CHAPTER 5 RESULTS

5.1 INTRODUCTION

In Chapter 1 the statement is made: "The author believes that the understanding of forecasting methodologies is important. However, the real test comes in their applicability in practice and their impact on planning and decision-making." This chapter provides the reader with results to evaluate the forecasting methods (Chapter 3) and the results obtained from the balancing algorithm (Chapter 4). ***All loads are in MW***.

5.2 FORECAST RESULTS

From equations (4.2.3) and (4.2.6)

$$MSD = PS + INT + TXLOSS + TOTDX \quad (5.2.1)$$

and

$$TOTDX = \sum_{h=1} Area_h \quad (5.2.2)$$

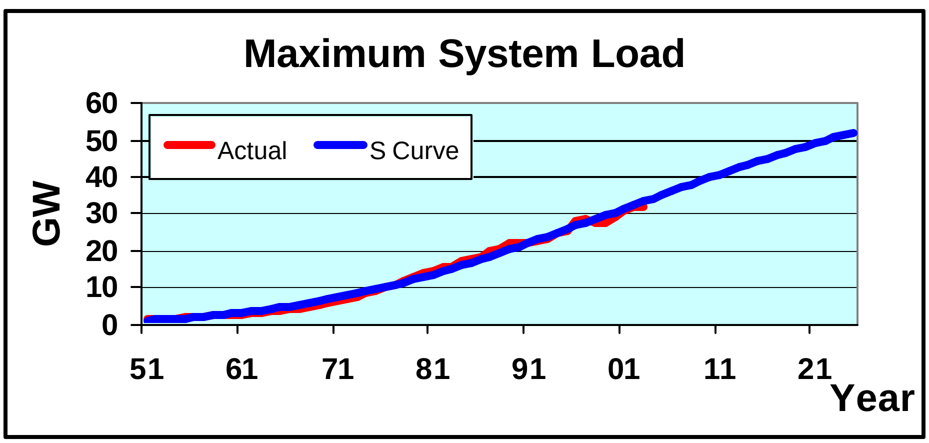

Figure 5.2.1 – Maximum System Load

The maximum system load is determined from equation (3.2.1). The S-curve results are displayed in Figure 5.2.1. The expected load for 2025 is 52.3 GW.

A second S-curve is determined with an expected load of 57.14 GW for 2025. The different S-curves are compared in Figure 5.2.2.

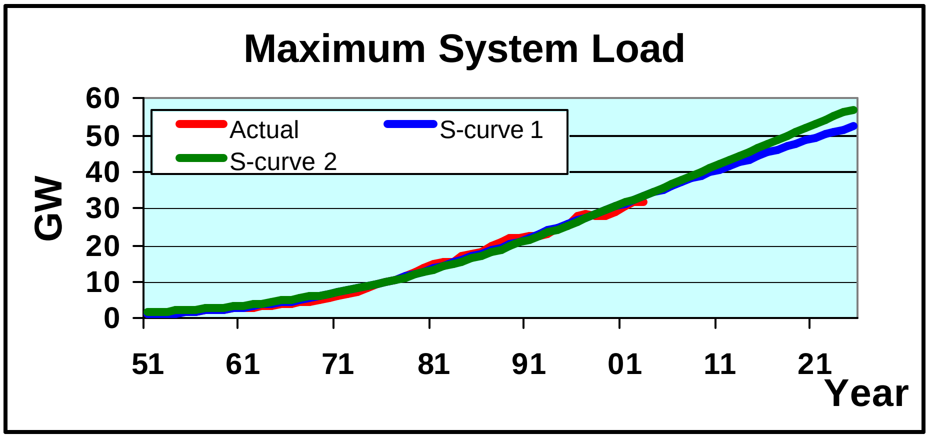

Figure 5.2.2 – Two Curves for Maximum System Load

The second S-curve is close to the moderate scenario results (Chapter 3). A third S-curve (close to the high scenario) is shown in Figure 5.2.3. The expected load for 2025 is 70.5 GW.

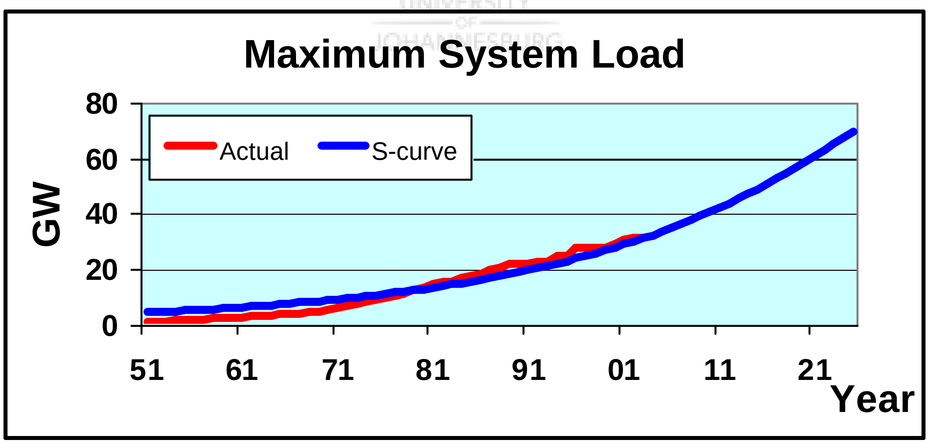

Figure 5.2.3 – Maximum System Load (Close to High Scenario)

From equation (5.2.1) the TOTDX load equals

$$TOTDX = MSD - PS - INT - TXLOSS \quad (5.2.3)$$

From equation (5.2.3) the TOTDX load is calculated for each of the three S-curves. The results are shown in Table 5.2.1.

The power station loads are very small - approximately 0.1 % of the maximum system load see Figure 5.2.4.

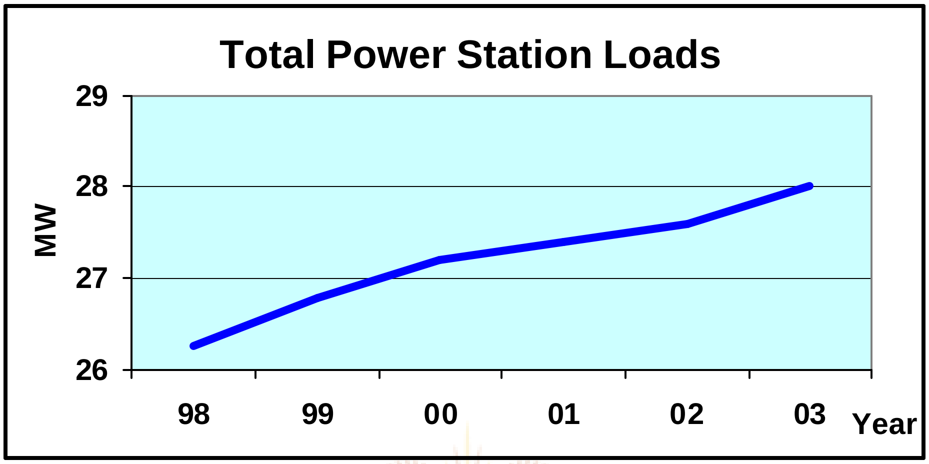

Figure 5.2.4 – Total Power Station Loads at System Peak

The total international customer loads show a large growth see Figure 5.2.5, but the expected load at the end of the forecasting horizon is expected to double.

Figure 5.2.5 – International Customer Loads

The transmission electrical losses are on average 3.2% and this figure is used to balance the loads see Figure 5.2.6.

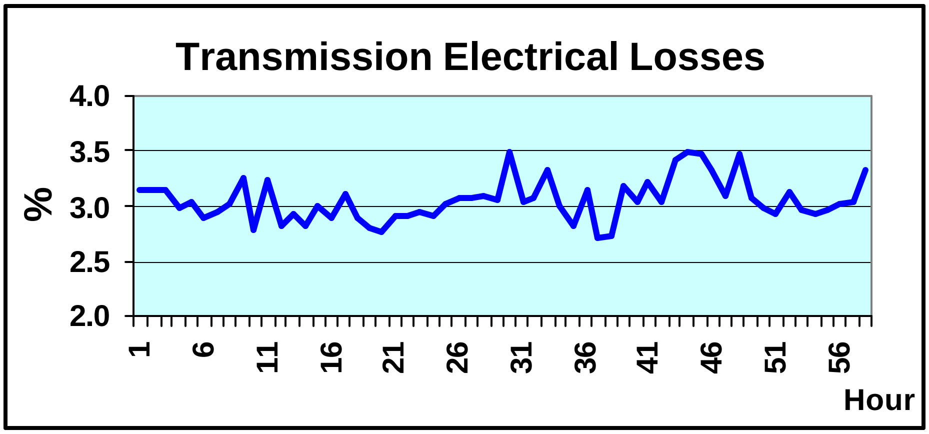

Figure 5.2.6 – % Transmission Electrical Losses

From equation (5.2.2) the TOTDX load is calculated from the area loads. The results are shown in Table 5.2.1.

Next a short overview on the area loads. Hutchinson Educational Encyclopaedia (1999) has been used as reference.

The annual load for Area 1 shows not much growth over time. However, the growth in the area is approximately 2 %. If Figure A.2.1 (ANEXURE A) is studied carefully, there was a load decrease in 1996 and 1999. In 1996 a feeder breaker was closed in the area and the result was a decrease in area load. One of the customers commissioned a power station in 1999 and that explains the 1999 load decrease. The area is around Bloemfontein towards the eastern border of the province. The Golden Gate and the eastern Free State areas are excluded see Figure 5.2.7.

