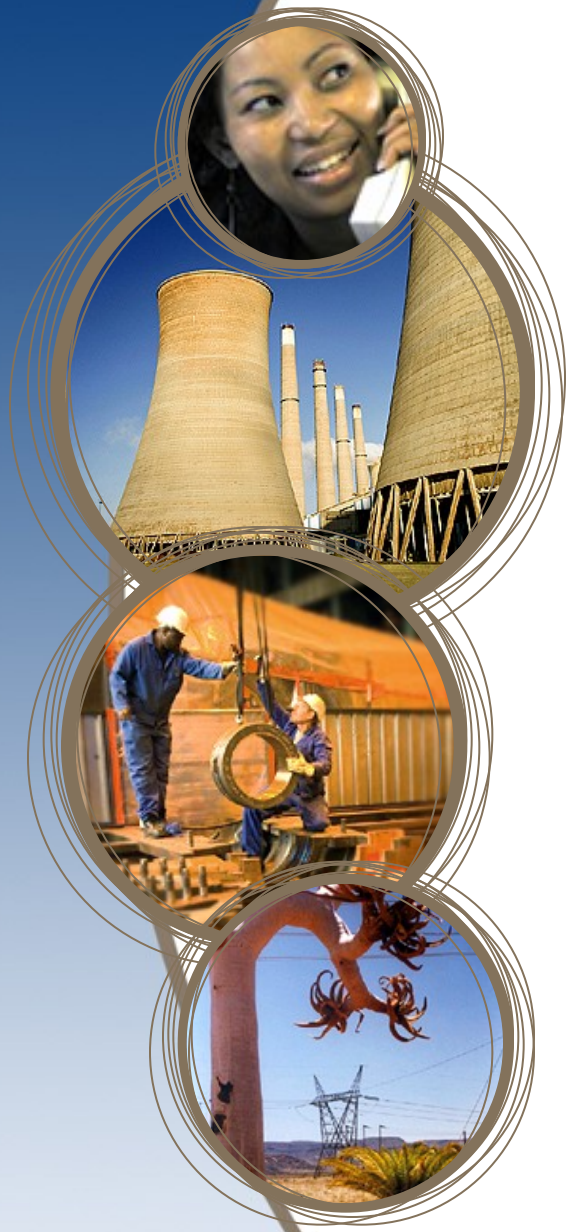


CURRENT AND VOLTAGE MONITOR SYSTEM (CVM)

21 - 22 July 2011

Rudi Kleinhans

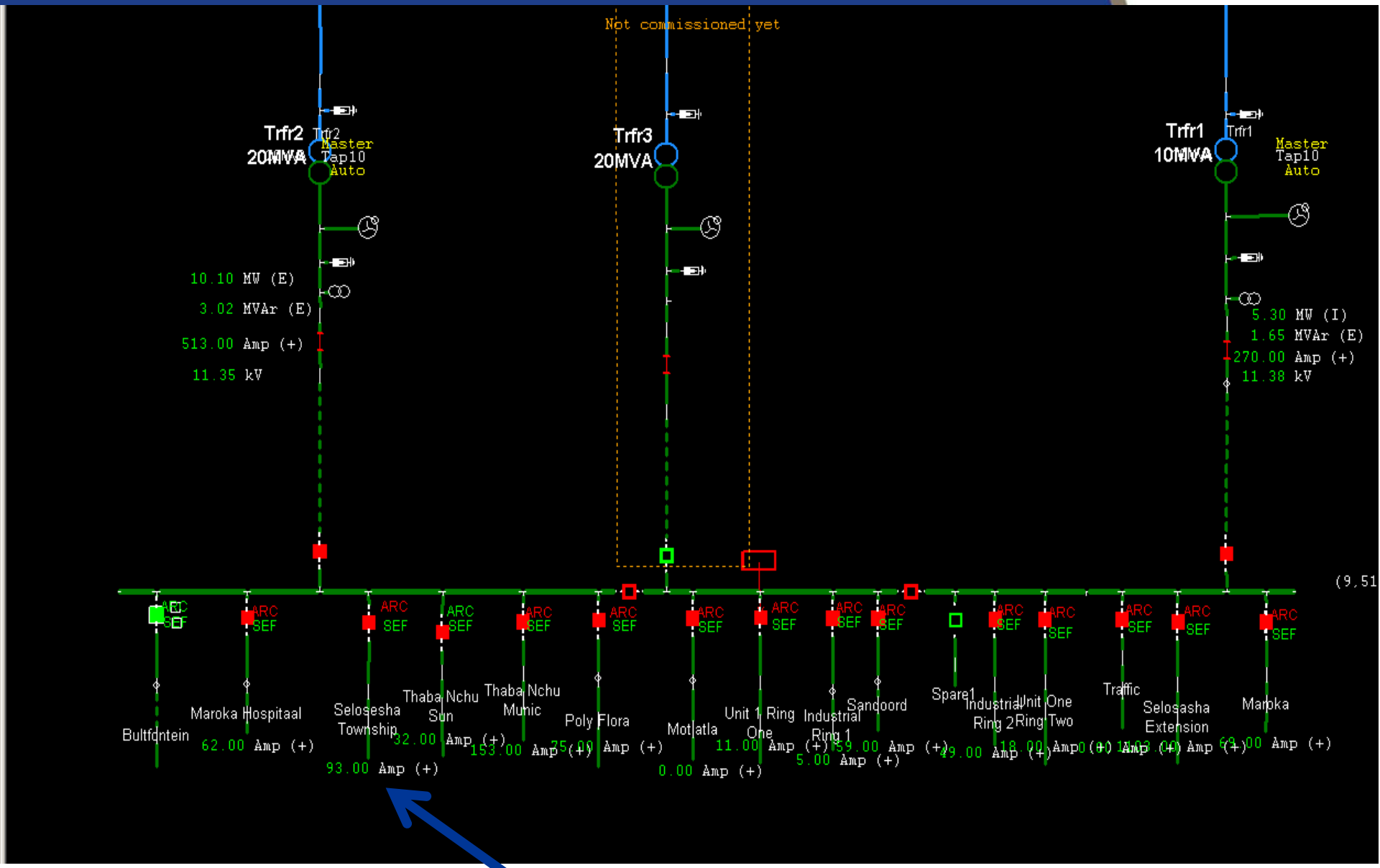
Current and Voltage Monitor System

- Introduction
- Problem statement
- Equipment
- Results
- Revenue losses
- Conclusion

