total losses in 132kV network	3.8	33,342,840	33,342,840	573,474,482	0.3410%	
less 132/11kV ZS bypass (inlcuding bypass losses)	341.9	2,994,758,120				
add 132kV embedded generation		3,234,493,815				
Energy available to Transmission Substations		**6,782,844,703**	52,526,248	554,291,073	0.2836%	0.7766%
less unallocated TS losses	2.2	19,183,409				
Energy into Subtransmission Network (33/66kV)		**6,763,661,294**				
less unallocated 33/66kV line losses	4.2	37,163,932	89,690,180	517,127,141	0.4521%	1.0912%
add 33kV and 66kV embedded generation		1,493,219,660				
less unallocated 33kV and 66kV major customer loads		632,891,267				
Energy into Zone Substations		**7,586,825,755**	137,092,265	469,725,056	0.3970%	1.1481%
add back 132/11kV ZS bypass	341.9	2,994,758,120				
add back 66kV direct connections bypass	160.6	1,407,045,955				
less unallocated ZS losses	5.4	47,402,084				
less unallocated HV Customers connected to ZS		47,126,430				
Energy into High Voltage Distribution Network		**11,894,101,316**	219,138,782	387,678,539	0.6913%	1.8464%
Add embedded generation at HV		56,534,137				
less unallocated distribution network losses	9.4	82,046,518				
less generation consumption						
less unallocated 11kV and 22kV HVC's		1,063,615,612				
Energy into Distribution Substations		**10,804,973,323**	509,869,855	96,947,467	2.7651%	4.8493%
add embedded generation at distribution substations						
less distribution transformer losses	33.2	290,731,072				
less LV Customers connected to Dist Sub		1,709,878,099				
Energy into Low Voltage Distribution Network		**8,804,364,152**	606,817,321		1.0893%	6.8179%
Add PV generation		114,932,241				
Total IN		8,919,296,393				
LV Network Customers (incl unmetered)		8,822,169,071.15				
Allowance for theft @ 0.5% of total sales		78,184,755	17,982,493.76			
LV Losses		96,947,467				
Calculation of Overall System Losses				15,396,888,749	15,156,826,403	
Scaled Energy In		11,141,890,856				
Scaled Generation In		4,899,000,000		4,727,713,475		
Scaled Billed Energy to unallocated customers		12,275,680,481				
Site specific customers Energy		3,121,208,271				
Losses allocated to site specific customers		37,184,784				
Total Available Losses (excluding site specifics but including theft)		606,817,321	139,567,984	(Scaled Generation + Scaled BSP energy) less (Scaled		
Total Losses including site specific and theft		644,002,105				
Overall System Loss Factor (excl Major Customers)		4.94%				
Overall System Loss Factor (incl Major Customers)		4.18%				
Overall System Losses as a % of Energy Imports		3.96%				

Appendix B – Billed Energy Data for 2013/14 Financial Year incl Reconciliation of Calculated to Actual Losses

13/14 Data	
Energy Imports	
Summary - Energy Imports	kWh
TransGrid - All BSP	11,381,953,202
Embedded Generators	4,899,179,853
Sunpower - included in "Embedded Generators" Total	
Total Imports kWh	**16,281,133,055**
Embedded Generators breakdown	kWh
Landfill Gas	**117,339,501**
Non-Renewable	**4,660,198,183**
Renewable - PV, Hydro & Wind	**121,642,169**
Total Embedded Generation	**4,899,179,853**
Energy Exports	
Consumption Data based on WAPC	kWh
Total Board Report	**15,636,951,097**
Dom & CLd (not including NSW Solar Bonus Scheme)	**5,146,965,719**
Domestic	**4,288,199,974**
Controlled Load	**858,765,745**
NSW Solar Bonus Scheme	**178,687,405**
Commercial	**2,169,283,073**
General Supply Non TOU	**1,689,793,678**
General Supply TOU	**335,753,224**
Unmetered -	**143,736,171**
Industrial	**8,320,702,305**
Low Voltage TOU Demand	**3,455,860,724**
High Voltage TOU Demand	**1,636,995,650**
Subtransmission TOU Demand	**1,851,763,444**
Bulk & Inter-distributor Transfer	**1,376,082,487**

Existing and Potential Site Specific Customers	
High Voltage TOU Demand	**1,636,995,649**
Sub Transmission TOU Demand	**1,851,763,442**
Bulk & Inter-distributor Transfer	**1,376,082,488**

Subtract from Subtransmission TOU Demand (N39) Tariff	1,851,763,444
N39 Tariff Consumption without site specifics in current year	424,750,380
Subtract from N53 Tariff	
N53 Tariff Consumption without site specifics in current year	143,677,057
.	
Total of all LV customers (including all unmeterd)	**10,772,109,516**
Total of all HV customers (excluding site specifics)	**1,110,742,042**
Total of all ST Customers (excluding site specifics)	**632,891,267**
Total energy consumption of all site specifics in current year >40Gwh or >10M	**3,121,208,271**
Cross Check Total Consumption	**15,636,951,095**
Difference	**2**
Unallocated 33kv and 66kV customers (energy) kWh	**632,891,267**
HV Customers Connected Directly to Zone Sub HHVT	**47,126,430**
HV Customers Connected into HV network HHVL	**1,063,615,612**
LV Customers connected directly to Distribution Sub HLVT	**1,709,878,099**
LV Customers connected into the LV network HLVL * excludes unmetered	**8,918,495,246**
Unmetered LV Supplies	**143,736,171**
Site Specifics from above	**3,121,208,271**
Cross Check total Consumption	**15,636,951,095**
	2
Total Energy in	**16,281,133,055**
Total Billed Energy	**15,636,951,097**
Actual Losses (last Financial Year)	644,181,958
Overall losses as a function of Energy Imports	3.96%
Overall losses as a function of Energy Sales	4.12%
Allowance for Theft (0.5% of total sales)	78,184,755
Theft as a % of low voltage sales (s4.3 of report)	0.73%
General Customers Billed (Total Billed less Site Specific Customers)	12,515,742,827
Energy in incl Generation	16,281,133,055
Site Specifics	3,121,208,271
Overall Losses Energy In less General Customers Billed + CRP	644,181,958
Overall Loss factor as a function of Billed Energy	4.12%
Forecast Losses for 2013/14 (From that year's DLF report)	662,109,404
Loss Difference	17,927,446
Error as % of Energy Distributed	0.11%