Bloemfontein is the capital of the Free State (formerly Orange Free State), judicial capital of the Republic of South Africa, and with a population of 300 150 in1991. Founded in 1846 and declared a municipality in 1880, the city produces canned fruit, glassware, furniture, plastics, and railway engineering. The city's climate makes it a popular health resort.

Bloemfontein is situated on the Modder River, and is 1 405 metres above sea level. Connected by rail and road with Cape Town, Port Elizabeth, and Johannesburg, the city is a major agricultural centre, railway junction, and tourist stopover point.

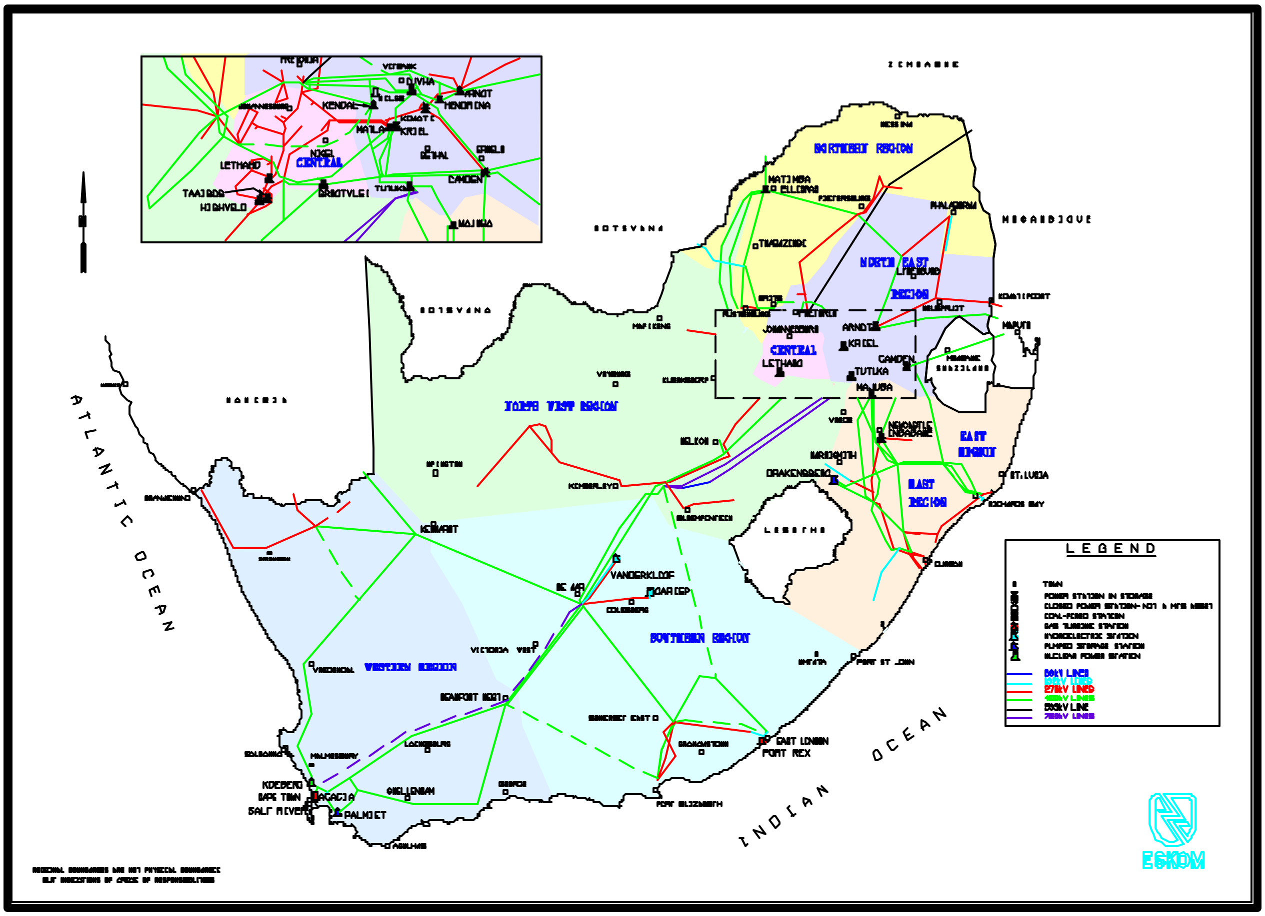

Figure 5.2.7 – Geographical Map of South Africa

Among its public buildings are the Raadzaal, formerly the meeting place of the Orange Free State Raad, now the seat of the provincial council, an Anglican cathedral, a large Dutch Reformed church, the National Museum, and the National Afrikaans Literary Museum. It is also the site of the University of the Orange Free State and Vista University. It was chosen as the seat of the Supreme Court of South Africa in 1910. Owing to the exceptionally clear atmosphere Harvard and Michigan universities built their observatories at

Bloemfontein. The ongoing Orange River irrigation project is accelerating considerably the growth of Bloemfontein (and the Free State as a whole).

The loads for area 9 (Figure A.2.9) are mainly between Kimberley and Upington in the Northern Cape see Figure 5.2.7. Large load growths are expected in the area see Figure A.2.28.

Kimberley is the diamond-mining capital city of the Northern Cape Province. Kimberley is approximately 153 kilometres north west of Bloemfontein, and 1 223 metres above sea level. The population in 1991 was 167 100. De Beers Consolidated Mines have controlled the mines since 1887. A number of irrigation schemes in the area, using water from the Orange River, allow extensive cereal cultivation and cattle ranching.

Diamonds were first discovered near Kimberley in 1870. Within a few years people came from all over the world to pan the alluvial deposits along the Orange River. On the outskirts of the city is the now water-filled Kimberley Open Mine known as the “Big Hole” with a circumference of nearly 1 500 metres. During its 44 years of active life it yielded 15 million carats of diamonds. It was closed in 1915 when no longer profitable. Kimberley's prosperity declined when the diamond output decreased during World War I. It recovered with the discovery and exploitation of limestone and base minerals including asbestos, manganese, gypsum, and wolfram.

Secondary industries include engineering, clothing manufacture, textiles, diamond cutting, and pulp and paper manufacturing.

Goldmines are the dominant loads in areas 15, 25 and 27 (Figures A.2.15, A.2.25 and A.2.27). The decrease in load for Area 25 is the downscale of goldmine activities. Area 25 is mainly situated around Welkom in the Free State. Klerksdorp, Mafikeng and Vryburg are located in Area 15. Area 27 is west of Johannesburg and east of Area 15.

The five area loads (Northwest) are added and compared with the TOTDX load see Figure 5.2.8.

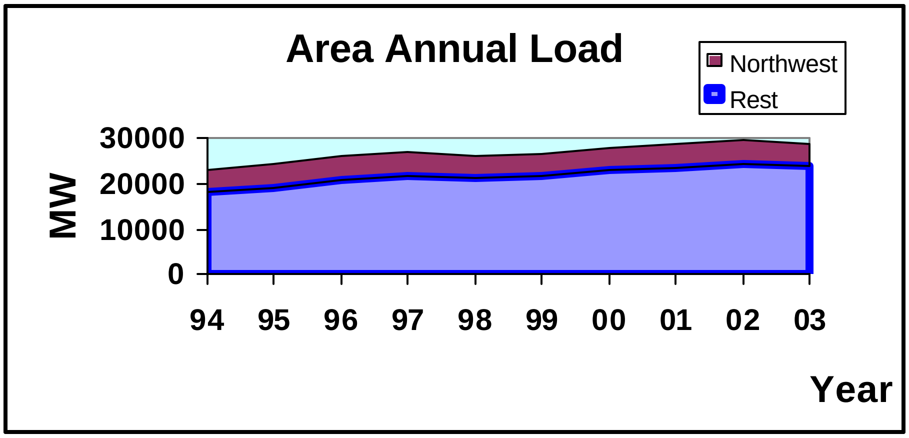

Figure 5.2.8 – Northwest Annual Load

The next four areas are located in KwaZulu-Natal see Figure 5.2.7 (East Region). Area 2 (see Figure A.2.2 for past load growths) is situated at the southern coastal area. Durban (situated in the area) is the third largest city in South Africa and its harbour is one of the main South African harbours. The population in the urban area is 1 137 400. Exports include coal, chemicals, steel, granite, wood products, sugar, fruit, grain, rice, and wool; imports include heavy machinery and mining equipment. Durban is also a holiday resort.

Founded in 1824 as Port Natal, it was renamed in 1835 after General Benjamin d'Urban (1777-1849), lieutenant governor of the eastern district of Cape Colony 1834-37. Near the city are the University of Durban-Westville and the University of Natal.

Large growth in Area 4 (northern coastal area) in 1994 and 1995 was due to the commissioning of an aluminium smelter in the area. The growth between 2003 and 2004 is the result of further aluminium expansions see Figure A.2.4. Ulundi former capital of the former independent homeland KwaZulu and Richards Bay are situated in the area.

Areas 11 and 13 supply the midlands of KZN. The Drakensberg (western border of Area 11) is the principal mountain range of South Africa. The seaward slopes are steep and precipitous, while landwards the slopes are more gradual and form part of the interior plateau. The portion of the chain between KwaZulu-Natal and Lesotho contains the highest points in the Maluti Range of Lesotho, which forms part of the Drakensberg system; Champagne Castle, Mont-aux -Sources, Giant's Castle and other peaks are over 3 000 metres in altitude, and all within 100 kilometres of each other. Area 13 is more to the northern midlands, New Castle municipality is situated in the area. See Figures A.2.11 and A.2.13 for historical loads.