INTRODUCTION

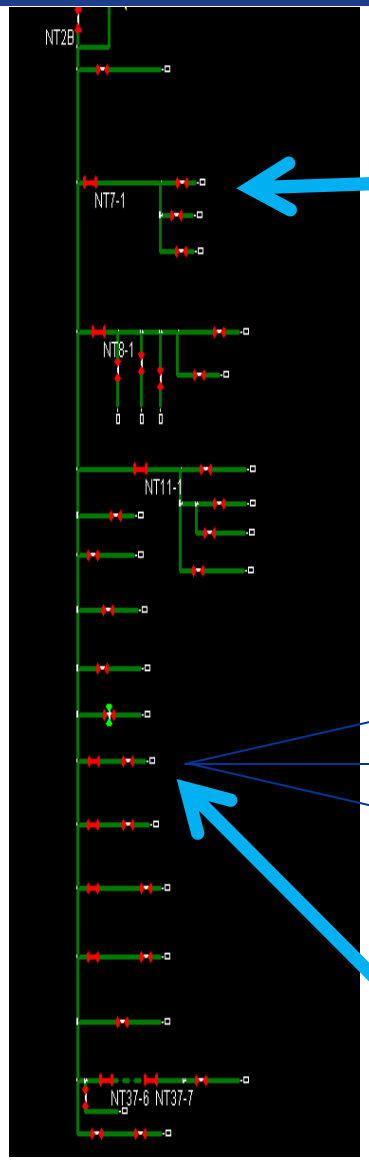
- According to statistics the average failure rate of Pole Mounted Transformers in Eskom NWR is 5 percent per year
- In the North Western Region there are 35948 Pole Mounted Transformers (thus 1794 transformers are failing annually)
- Replacement cost can vary between R 44 000 and R180 000 per transformer depending on the kVA of the transformer
- We suspect that the reasons for transformer failures are lightning and transformer overloading
- There are no indication which Pole Mounted Transformers are overloading

PROBLEM STATEMENT



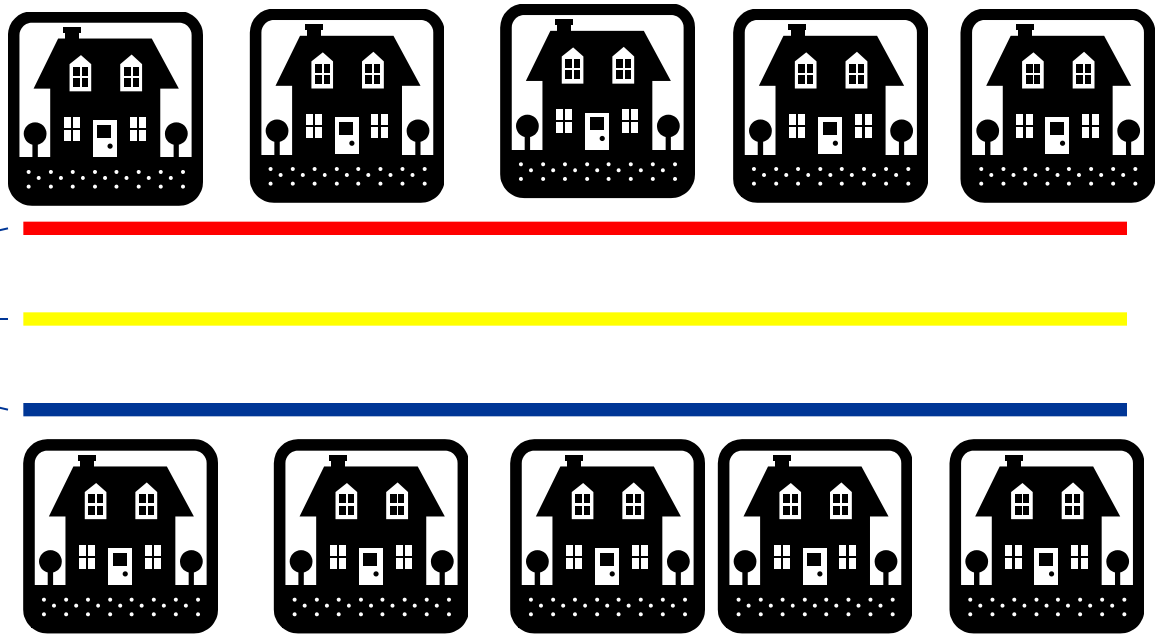
Eskom measures the load at the source

Current and Voltage Monitor System



25 Pole Mounted Transformers (up to 5000 houses on a feeder)

Between 50 to 200 houses per transformer



How do we measure at the Pole Mounted Transformer ?

Current and Voltage Monitor System

EQUIPMENT

- Compiled a specification for a CVM unit
- The CVM must be able to be commissioned live – to avoid interruptions
- The CVM must be remotely accessible via GPRS
- kWh and kVA readings to be remotely available
- All abnormalities for example open conductor, AC fail, high Voltages to alarm the Regional Control Centre
- All Voltage and Current graphs can be downloaded
- Earth fault current detection
- Current spectrum from 0 to 1000 Amps

Configuration settings:

Configuration Name: BLOEM_SELO_200kVA

Current high:

Red current high:	450.000	A	SMS ☑	Alarm ☑
Red current high recovery:	420.000	A		
White current high:	450.000	A	SMS ☑	Alarm ☑
White current high recovery:	420.000	A		
Blue current high:	450.000	A	SMS ☑	Alarm ☑
Blue current high recovery:	420.000	A		

Voltage high:

Red voltage high:	265.000	V	SMS ☑	Alarm ☑
Red voltage high recovery:	260.000	V		
White voltage high:	265.000	V	SMS ☑	Alarm ☑
White voltage high recovery:	260.000	V		
Blue voltage high:	265.000	V	SMS ☑	Alarm ☑
Blue voltage high recovery:	260.000	V		

Current low:

Red current low:	15.000	A	SMS ☐	Alarm ☐
Red current low recovery:	20.000	A		
White current low:	15.000	A	SMS ☐	Alarm ☐
White current low recovery:	20.000	A		
Blue current low:	15.000	A	SMS ☐	Alarm ☐
Blue current low recovery:	20.000	A		

Voltage low:

Red voltage low:	190.000	V	SMS ☐	Alarm ☑
Red voltage low recovery:	200.000	V		
White voltage low:	190.000	V	SMS ☑	Alarm ☑
White voltage low recovery:	200.000	V		
Blue voltage low:	190.000	V	SMS ☐	Alarm ☑
Blue voltage low recovery:	200.000	V		

Temperature:

Temperature high:	70.000	deg C
Temperature high recovery:	60.000	deg C

AC Healthy:

AC falls away: ☐ SMS

AC Recovers: ☐ SMS

Cellphone numbers:

	Number:	Name:	
#1	+27837090871	RUDI	☑ Active
#2	+27835550675	WMC	☑ Active
#3			☐ Active
#4			☐ Active
#5			☐ Active

Phase difference (Current):

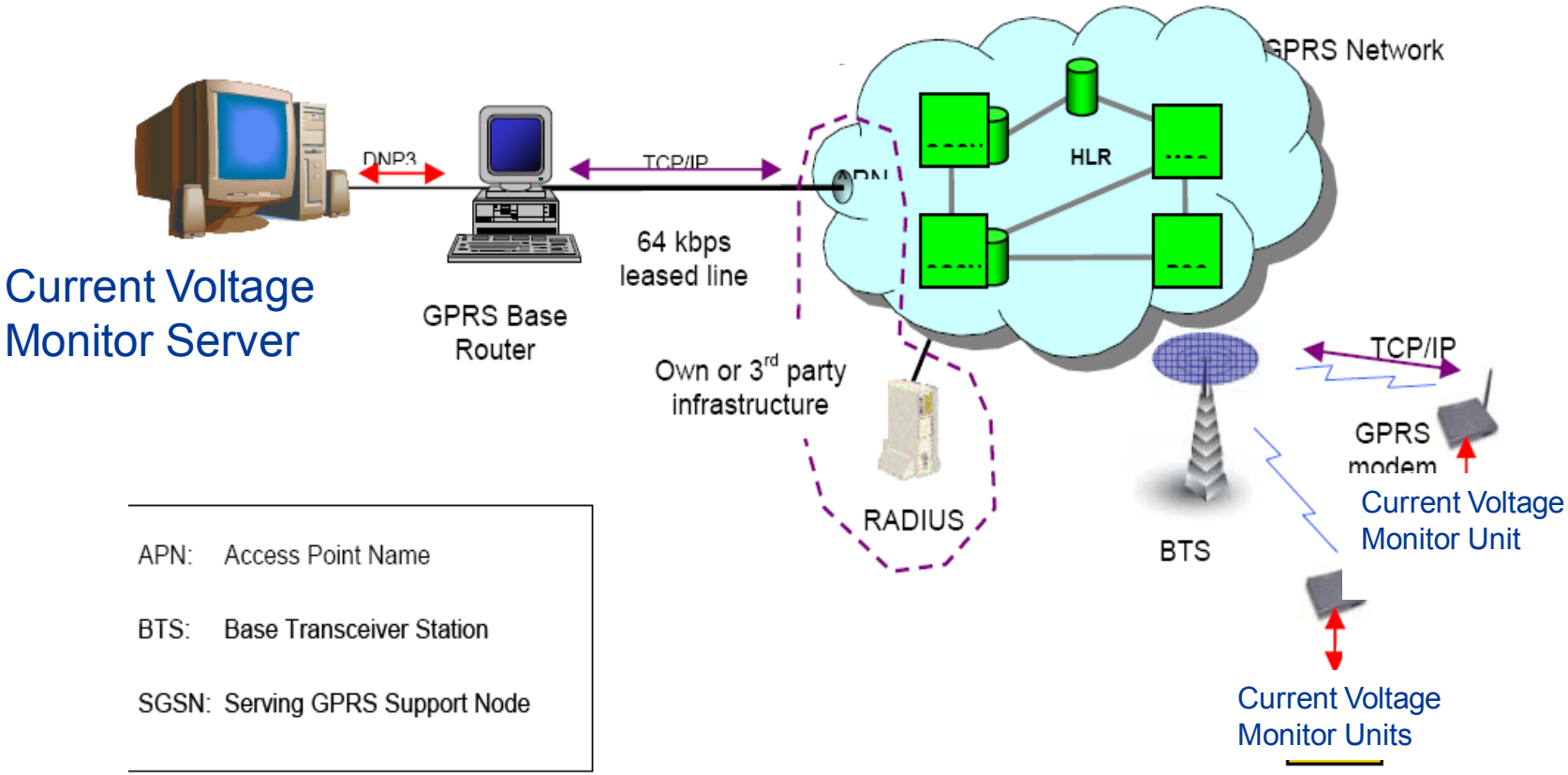
Maximum phase difference:	300.000	%	☑ Alarm
Phase difference recovery:	200.000	%	
Phase difference debounce (mins):	120.000	minutes	

Datalogging:

Log interval (out of alarm):	1800	seconds
Log interval (in alarm):	60	seconds

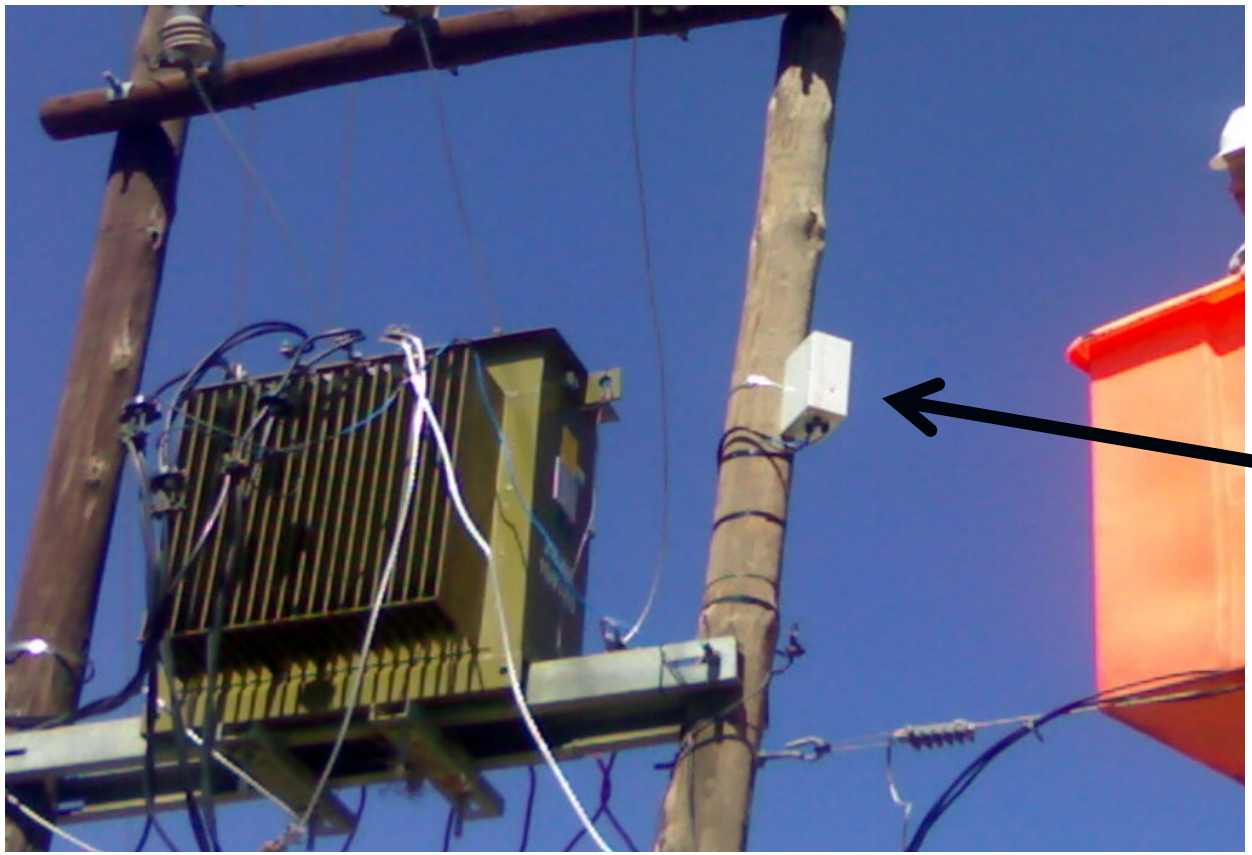
Save Cancel

GPRS PHILOSOPHY



APN:	Access Point Name
BTS:	Base Transceiver Station
SGSN:	Serving GPRS Support Node