Appendix C – Calculation of Losses for Distribution Substations

Rating (kVA)	No. in service	Total Losses (MW)	Assumed LLF	Avg full load series loss %	Avg full load series loss kW	Utilisation Factor	Total Series Loss (MW)	No load Loss %	No load loss per tfr (kW)	Total No Load Losses (MW)
0	1475	-	0.21	1.50%	0	50.00%	-	0.50%	0	0.0000
3	2	0.0000	0.21	1.50%	0.045	50.00%	0.00000	0.50%	0.015	0.0000
5	108	0.0031	0.21	1.50%	0.075	50.00%	0.00043	0.50%	0.025	0.0027
6	0	-	0.21	1.50%	0.09	50.00%	-	0.50%	0.03	0.0000
8	2	0.0001	0.21	1.50%	0.1125	11.00%	0.00000	0.50%	0.0375	0.0001
10	684	0.0420	0.21	1.50%	0.15	60.00%	0.00776	0.50%	0.05	0.0342
15	416	0.0383	0.21	1.50%	0.225	60.00%	0.00708	0.50%	0.075	0.0312
16	460	0.0451	0.21	1.50%	0.24	60.00%	0.00835	0.50%	0.08	0.0368
20	16	0.0019	0.21	1.20%	0.24	65.00%	0.00034	0.50%	0.1	0.0016
23	6	0.0009	0.21	1.20%	0.276	81.00%	0.00023	0.50%	0.115	0.0007
25	3335	0.5228	0.21	1.20%	0.3	71.00%	0.10591	0.50%	0.125	0.4169
30	0	-	0.21	1.20%	0.36	60.00%	-	0.50%	0.15	0.0000
50	1171	0.3407	0.21	1.20%	0.6	57.00%	0.04794	0.50%	0.25	0.2928
55	1	0.0003	0.21	1.20%	0.66	54.60%	0.00004	0.40%	0.22	0.0002
58	7	0.0020	0.21	1.20%	0.696	60.00%	0.00037	0.40%	0.232	0.0016
63	1559	0.4933	0.21	1.20%	0.756	63.70%	0.10043	0.40%	0.252	0.3929
75	6	0.0022	0.23	1.20%	0.9	60.00%	0.00045	0.40%	0.3	0.0018
100	2717	1.3496	0.23	1.20%	1.2	59.20%	0.26281	0.40%	0.4	1.0868
110	3	0.0012	0.23	1.10%	1.21	54.70%	0.00025	0.30%	0.33	0.0010
150	431	0.2689	0.23	1.10%	1.65	67.70%	0.07497	0.30%	0.45	0.1940
160	147	0.0920	0.23	1.10%	1.76	60.00%	0.02142	0.30%	0.48	0.0706
200	2625	2.0692	0.23	1.10%	2.2	61.00%	0.49424	0.30%	0.6	1.5750
220	4	0.0034	0.23	1.00%	2.2	61.00%	0.00075	0.30%	0.66	0.0026
250	857	0.9076	0.23	1.00%	2.5	73.30%	0.26476	0.30%	0.75	0.6428
260	3	0.0027	0.23	1.00%	2.6	63.10%	0.00071	0.25%	0.65	0.0020
300	3870	4.0727	0.23	1.00%	3	66.20%	1.17024	0.25%	0.75	2.9025
315	2255	2.3801	0.23	0.95%	2.9925	62.40%	0.60433	0.25%	0.7875	1.7758
400	1425	1.7184	0.23	0.95%	3.8	48.54%	0.29344	0.25%	1	1.4250
500	5538	8.8121	0.23	0.90%	4.5	57.42%	1.88955	0.25%	1.25	6.9225
600	57	0.1001	0.23	0.90%	5.4	45.35%	0.01456	0.25%	1.5	0.0855
750	306	0.6807	0.23	0.90%	6.75	47.44%	0.10692	0.25%	1.875	0.5738
800	30	0.0762	0.23	0.90%	7.2	57.13%	0.01621	0.25%	2	0.0600
910	0	-	0.23	0.90%	8.19	52.19%	-	0.25%	2.275	0.0000
1000	2046	7.6457	0.23	0.90%	9	77.30%	2.53067	0.25%	2.5	5.1150
1500	327	1.4308	0.23	0.90%	13.5	44.88%	0.20451	0.25%	3.75	1.2263
2000	0	-	0.23	0.90%	18	55.00%	-	0.25%	5	0.0000
2500	0	-	0.23	0.90%	22.5	52.36%	-	0.25%	6.25	0.0000
3000	9	0.0844	0.23	0.90%	27	55.00%	0.01691	0.25%	7.5	0.0675
5000	0	-	0.23	0.90%	45	56.21%	-	0.25%	12.5	0.0000
10000	0	-	0.23	0.90%	90	38.93%	-	0.25%	25	0.0000
	31898	**33.1885**					**8.2466**			**24.94**