The four area loads (KZN) are added and compared with the TOTDX load see Figure 5.2.9.

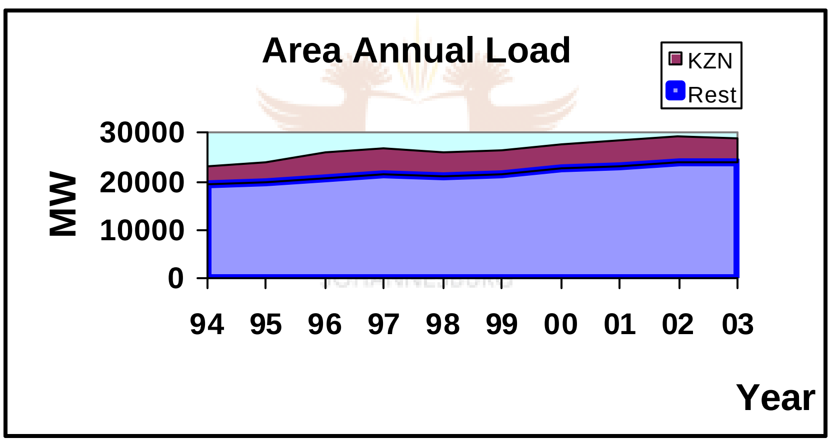

Figure 5.2.9 – KZN Annual Load

The Northwest annual load (Figure 5.2.8) has not grown much over the past ten years compare to the growth in the KZN annual load (Figure 5.2.9). However the actual load growth occurred mainly in Area 4.

Area 3 is supplying the northern areas of the Eastern Cape. East London municipality is located in the area. East London is at the mouth of the Buffalo River. The annual load in Area 8 (Figures A.2.8) varies and the substations in the area also show large variances in their annual loads (Figures A.3.1 and A.3.2). The main reason is the impact of generation in that area. The area supplies customers around the Vanderkloof-and Gariep dams. Area 19 supplies the Port Elizabeth area, large load increases are expected in the area see Figure A.2.29.

Port Elizabeth is the industrial port in Eastern Cape Province, South Africa. Local industries include motor assembly plants, shoemaking, foundries, sawmills, flour mills, canning factories, engineering, food processing, and the production of soap, tyres, furniture, chemicals, safety glass, electrical goods, cable, steel, textiles, plastics, and paints. The port also exports manganese ore and has large pre-cooling plants for fruit.

The three area loads (E-Cape) are added and compared with the TOTDX load see Figure 5.2.10.

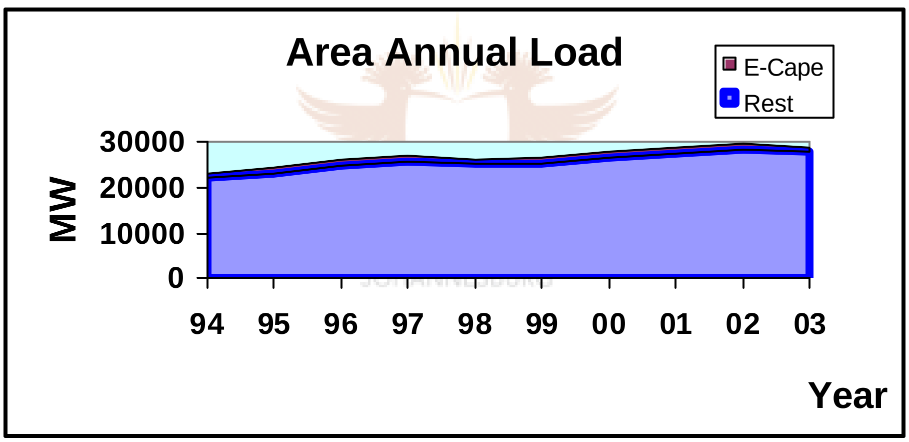

Figure 5.2.10 – E-Cape Annual Load

The E-Cape annual has not grown much see Figures 5.2.3, 5.2.8 and 5.2.19.

A new stainless steel plant was commissioned in Area 5 (see the first three years Figure A.2.5). Area 5 supplies the coal-and goldmines in the Mpumalanga province. Some large steel plants are located in the area. Middelburg and Witbank are some of the largest cities in the area.

Area 6 shows not much growth, but however the large SASOL petrochemical plant in Secunda dominates the area load profile see Figure A.2.6.

The lowveld area of the Mpumalanga province is mainly supplied by area 10. A ferro chrome plant shut down in 2001 due to low ferro-chrome prices see Figure A.2.10. The growth in the area is mainly the commissioning of new ferro chrome plants.

The three area loads (Northeast) are added and compared with the TOTDX load see Figure 5.2.11.

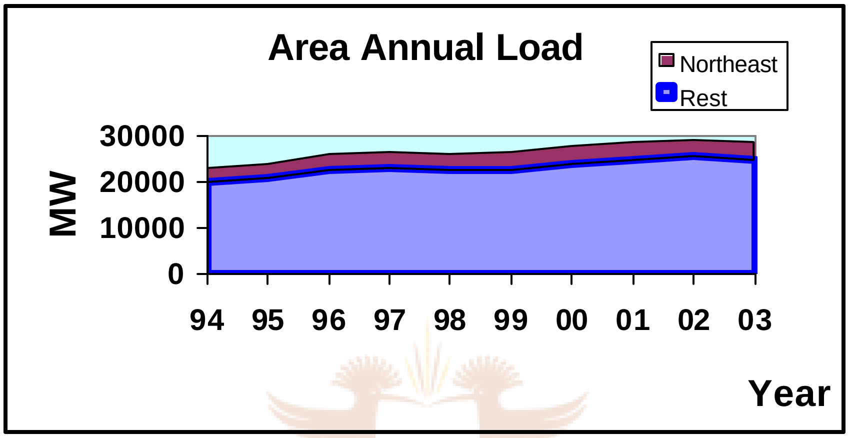

Figure 5.2.11 – Northeast Annual Load

Area 20 supplies loads such as Brits and Pretoria municipalities, and a ferro chrome smelter. The area has a steady growth over the past ten years see Figure A.2.20.

Pretoria is the country's administrative capital; population of 1 080 200 in 1991. Industries include engineering, chemicals, iron, steel, cement, diamonds, granite quarrying, chemicals, and food processing. Founded in 1855, it was named after Boer leader Andries Pretorius. It was the administrative capital of the Union of South Africa from 1910 and capital of Transvaal Province 1860-1994.

Pretoria is situated at the foot of the Magaliesberg, 1 370 metres above sea level. Pretoria is the headquarters of the South African Iron and Steel Corporation (ISCOR) which produces most of South Africa's steel. The city has many fine public buildings such as the Union Buildings. The University of

Pretoria (1908) is the biggest residential university in South Africa and there is also the University of South Africa which offers tuition by correspondence. Onderstepoort has one of the world's largest veterinary research stations.

Area 7 has a steady growth over the past ten years see Figure A.2.7. The area includes the Johannesburg City Council and ranges northwards close to the Jukskei river, eastwards to the Johannesburg International airport, westwards to Lanseria airport, and southwards close to Lenasia.

Johannesburg is the largest city of South Africa, situated on the Witwatersrand River in Gauteng Province; population (urban area) of 1 916 100. It is the centre of a large gold-mining industry; other industries include engineering works, meat-chilling plants, and clothing factories.

Notable buildings include the law courts, Escom House (Electricity Supply Commission), the South African Railways Administration Building, the City Hall, Chamber of Mines and Stock Exchange, the Witwatersrand and Rand Afrikaans universities, and the Union Observatory.

Johannesburg was founded after the discovery of gold by the Australian prospector George Harrison in 1886, and was probably named after Jan (Johannes) Meyer, the first mining commissioner.

Johannesburg lies 1 760 metres above sea level. Cape Town is 1 530 kilometres to the south, Durban 799 kilometres, and Pretoria 56 kilometres to the north. Johannesburg is the centre of the Witwatersrand, where the world's greatest goldfields are situated.

The city has a mild climate with average rainfall of 750 millimetres and a temperature range 13-25ºC.

Johannesburg is a major manufacturing, as well as a commercial and banking, city. It has many light industries, such as cigarettes, textiles, plastics, packaging, and engineering.

The railway station, the centre of the South African system, was opened in 1964. Johannesburg International Airport to the southwest of the city handles international traffic.

Area 14 supplies mainly the areas around the municipalities of Benoni, Delmas, Heidelberg, Nigel and Springs. A large zinc smelter and goldmines are some of the loads in the area. In 1994 load was transferred to Area 27, see Figures A.2.14 and A.2.27.

Some of the reasons for the load variations in Area 23 (Figure A.2.23) are ferro manganese smelters that closed and re-opened over that period, and iron and steels plants.

The four area loads (Central) are added and compared with the TOTDX load see Figure 5.2.12.