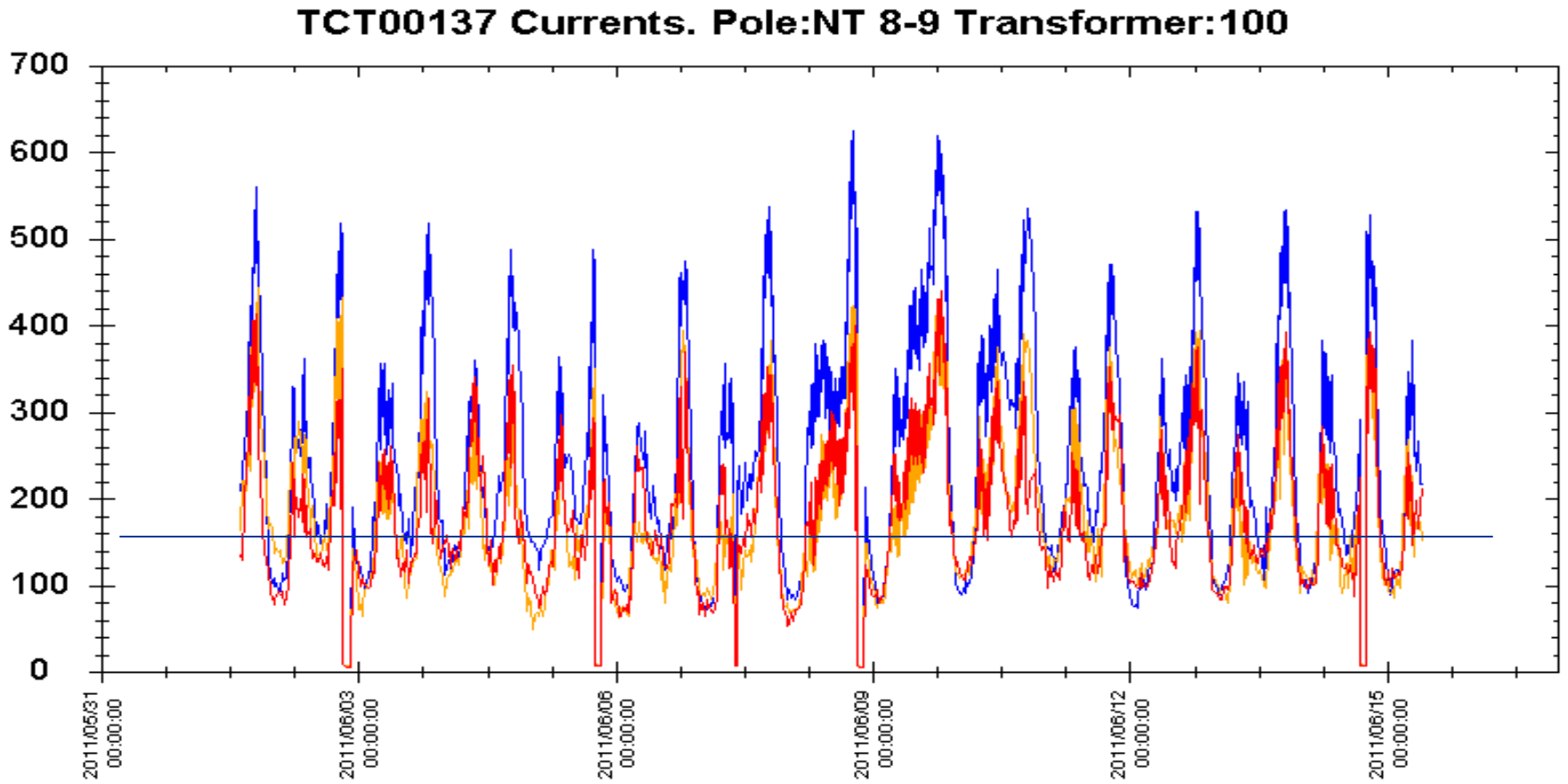
CVM – INSTALLED



CVM installed at 100 kVA Pole Mounted Transformer

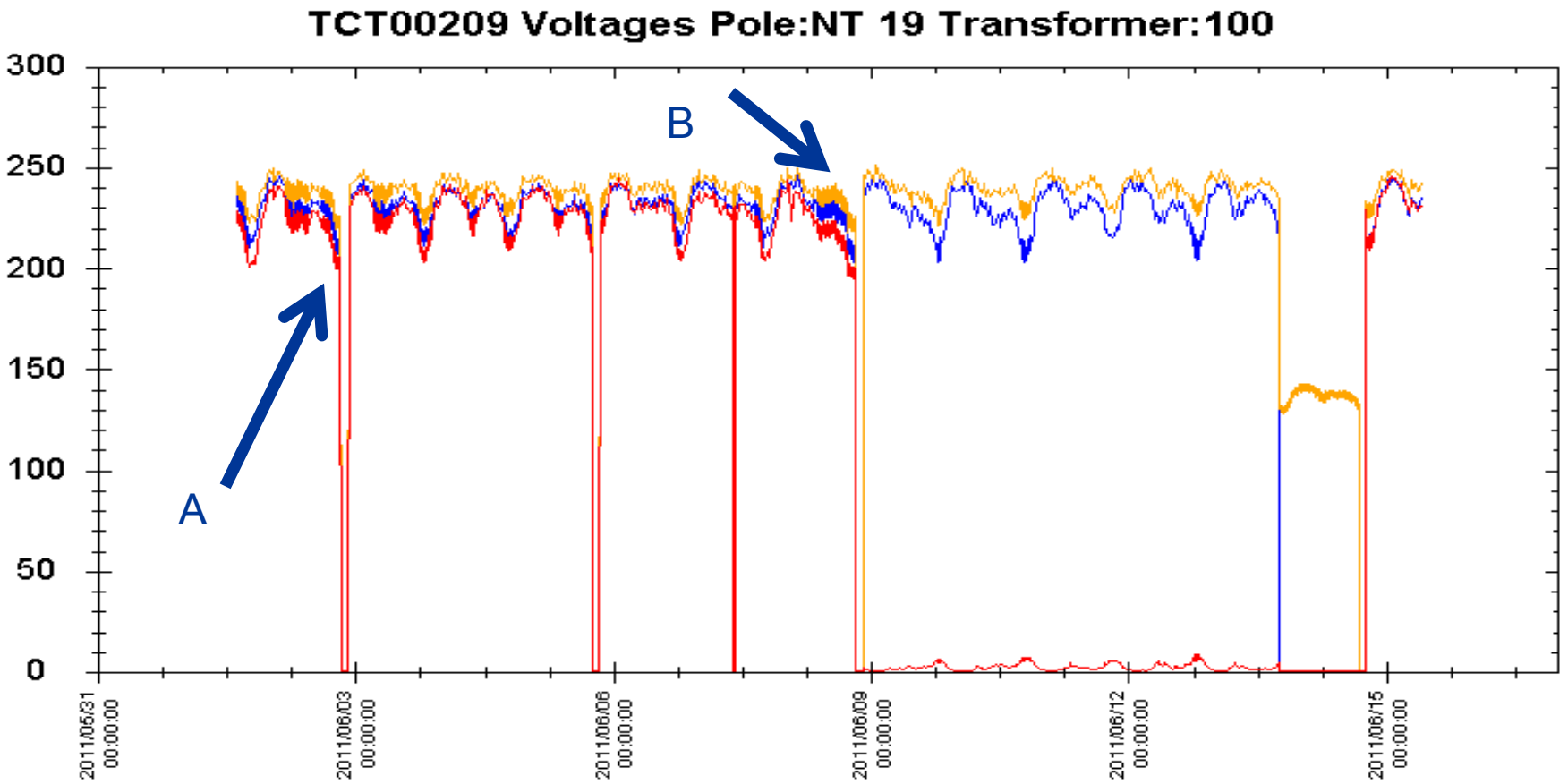
RESULTS

- An example of Transformer overloading



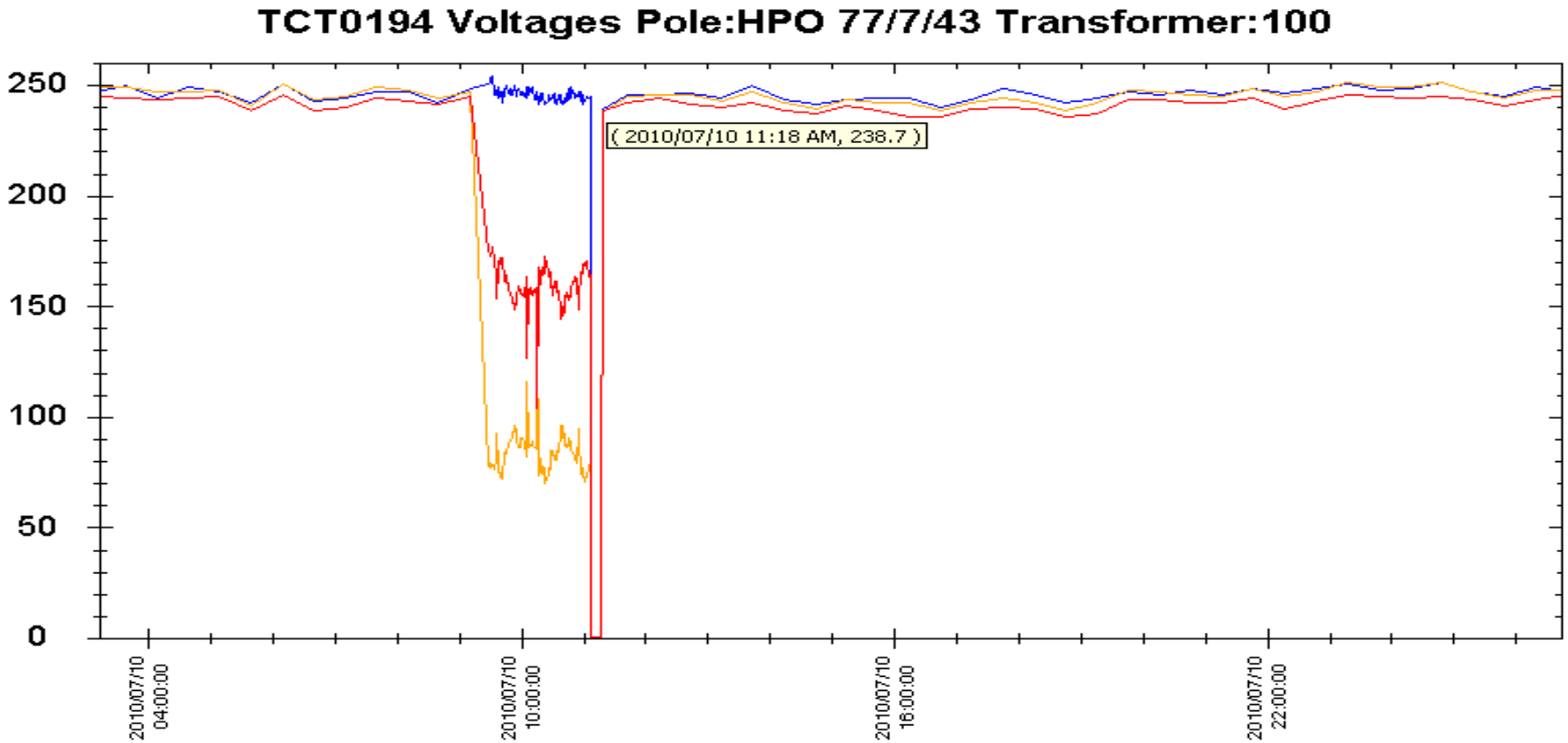
RESULTS

- An example of interruptions



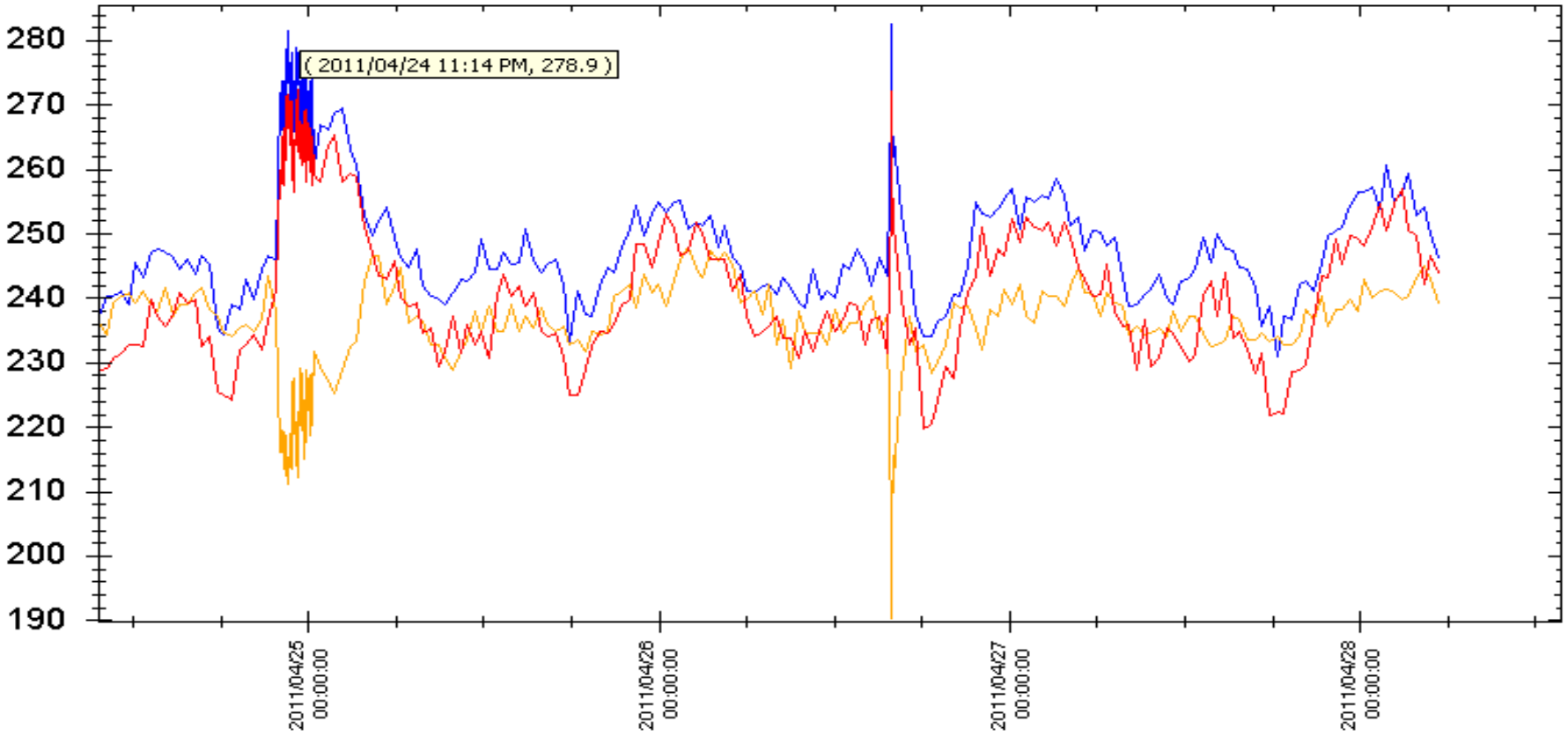
RESULTS

- An example of HV Conductor burning off



RESULTS

- An example of loose Neutral – Causing over Voltages



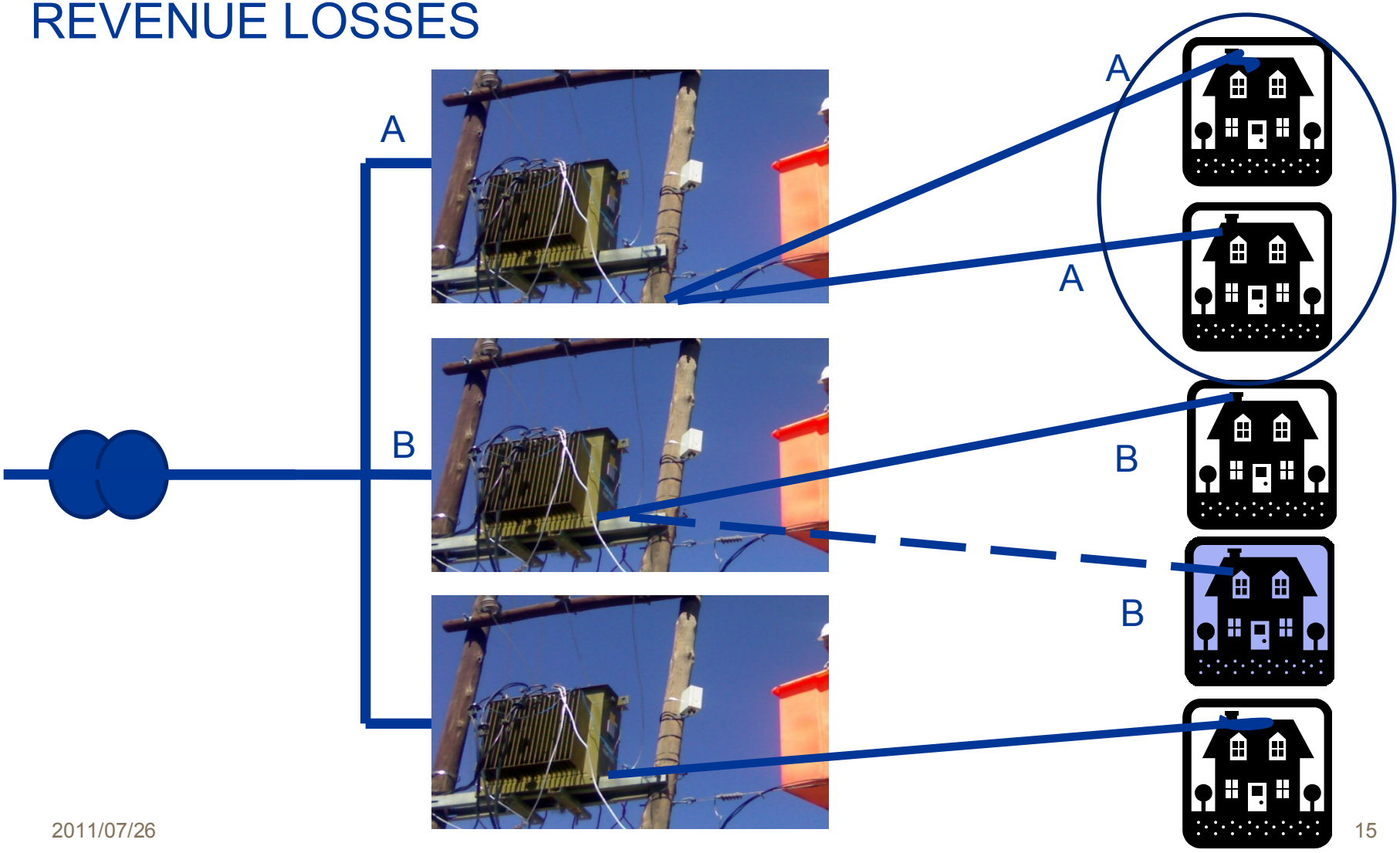
REVENUE LOSSES

What methodology was used?