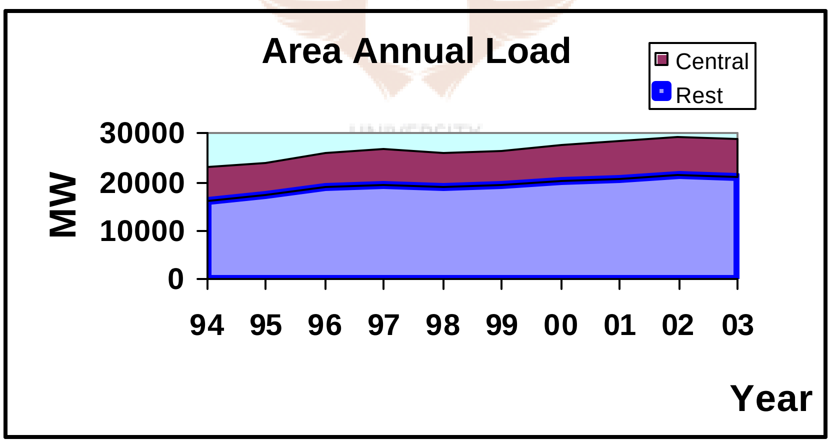

Figure 5.2.12 – Central Annual Load

For years the annual load for Area 12 was constant and then a new substation was commissioned to supply agricultural activities (2000). The load drop in 2003 was because of hail destroying some of the vineyards see Figure A.2.12. The area is situated roughly between Kenhardt, Springbok and Oranjemund.

Area 17 supplies the Cape peninsula, area 22 the Southern cape (George, Laingsburg, Swellendam, etc.) and area 26 the area around Saldanha and Vredendal. The increase in load for Area 26 is the commissioning of Saldanha stainless steel smelter. See Figures A.2.17, A.2.22 and A.2.26.

Figure 5.2.13 – Saldanha Steel Plant Launched in 1999

Cape Town is the oldest city (founded 1652) in South Africa, situated at the northern end of the Cape Peninsula, on Table Bay. Industries include horticulture and trade in wool, wine, fruit, grain, and oil. Tourism is important. It is the legislative capital of the Republic of South Africa and capital of Western Cape province.

Cape Town is South Africa's second commercial and manufacturing city and many light industries are established in its suburbs. The harbour and docks are modern and well equipped with ship repairing facilities. Cape Town's beautiful situation, excellent beaches, and impressive hinterland have made it South Africa's leading holiday centre; it is the most visited city in the country. The Victoria and Alfred waterfront complex (developed from the city's Victorian harbour in the 1990s), comprising shopping malls, restaurants and other attractions, is the city's most popular tourist destination.

The four area loads (Western) are added and compared with the TOTDX load see Figure 5.2.14.

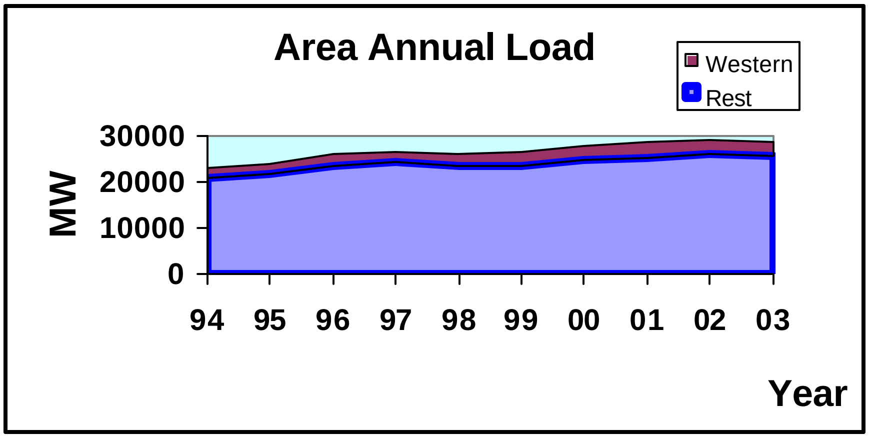

Figure 5.2.14 – Western Annual Load

Area 16 supplies the iron ore mining activities at Thabazimbi, the platinum mines north of Northam, and up to Ellisras. Area 18 supplies the old Lebowa homeland areas including Pietersburg and Messina municipalities. Area 24 is located roughly north of Pretoria and south of Pietersburg. See Figures A.2.16, A.2.18 and A.2.24 for historical annual load profiles.

Area 21 has large platinum mining and ferro chrome activities. The area is situated on the western limb of the Bushveld complex (Rustenburg). The area load has more than double over the past ten years sees Figure A.2.21.

Some of the increas ed loads came from newly commissioned plants such as the concentrator plant at Modikwa (Area 10), completed its first full year of production in 2003, and the Polokwane Smelter (Area 18) see Figures 5.2.15 and 5.2.16. {Reference: Anglo Platinum Annual Report 2003]

Figure 5.2.15 – The Concentrator Plant at Modikwa

Polokwane smelter (Area 18) is successfully commissioned in March 2003, and has performed exceptionally well. The furnace operated at design power levels (68 Megawatts) and chrome levels greater than 2% for sustained periods during the latter part of 2003. The capital expenditure was announced at R1,31 billion (2001 terms). See Figure 5.2.16, a technician is tapping the molten matte into the casting machine.

Figure 5.2.16 – Polokwane Smelter

The four area loads (Northern) are added and compared with the TOTDX load see Figure 5.2.17.

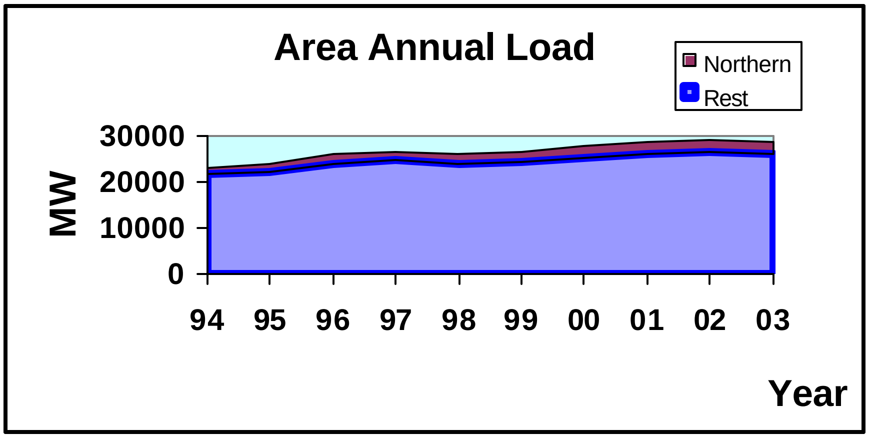

Figure 5.2.17 – Northern Annual Load

The results for the different TOTDX loads are summated below:

Table 5.2.1 TOTDX Loads

	S-curve 1	S-curve 2	S-curve 3	Areas
2004	31441.3	31864.4	29916.5	31640.0
2005	32346.6	32898.4	31128.9	33152.4
2006	33249.4	33938.7	32387.9	34198.2
2007	34006.0	34841.3	33551.8	34953.9
2008	34897.6	35887.3	34903.8	36073.5
2009	35733.5	36885.8	36255.2	36730.5
2010	36610.5	37933.5	37704.8	37860.5
2011	37426.4	38927.7	39152.1	38504.3
2012	38287.8	39974.9	40705.8	39957.0
2013	39113.1	40993.3	42285.9	40488.7
2014	39934.7	42014.9	43926.5	40975.7
2015	40736.4	43023.2	45612.9	41467.9
2016	41527.9	44027.6	47356.4	41964.0
2017	42308.7	45027.3	49157.9	42461.7
2018	43058.5	46001.7	50998.4	42896.4
2019	43821.1	46994.2	52922.7	43739.7
2020	44564.0	47972.0	54899.5	44261.8
2021	45295.0	48942.6	56937.5	45068.2
2022	46013.9	49905.4	59037.0	45571.7
2023	46720.5	50859.9	61198.5	46065.9
2024	47414.6	51805.5	63422.0	46550.2
2025	48096.1	52741.8	65707.5	46919.5

The results from the S-curves are a top-down approach. The results from Equation (5.2.2) follow a bottom-up approach. In areas 9, 18 and 21 additional loads are added to cater for possible step load increases in the areas see Table 5.2.4. Even with adding the additional loads the expected load in 2025 is 1.176 GW lower than the load for TOTDX (S-curve 1). The normal area load growths (area 10, 18 and 21) may even be too high. Therefore the results for the first S-curve are used as benchmark for the other loads.

The next step is to balance the area loads, the transmission substation loads and the distribution substation loads. The ranges for the area loads are kept very narrow in the balancing process. The main reason is to decompose the problem into smaller sub-problems. Changes in an area will not effect the loads in other areas, only the system peak and the generation pattern.

Table 5.2.2 compares the area load forecast results from the Balancing Algorithm and the S-curve:

Table 5.2.2 – Area Load Forecasts

	2004	2005	2006	2007		2004	2005	2006	2007
	Balancing Algorithm					S-Curves			
Area 1	390	398	407	418		391	397	403	409
Area 2	2032	2068	2106	2146		2040	2068	2095	2122
Area 3	412	422	429	436		412	421	430	439
Area 4	2281	2287	2292	2297		2267	2274	2281	2287
Area 5	1979	2016	2053	2082		1990	2017	2045	2073
Area 6	1010	1022	1028	1036		1014	1021	1028	1035
Area 7	3618	3671	3719	3761		3679	3739	3798	3857
Area 8	246	248	250	251		247	249	250	252
Area 9	409	415	541	653		408	414	537	649
Area 10	1177	1223	1268	1310		1184	1231	1278	1326
Area 11	1150	1168	1184	1200		1139	1173	1206	1238
Area 12	139	146	149	153		130	134	137	141
Area 13	657	662	667	672		657	661	665	670
Area 14	1578	1592	1605	1619		1575	1585	1595	1605
Area 15	1780	1786	1793	1798		1785	1793	1801	1809
Area 16	389	393	400	404		386	391	397	402
Area 17	2043	2078	2118	2154		2055	2092	2128	2164
Area 18	814	833	910	1030		814	828	843	909
Area 19	700	1638	1652	1735		701	1634	1647	1720
Area 20	1767	1810	1854	1899		1778	1815	1853	1890
Area 21	1538	1610	2160	2238		1535	1597	2110	2191
Area 22	628	640	651	662		625	637	649	662
Area 23	1335	1437	1456	1520		1432	1557	1568	1624

	2004	2005	2006	2007		2004	2005	2006	2007
	Balancing Algorithm					S-Curves			
Area 24	299	306	312	319		300	307	313	319
Area 25	802	810	815	821		807	813	818	824
Area 26	472	477	482	488		472	476	481	485
Area 27	1830	1845	1861	1876		1817	1829	1841	1853
TOTDX	31476	32997	34162	34974		31640	33152	34198	34954

The Load Dynamics software is used for the transmission substation forecast. Table 5.2.3 displays some results:

Table 5.2.3 – Load Dynamics Results

	2004	2005	2006	2007	2008
TX 26					
1%-LB	370.8	382.3	394.5	407.8	423.2
Mean	383.0	401.3	420.1	439.7	460.2
99%-UB	387.1	410.5	435.2	461.1	487.8
TX 27					
1%-LB	245.7	248.3	251.0	253.9	258.4
Mean	250.2	256.3	262.4	268.6	274.9
99%-UB	252.2	260.7	269.4	278.5	287.7
TX 28					
1%-LB	269.2	271.7	274.2	276.9	279.7
Mean	271.7	275.8	280.0	284.4	288.8
99%-UB	272.8	277.7	282.7	287.6	292.5
TX 29					
1%-LB	330.0	330.9	331.9	333.5	334.5
Mean	333.4	336.8	340.4	343.9	347.2
99%-UB	336.0	339.5	345.6	349.3	355.5
TX 30					
1%-LB	568.1	569.3	570.5	571.9	573.6
Mean	573.6	578.7	583.9	588.8	593.4
99%-UB	576.0	580.6	588.7	593.5	601.7
TX 31					
1%-LB	462.7	464.1	465.6	467.1	468.7
Mean	466.9	472.3	478.0	483.9	489.9
99%-UB	470.4	478.9	487.5	496.2	504.9
TX 32					
1%-LB	317.0	317.3	317.7	318.1	318.5
Mean	319.8	322.2	324.7	327.2	329.8
99%-UB	321.8	324.4	329.2	331.9	336.8

The balanced results for area and the transmission substation loads are displayed in Table 5.2.4.

Table 5.2.4 – Area and Transmission Substation Results (From the Balancing Algorithm).

		2004	2005	2006	2007
Area 1		390.1	398.2	407.3	417.6
	TX 1	300.7	308.0	316.4	325.9
	TX 2	88.7	89.5	90.2	91.1
	TX 3	0.7	0.7	0.7	0.7
Area 2		2032.1	2067.5	2106.1	2145.5
	TX 4	207.2	210.2	212.8	217.0
	TX 5	390.3	400.4	410.7	421.4
	TX 6	206.1	207.3	208.7	209.8
	TX 7	368.7	377.1	385.6	393.7
	TX 8	859.9	872.6	888.3	903.5
Area 3		411.9	421.5	429.0	435.6
	TX 9	46.0	47.3	48.7	49.5
	TX 10	251.7	257.1	263.7	267.8
	TX 11	114.1	117.0	116.7	118.4
Area 4		2280.6	2286.5	2291.9	2296.9
	TX 12	1423.7	1425.3	1426.5	1427.5
	TX 13	561.8	566.2	570.5	574.5
	TX 14	295.0	295.0	295.0	295.0
	TX 15	0.0	0.0	0.0	0.0
Area 5		1979.3	2016.4	2053.3	2081.7
	TX 16	18.3	18.6	18.8	19.2
	TX 17	190.9	192.7	192.4	196.2
	TX 18	0.0	0.0	0.0	0.0
	TX 19	96.8	97.8	98.7	99.6
	TX 20	375.9	382.1	386.8	391.2
	TX 21	178.3	179.8	181.2	183.5
	TX 22	333.5	341.4	352.3	362.1
	TX 23	785.7	804.1	823.0	829.9
Area 6		1009.6	1022.1	1028.4	1035.7
	TX 24	99.5	100.2	104.6	105.3
	TX 25	910.1	921.8	923.8	930.3
Area 7		3618.4	3670.8	3719.2	3761.3
	TX 26	372.6	379.6	387.0	396.0
	TX 27	250.2	251.6	253.4	254.8
	TX 28	271.3	274.9	277.9	281.0
	TX 29	333.3	336.7	340.4	343.9
	TX 30	571.9	578.7	585.1	588.9
	TX 31	467.4	471.8	475.2	478.2
	TX 32	319.7	322.1	324.7	327.3
	TX 33	465.6	483.3	499.5	511.7
	TX 34	0.0	0.0	0.0	0.0
	TX 35	566.4	572.0	576.0	579.6
Area 8		246.4	247.8	249.7	251.2
	TX 36	58.2	58.8	59.3	59.9
	TX 37	65.3	65.5	65.7	65.9
	TX 38	122.9	123.5	124.7	125.4

		2004	2005	2006	2007
Area 9		409.0	415.4	540.9	653.0
	TX 39	187.7	190.8	194.3	197.3
	TX 40	108.8	110.3	112.2	113.6
	TX 41	27.6	28.1	28.6	29.2
	Area 9 Add	0.0	0.0	0.0	0.0
	TX 42	0.0	0.0	118.0	224.0
	TX 43	84.8	86.2	87.9	89.0
Area 10		1177.1	1222.8	1268.4	1310.3
	TX 44	87.4	89.1	92.0	93.2
	TX 45	201.2	203.8	205.4	206.9
	TX 46	0.0	0.0	0.0	0.0
	TX 47	62.7	63.4	64.2	64.9
	TX 48	259.4	267.9	273.0	276.7
	TX 49	383.8	413.4	445.7	477.7
	TX 50	182.5	185.2	188.1	190.9
Area 11		1149.6	1167.5	1183.7	1199.6
	TX 51	360.5	368.7	373.9	379.3
	TX 52	128.0	128.9	129.9	130.9
	TX 53	75.6	76.2	76.8	77.5
	TX 54	0.0	0.0	0.0	0.0
	TX 55	184.9	186.0	187.6	188.8
	TX 56	253.5	258.7	264.3	269.9
	TX 57	147.2	149.1	151.2	153.2
Area 12		139.1	146.3	149.1	153.2
	TX 58	21.1	21.3	21.5	21.6
	TX 59	11.1	11.2	11.2	11.3
	TX 60	0.0	0.0	0.0	0.0
	TX 61	16.2	16.3	16.4	16.5
	TX 62	21.1	21.3	21.6	21.7
	TX 63	38.3	38.7	39.0	39.3
	TX 64	31.2	37.5	39.5	42.8
Area 13		656.8	661.8	667.4	671.5
	TX 65	82.5	83.1	83.6	84.1
	TX 66	223.3	224.3	225.5	226.5
	TX 67	107.1	108.8	109.4	110.4
	TX 68	42.9	43.3	44.0	44.2
	TX 69	158.9	159.7	162.0	163.1
	TX 70	42.2	42.6	42.9	43.2
Area 14		1577.5	1592.4	1605.1	1619.0
	TX 71	249.4	252.2	255.1	258.0
	TX 72	404.7	407.8	411.5	415.3
	TX 73	37.1	37.6	37.8	38.3
	TX 74	390.0	392.5	395.3	398.2
	TX 75	239.4	240.7	242.4	244.2
	TX 76	256.9	261.6	263.0	265.1
Area 15		1779.5	1785.9	1792.6	1797.7
	TX 77	209.8	211.1	211.8	212.8
	TX 78	547.2	550.7	553.2	554.7
	TX 79	327.0	328.9	329.9	330.1
	TX 80	427.7	425.1	425.1	425.1
	TX 81	267.8	270.2	272.7	275.0
Area 16		389.3	393.1	399.9	403.9
	TX 82	122.8	123.8	127.2	128.5
	TX 83	266.5	269.3	272.7	275.5