1. Used the kWh data of the CVM
2. Downloaded all the customer account numbers linked to a specific transformer
3. Downloaded all the revenue received from all the customers linked to a specific transformer over a period of five months
4. Then calculated the kWh value from the revenue received
5. Compare the calculated kWh to the measured kWh

Current and Voltage Monitor System

REVENUE LOSSES



Account	Revenue
87	37
9774763678	9774763678
8363800004	7571280705
9477511381	9770733910
9805229713	7032583213
6074465385	7144476577
7606832163	7983782972
5092873288	7566318295
8985835288	7709223200
5777256474	6378664327
6102882052	7080996160
5707213249	7068223244
7388501655	5699461420
5951280312	8769683043
6547074935	5200420201
7926879279	6987040561
6096255663	6964911875
5957110916	5590959648
7524938343	8985835288
5980308409	5092873288
6256732269	9941760844
7144476577	7356420704
7136155015	5755934941
5889416476	6102882052
6027762462	6074465385
5755934941	5707213249
5808296505	6547074935
5098091275	5889416476
8504392014	6027762462
6378664327	7926879279
6958396068	5951280312
6346745076	7915780164
6840366784	9710924042
7032583213	6346745076
5916233894	7507411119
7566318295	7520394101
7184954990	7199443829
8769683043	7818982458
6964911875	
5701072815	
7397313708	
8763241175	
7459587476	
6983061214	
5200420201	
6108695041	
7868286889	
9227306074	
7709223200	
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7626939662	
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7058828499	
7054361536	
6155576931	
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7068223244	
8297124759	
5819139626	
7922861481	
5794212011	
7080996160	
9381560932	
6509768412	
7818982458	
6298208357	
7507411119	
7915780164	
7520394101	
7571280705	
8220579281	
8183269968	
8230666090	

Account	Revenue
87	38
9774763678	9.77E+09
8363800004	5.78E+09
9477511381	7.57E+09
9805229713	9.77E+09
6074465385	7.03E+09
7606832163	7.14E+09
5092873288	5.82E+09
8985835288	7.57E+09
5777256474	6.38E+09
6102882052	7.07E+09
5707213249	5.7E+09
7388501655	8.77E+09
5951280312	5.2E+09
6547074935	6.99E+09
7926879279	6.96E+09
6096255663	5.59E+09
5957110916	8.99E+09
7524938343	5.09E+09
5980308409	9.94E+09
6256732269	7.36E+09
7144476577	5.76E+09
7136155015	6.1E+09
5889416476	6.07E+09
6027762462	5.71E+09
5755934941	6.55E+09
5808296505	6.03E+09
5098091275	7.87E+09
8504392014	7.93E+09
6378664327	9.81E+09
6958396068	5.95E+09
6346745076	8.76E+09
6840366784	7.92E+09
7032583213	6.35E+09
5916233894	8.99E+09
7566318295	7.51E+09
7184954990	7.52E+09
8769683043	7.2E+09
6964911875	7.82E+09
5701072815	
7397313708	
8763241175	
7459587476	
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6298208357	
7507411119	
7915780164	
7520394101	
7571280705	
8220579281	
8183269968	
8230666090	

Account	Revenue
87	42
9774763678	9.77E+09
8363800004	7.57E+09
9477511381	9.77E+09
9805229713	7.03E+09
6074465385	7.14E+09
7606832163	5.82E+09
5092873288	7.98E+09
8985835288	7.57E+09
5777256474	6.98E+09
6102882052	6.38E+09
5707213249	5.7E+09
7388501655	8.77E+09
5951280312	5.2E+09
6547074935	6.99E+09
7926879279	6.96E+09
6096255663	5.59E+09
5957110916	8.99E+09
7524938343	5.09E+09
5980308409	9.94E+09
6256732269	7.36E+09
7144476577	7.18E+09
7136155015	5.76E+09
5889416476	6.1E+09
6027762462	6.07E+09
5755934941	5.71E+09
5808296505	6.55E+09
5098091275	5.89E+09
8504392014	6.03E+09
6378664327	7.39E+09
6958396068	7.93E+09
6346745076	9.81E+09
6840366784	5.95E+09
7032583213	6.84E+09
5916233894	7.92E+09
7566318295	9.71E+09
7184954990	6.35E+09
8769683043	8.99E+09
6964911875	7.51E+09
5701072815	7.52E+09
7397313708	8.18E+09
8763241175	7.2E+09
7459587476	7.82E+09
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5755934941	6102882052
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8769683043	9710924042
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6298208357	
7507411119	
7915780164	
7520394101	
7571280705	
8220579281	
8183269968	
8230666090	