		2004	2005	2006	2007
Area 17		2043.3	2077.9	2117.8	2153.9
	TX 84	511.8	521.9	532.1	542.5
	TX 85	114.0	114.5	115.3	115.9
	TX 86	913.8	935.0	959.1	977.6
	TX 87	503.6	506.5	511.4	517.9
Area 18		814.3	832.5	910.0	1029.7
	Area 18 add	0.0	0.0	0.0	51.4
	TX 88	158.6	160.4	162.5	164.5
	TX 89	212.5	215.3	218.6	221.9
	TX 90	443.2	456.8	529.0	591.8
Area 19		700.0	1637.5	1652.0	1734.8
	TX 91	0.0	920.0	920.0	980.0
	TX 92	618.6	634.1	646.2	665.6
	TX 93	5.0	5.0	5.0	5.0
	TX 94	76.4	78.5	80.7	84.3
Area 20		1767.3	1810.3	1853.9	1898.6
	TX 95	0.0	0.0	0.0	0.0
	TX 96	690.2	705.6	722.4	739.6
	TX 97	412.5	421.7	445.8	455.0
	TX 98	557.5	572.7	573.0	588.4
	TX 99	107.1	110.3	112.7	115.6
Area 21		1538.4	1609.6	2159.9	2238.2
	TX 100	436.7	459.6	591.0	616.2
	TX 101	678.2	718.3	739.6	767.5
	Area 21 add	0.0	0.0	309.1	330.7
	TX 102	423.5	431.7	520.2	523.8
Area 22		628.2	639.6	650.7	662.3
	TX 103	267.2	272.5	277.9	283.5
	TX 104	43.3	43.6	44.1	44.5
	TX 105	317.7	323.5	328.7	334.4
Area 23		1334.9	1436.7	1456.0	1519.7
	TX 106	198.8	200.9	202.6	204.6
	TX 107	308.2	394.6	404.5	459.0
	TX 1 08	327.8	330.3	333.3	335.9
	TX 109	318.6	321.3	324.0	326.6
	TX 110	44.3	51.1	51.8	52.7
	TX 111	137.2	138.4	139.7	141.0
Area 24		299.2	305.8	312.2	319.0
	TX 112	221.4	227.0	232.7	238.6
	TX 113	77.8	78.7	79.6	80.5
Area 25		802.3	809.7	815.1	820.7
	TX 114	187.0	188.0	189.0	190.0
	TX 115	212.5	213.8	214.9	216.8
	TX 116	402.8	407.9	411.1	413.9
Area 26		471.7	476.6	482.0	487.6
	TX 117	396.1	399.5	403.9	408.7
	TX 118	10.9	11.0	11.0	11.1
	TX 119	64.7	66.2	67.1	67.8
Area 27		1829.8	1844.7	1860.6	1875.8
	TX 120	346.1	348.4	350.3	352.3
	TX 121	194.3	196.0	197.8	199.7
	TX 122	257.0	258.8	260.6	262.4
	TX 123	694.3	700.4	707.6	713.9
	TX 124	338.2	341.2	344.2	347.5

The unbalanced and balanced loads for transmission substation TX26 (Area 7) are shown in Table 5.2.5. The balanced loads are much lower compared to the unbalanced loads. See also Tables 5.2.3 and 5.2.4.

The substation has two 275/ 88 kV (315 MVA) transformers. The substation is exceeding its firm capacity, and a third transformer is required. With the third transformer commissioned the substation will not exceed its firm capacity in the forecast horizon according the balanced loads see Table 5.2.25. According the unbalanced loads the firm capacity may be exceeded around 2020. The unbalanced area loads (Area 7) were forecasted too high and therefore to balance the transmission substation loads, transmission substation (TX26) loads were also forecasted too high see Table 5.2.2.

This process to revise and review the different load forecasts, and to ensure consensus exists between the different load forecasts, was the *main reason* why the balancing algorithm was developed.

Table 5.2.5 – TX 26 Balanced and Unbalanced Load comparison

	1%-LB	Mean	99% -UB	Balanced
2004	370.8	383.0	387.1	372.6
2005	382.3	401.3	410.5	379.6
2006	394.5	420.1	435.2	387.0
2007	407.8	439.7	461.1	396.0
2008	423.2	460.2	487.8	403.5
2009	438.6	481.6	514.5	411.4
2010	456.1	504.0	542.6	419.1
2011	473.5	527.2	570.5	427.0
2012	492.3	550.1	597.7	435.1
2013	512.5	571.2	622.2	442.6
2014	531.3	590.3	645.5	450.5
2015	547.0	607.3	664.5	458.6
2016	560.7	622.5	678.9	466.2
2017	571.6	635.8	686.3	474.0
2018	582.2	647.4	688.0	481.9
2019	592.1	657.2	688.6	489.9
2020	601.1	665.2	688.8	497.8
2021	609.3	671.5	688.9	505.5
2022	616.9	676.4	688.9	513.3
2023	624.0	679.9	689.0	521.2
2024	631.4	684.3	689.0	529.0
2025	638.7	688.6	689.0	536.7

The balanced system load, S-curve loads and actual loads are compared in Figure 5.2.18.

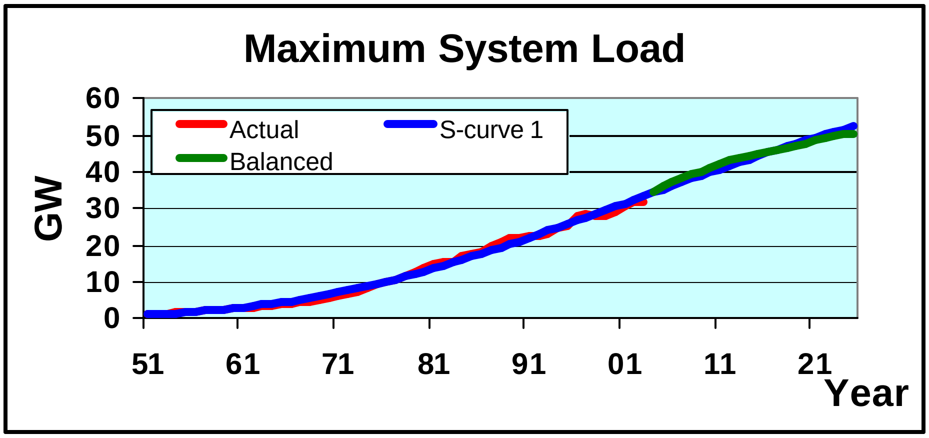

Figure 5.2.18 – Balanced and S-curve Maximum System Load

The three graphical measures discussed in Chapter 3 are displayed next in Figures 5.2.19, 5.2.20 and 5.2.21. The actual loads and the results from the balancing algorithm are used as explained in Chapter 3.

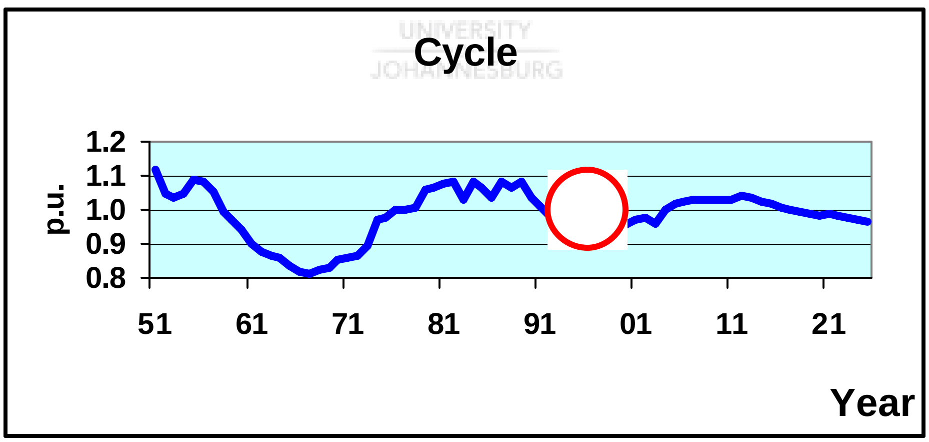

Figure 5.2.19 – Cycle

The encircled area (Figure 5.2.19) shows a high growth in the year 1996. The graphical results are displayed as the years the cycle value is above or below one see Table 5.2.6. From 1992 to 1998 it is expected that the cycle results should be below one, however for the years 1996 and 1997 the results are above one see Table 5.2.6.

Table 5.2.6 – Summary of Cycle Results

From	To	Above 1	Below 1
1951	1957	7	
1958	1975		18
1976	1991	16	
1992	1995		4
1996	1997	2	
1998	2003		6
2004	2017	14	
2018	2025		8

The annual increase (Figure 5.2.20) shows also a high increase in 1996.