Account	Revenue		
87	32	46	
9774763678	5777256474		
8363800004	9770733910	1	
9477511381	7144476577	1	
9805229713	6378664327		
6074465385	7068223244		
7606832163	6564961867	1	
5092873288	8359238068		
8985835288	8297124759		
5777256474	7922861481		
6102882052	7626939662		
5707213249	8769683043		
7388501655	5200420201	1	
5951280312	6987040561		
6547074935	6964911875		
7926879279	5590959648		
6096255663	8985835288	1	
5957110916	5092873288	1	
7524938343	7356420704	1	
5980308409	5755934941	1	
6256732269	6074465385	1	
7144476577	5707213249		
7136155015	6547074935	1	
5889416476	5889416476		
6027762462	6027762462		
5755934941	7868286889		
5808296505	7926879279	1	
5098091275	5951280312	1	
8504392014	7915780164	1	
6378664327	9710924042		
6958396068	7507411119	1	
6346745076	8183269968		
6840366784	7818982458	1	
7032583213			
5916233894		1	
7566318295			
7184954990		1	
8769683043			
6964911875			
5701072815		1	
7397313708		1	
8763241175		1	
7459587476		1	
6983061214		1	
5200420201			
6108695041		1	
7868286889			
9227306074		1	
7709223200		1	
9941760844			
5699461420			
7626939662		1	
6564961867		1	
7058828499		1	
7054361536		1	
6155576931		1	
8991492679		1	
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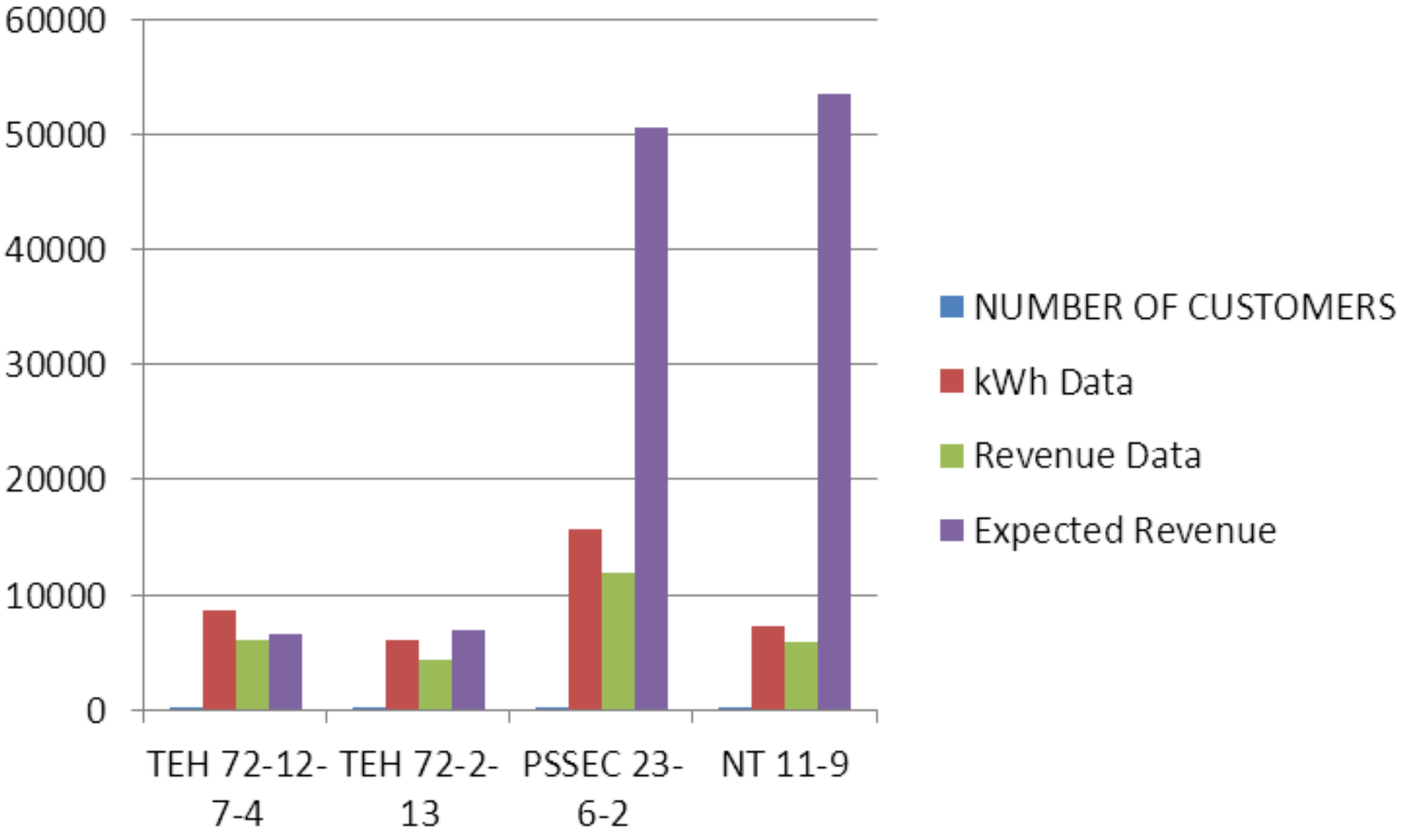
8297124759		1	
5819139626			
7922861481		1	
5794212011		1	
7080996160		1	
9381560932		1	
6509768412		1	
7818982458			
6298208357		1	
7507411119			
7915780164			
7520394101			
7571280705			
8220579281		1	
8183269968			
8230666090		1	

Revenue Comparison

		January 2011		February 2011		March 2011		April 2011		May 2011	
		kWh	Revenue	kWh	Revenue	kWh	Revenue	kWh	Revenue	kWh	Revenue
TEH 72-12-7-4	From Revenue	9905	6489	11033	7229	10601	6944	10928	7958	8628	6157
(92 Tot Cust)	Number of customers	75		76		79		82		82	
	Measured							9437	6183	10061	6592
	Percentage kWh diff							16		14	
TEH 72-2-13	From Revenue			7033	4609	7345	4813	8061	5761	6103	4281
(92 Tot Cust)	Number of customers paying			72		72		75		73	
	Measured					9409	6166	10125	6636	10534	6904
	Percentage kWh diff					22		20		42	
PSSEC 23-6-2	From Revenue	25988	17033	22166	14528	23980	15718	20589	15791	15654	11864
(168 Tot Cust)	Number of customers	115		112		112		105		101	
	Measured			57919	37962	64506	42280	68297	44765	77145	50565
	Percentage kWh diff			62		63		70		80	
NT11-9	From Revenue	10990	7182	8435	5503	10264	6726	10508	8362	7214	5836
(87 Tot Cust)	Number of customers	37		38		42		42		32	
	Measured			51516		58995		67714	44014	82194	
	Percentage			84		83		84		91	

Revenue Comparison



RESULTS

ILLEGAL CONNECTIONS RESULTS IN:

- HV conductors burning off
- LV conductors burning off
- Neutral connections burning off
- Abnormal high and low Voltages
- Unnecessary interruptions
- Unnecessary overtime that needs to be worked at night – safety hazard
- Loss of income

CONCLUSION

- The CVM can now be implemented to identify overloading, over and under Voltages and supply interruption.
- Unbalanced loading can be corrected
- Eskom can pro-actively upgrade transformers prior to failing
- Eskom can act immediately on the alarms and restore power supply quicker
- Revenue losses can be calculated per transformer
- A priority list to identify which transformers have the highest theft can be compiled

CONCLUSION

- With the demand for electricity in South Africa it is essential that we all pay for the energy used to ensure that we can build power stations and maintain our networks.
- Our vision is the future of our kids

Thank You