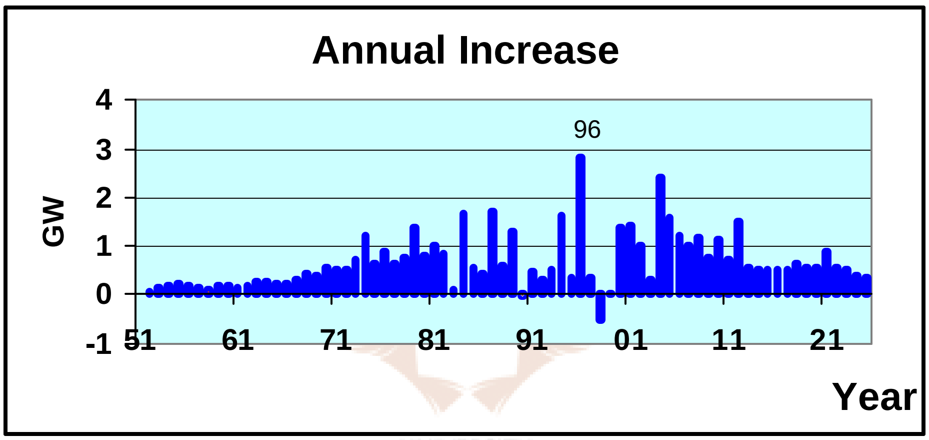

Figure 5.2.20 – Annual GW System Peak Increase

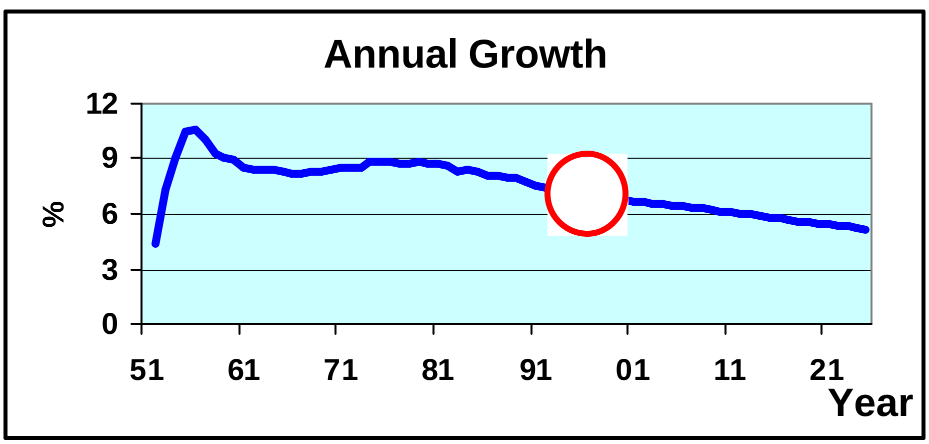

Figure 5.2.21 – Annual Growth

The results in Figure 5.2.21 have been determined by equation (3.2.2). Again the results in 1996 is higher as expected. The increase is the commissioning of an aluminium smelter in Area 4 (Figure A.2.4), stainless steel plant in Area 5 (Figure A.2.5), and a stainless plant in Area 26 (Figure A.2.26)

According to a newspaper article (Sake Rapport 25 April 2004) the expected cost of a 3.6 GW power station is 30 milliard Rand (R 30 X 10^9). Given a maximum generation capacity is 40 GW then at least three power stations are required to meet the balanced load see Figure 5.2.22.

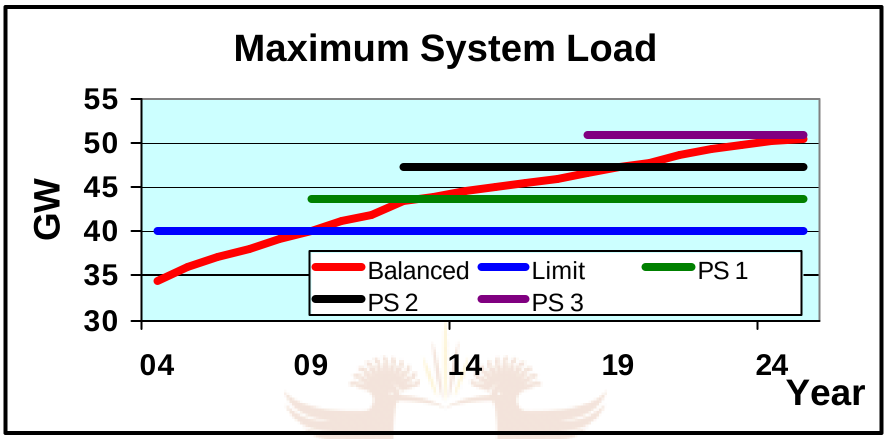

Figure 5.2.22 – Generation Required

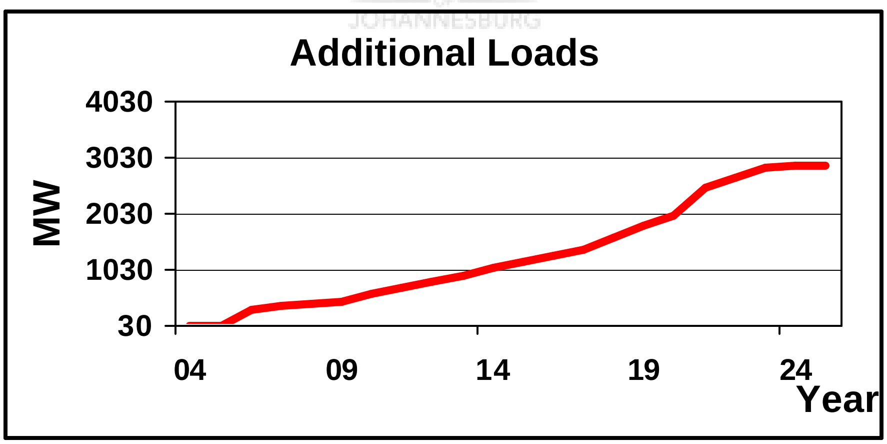

Figure 5.2.23 – Additional Loads

If S-curve two are used two more power stations are required. Again the maximum system load is a critical input to the balancing algorithm and the distribution substation loads. Referring to Figure 5.2.23, if the additional loads are excluded from the balanced loads, almost one less power station is required. Again this demonstrates the importance of the maximum system load. The expected step loads are almost impossible to forecasts, but with a reasonable system load, some assessment of additional area loads can be made.

The area-expected load is the "total load" that will flow between transmission and distribution in the area. The transmission substation loads give the answer to where and how much in the area. Different network operations and generation patterns, as well as network topology changes, make transmission substation forecast very difficult in some cases.

To demonstrate the point, compare the loads for two substations, Figures A.3.1 and A.3.2. The main reason is generation in the area. The next substation (Figure A.3.3) shows the impact of a customer with own generation. The power station was not generating in 1994, generating in 1995 (at time of transmission maximum system peaks) and finally closed before the winter of 1996. Figure A.3.4. shows a substation with a dominant traction load and with smaller loads to agricultural and residential sectors, etc. Figures A.3.5 and A.3.6 show the decrease of load at one substation when a new substation was commissioned. The last example shows the need of scaling factors. The load at time of system peak is approximately 30 MW lower as the maximum peak at 9h00 in the morning (Figure A.3.7).

TX1 is allocated to Area 1 (Table 5.2.4). The balanced loads for the distribution substation loads fed from TX1, are given in Table 5.2.7 (output from the balancing algorithm). Only the larger distribution loads are entered as ranges.

Table 5.2.7 – Balanced Distribution Substation Loads

MSD		2004	2005	2006	2007	2008
TX 1		300.7	308.0	316.4	325.9	335.3
(Balanced)	Losses	5.1	5.2	5.4	5.5	5.7
	Nett	295.6	302.8	311.0	320.4	329.6
	Ex/Im (Merapi to Harvard)	-15.0	-15.2	-15.3	-15.5	-15.6
	Ex/Im (Theseus to Harvard)	-15.0	-15.0	-15.0	-15.0	-15.0

MSD		2004	2005	2006	2007	2008
	Harvard 22 kV	4.6	4.7	4.8	4.8	4.8
	Paradys	1.7	1.8	1.8	1.8	1.8
	Parkwes	257.0	263.2	270.5	279.2	287.5
	Sannaspos	3.3	3.3	3.3	3.3	3.3
	Selosesha	25.0	25.3	25.5	25.8	26.0
	Vaalkraal	34.0	34.7	35.4	35.9	36.8
Upper	Ex/Im (Merapi to Harvard)	-15.0	-15.2	-15.3	-15.5	-15.6
	Ex/Im (Theseus to Harvard)	-15.0	-15.0	-15.0	-15.0	-15.0
	Harvard 22 kV	4.6	4.7	4.8	4.8	4.8
	Paradys	1.7	1.8	1.8	1.8	1.8
	Parkwes	269.6	275.6	283.3	292.4	301.1
	Sannaspos	3.3	3.3	3.3	3.3	3.3
	Selosesha	25.0	25.3	25.5	25.8	26.0
	Vaalkraal	34.0	34.7	35.4	35.9	36.8
Lower	Ex/Im (Merapi to Harvard)	-15.0	-15.2	-15.3	-15.5	-15.6
	Ex/Im (Theseus to Harvard)	-15.0	-15.0	-15.0	-15.0	-15.0
	Harvard 22 kV	4.6	4.7	4.8	4.8	4.8
	Paradys	1.7	1.8	1.8	1.8	1.8
	Parkwes	255.0	261.6	269.0	277.6	285.9
	Sannaspos	3.3	3.3	3.3	3.3	3.3
	Selosesha	25.0	25.3	25.5	25.8	26.0
	Vaalkraal	34.0	34.7	35.4	35.9	36.8

The results for 2004 (Table 5.2.7) have been compared with power-flow studies see Table 5.2.8.

Table 5.2.8 – Comparison between Balanced and Power Flow Loads

	B/ Algo	PSS/E
TX 1	300.7	302
TX 2	88.7	89
TX 3	0.7	0.7

In Chapter 1 it was mentioned that P values are required for each load bus (point load), some results are shown in Table 5.2.9.

Table 5.2.9 – Point Loads

MSD	2004	2005	2006	2007	2008
1STELN_X	0.5	0.5	0.5	0.5	0.5
ABTDL88	52.8	53.8	54.6	55.7	56.7
ABTN88	74.6	75.7	76.7	77.9	79.1
ABTTR1	13.5	14.0	14.5	15.0	16.0
ACAC66	43.2	43.6	44.0	44.4	44.8

MSD	2004	2005	2006	2007	2008
ACACA33	26.8	27.3	27.9	28.4	29.0
ACRNH22	17.9	18.3	20.3	21.3	21.5
AFREX88	23.1	25.6	25.6	25.6	25.6
ALBANY1	47.6	48.3	49.0	50.0	51.0
ALCKS8_X	0.6	0.6	0.6	0.6	0.6
ALDL88	15.8	16.2	17.1	17.5	17.8
ALEXB66	3.1	3.1	3.1	3.1	3.1
ALICE1	80.2	80.8	82.9	84.0	85.3
ALMA4	57.2	0.0	0.0	0.0	0.0
ALOE66	34.0	34.7	35.0	35.6	36.1
AMAND213	41.0	53.0	53.0	53.0	53.0
AMANDE13	45.9	34.1	34.4	35.6	36.4
AMANDLA8	59.7	61.5	63.5	65.6	68.1
AMCR88	68.5	69.2	69.9	70.6	70.6
ANDKBHD1	16.0	16.0	16.0	16.0	19.8
ANGLED	13.0	13.0	13.0	13.0	13.0
ANGLGD	26.2	26.2	26.2	26.2	26.2
ANTJA1	0.8	0.8	0.8	0.8	0.8
AQUARI88	24.0	24.0	24.0	24.0	24.0
ARGON1	24.4	24.7	24.9	25.2	25.4
ARIES4	10.7	10.8	10.8	10.9	11.0
ARLN_TR	0.5	0.5	0.5	0.5	0.5
ARSFN_TR	0.3	0.3	0.3	0.3	0.3
ASCAW88	45.8	46.3	46.8	46.8	46.8
ASHT1	32.5	32.8	33.1	33.4	33.6
ATLANTT1	4.2	4.2	4.3	4.4	4.5
AUROR4	10.1	10.1	10.1	10.1	10.1
BABELE13	43.5	44.2	44.7	44.8	44.9

The results for the other transformer loads (Table 5.2.10) are verified with power flow studies. Different generation patterns, switching of the shunt reactors and capacitors (status), and the static var system outputs can change the power flow results.

Some transformer loads (mainly the backbone substations) are calculated from the balanced loads. Sometimes the loads are determined directly, or sometimes the weighted sums of loads are used (see Chapter 3).

Table 5.2.10 – Substation Loads determined from Balanced Loads

MSD	2004	2005	2006	2007	2008
Aggeneis 400/220 kV	131.9	139.3	142.3	146.3	150.5
Alpha 400/765 kV	1396.7	2116.7	2134.1	2233.4	2635.3
Apollo 400/275 kV	1098.5	1152.6	1153.5	1186.2	1217.8
Arnot 400/275 kV	780.3	811.2	834.5	857.4	875.7

MSD	2004	2005	2006	2007	2008
Beta 765/400 kV	1351.3	2060.3	2076.0	2173.6	2568.6
Bighorn 400/275 kV	610.4	646.5	665.6	690.8	691.1
Camden 400/275 kV	169.5	170.2	174.6	175.3	177.8
Chivelston 400/275 kV	452.1	456.6	460.2	464.2	467.8
Glockner 400/275 kV	666.5	746.7	762.6	810.9	831.5
Hector 400/275 kV	907.5	921.4	937.7	953.3	964.2
Hera 400/275 kV	1243.5	1254.3	1266.3	1277.6	1288.2
Hydra 400/220 kV	-418.4	-396.7	-417.2	-417.9	-417.2
Invubu 400/275 kV	874.3	878.8	883.2	887.2	891.2
Komatipoort 275/132 kV	62.7	63.4	64.2	64.9	66.0
Matla 400/275 kV	-430.9	-435.3	-439.5	-440.1	-439.7
Merensky 400/275 kV	230.3	248.0	267.4	286.6	305.6
Mersey 400/275 kV	1152.2	1175.6	1199.3	1224.7	1247.7
Minerva 400/275 kV	2257.3	2311.3	2380.2	2431.9	2480.7
Perseus 400/275 kV	399.6	406.8	474.1	535.3	594.5
Pluto 400/275 kV	722.0	729.6	785.7	790.1	809.3
Poseidon 220/132 kV	19.6	20.3	21.0	22.0	23.0
Poseidon 220/66 kV	30.8	31.2	31.5	32.0	32.5
Poseidon 400/220 kV	422.6	433.3	439.6	452.0	464.9
Ruigtevallei 220/132 kV	-239.8	-218.3	-239.0	-239.9	-239.5
Spitskop 400/132kV	237.8	240.2	242.8	245.3	247.9
Spitskop 400/275 kV	794.0	822.7	1003.6	1032.1	1107.3
Venus 400/275 kV	495.1	498.7	503.4	507.3	513.8
Witkop 400/275 kV	442.4	447.9	454.1	460.2	467.3

In Chapter 1, the last requirement to assist the planning engineer to determine the line loadability, is to scale the modelled loads. The modelled point loads (at time of maximum system load) are scaled either to the expected minimum or maximum load to study the line loadability.

An area has been studied to determine the difference between the area maximum (and minimum) loads and the load at time of maximum transmission system load. The results are displayed in Table 5.2.11. The weekly maximum and minimum loads for the areas are shown in ANEXURE B.

Table 5.2.11 – Minimum & Maximum Loads

1994	Max1	Max2	Max3	Min	MSD
MW	530.22	506.45	498.45	310.86	506.45
	WEEK 26	WEEK 30	WEEK 29	WEEK 52	
From	1994/06/26 00:00	1994/07/24 00:00	1994/07/17 00:00	1994/12/25 00:00	1994/07/24 00:00
To	1994/07/02 23:00	1994/07/30 23:00	1994/07/23 23:00	1994/12/31 23:00	1994/07/30 23:00
Max (Min) / MSD	1.05	1.00	0.98	0.61	1.00

1995	Max1	Max2	Max3	Min	MSD
MW	453.90	445.69	445.55	332.22	419.44
	WEEK 40	WEEK 37	WEEK 38	WEEK 52	
From	1995/10/01 00:00	1995/09/10 00:00	1995/09/17 00:00	1995/12/24 00:00	1995/07/16 00:00
To	1995/10/07 23:00	1995/09/16 23:00	1995/09/23 23:00	1995/12/30 23:00	1995/07/22 23:00
Max (Min) / MSD	1.08	1.06	1.06	0.79	1.00

1996	Max1	Max2	Max3	Min	MSD
MW	609.33	574.28	573.95	351.99	544.74
	WEEK 30	WEEK 28	WEEK 31	WEEK 16	
From	1996/07/28 00:00	1996/07/14 00:00	1996/08/04 00:00	1996/04/21 00:00	1996/07/21 00:00
To	1996/08/03 23:00	1996/07/20 23:00	1996/08/10 23:00	1996/04/27 23:00	1996/07/27 23:00
Max (Min) / MSD	1.12	1.05	1.05	0.65	1.00

1997	Max1	Max2	Max3	Min	MSD
MW	598.10	594.18	584.98	370.24	570.10
	WEEK 18	WEEK 34	WEEK 24	WEEK 51	
From	1997/05/04 00:00	1997/08/24 00:00	1997/06/15 00:00	1997/12/21 00:00	1997/06/29 00:00
To	1997/05/10 23:00	1997/08/30 23:00	1997/06/21 23:00	1997/12/27 23:00	1997/07/05 23:00
Max (Min) / MSD	1.05	1.04	1.03	0.65	1.00

1998	Max1	Max2	Max3	Min	MSD
MW	575.85	573.92	568.81	381.06	558.84
	WEEK 23	WEEK 31	WEEK 24	WEEK 51	
From	1998/06/07 00:00	1998/08/02 00:00	1998/06/14 00:00	1998/12/20 00:00	1998/06/07 00:00
To	1998/06/13 23:00	1998/08/08 23:00	1998/06/20 23:00	1998/12/26 23:00	1998/06/13 23:00
Max (Min) / MSD	1.03	1.03	1.02	0.68	1.00

1999	Max1	Max2	Max3	Min	MSD
MW	540.06	539.73	539.43	387.18	525.31
	WEEK 19	WEEK 18	WEEK 21	WEEK 51	
From	1999/05/09 00:00	1999/05/02 00:00	1999/05/23 00:00	1999/12/19 00:00	1999/06/20 00:00
To	1999/05/15 23:00	1999/05/08 23:00	1999/05/29 23:00	1999/12/25 23:00	1999/06/27 00:00
Max (Min) / MSD	1.03	1.03	1.03	0.74	1.00

2000	Max1	Max2	Max3	Min	MSD
MW	592.71	588.22	586.23	397.09	586.23
	WEEK 22	WEEK 18	WEEK 29	WEEK 52	
From	2000/05/28 00:00	2000/04/30 00:00	2000/07/16 00:00	2000/12/24 00:00	2000/07/16 00:00
To	2000/06/03 23:00	2000/05/06 23:00	2000/07/22 23:00	2000/12/30 23:00	2000/07/22 23:00
Max (Min) / MSD	1.01	1.00	1.00	0.68	1.00

2001	Max1	Max2	Max3	Min	MSD
MW	601.83	599.90	596.41	396.01	596.99
	WEEK 28	WEEK 29	WEEK 27	WEEK 51	
From	2001/07/15 00:00	2001/07/22 00:00	2001/07/08 00:00	2001/12/23 00:00	2001/07/22 00:00
To	2001/07/21 23:00	2001/07/28 23:00	2001/07/14 23:00	2001/12/29 23:00	2001/07/28 23:00
Max (Min) / MSD	1.01	1.00	1.00	0.66	1.00

2002	Max1	Max2	Max3	Min	MSD
MW	677.08	661.21	631.10	411.51	612.74
	WEEK 32	WEEK 31	WEEK 28	WEEK 51	
From	2002/08/11 00:00	2002/08/04 00:00	2002/07/14 00:00	2002/12/22 00:00	2002/07/14 00:00
To	2002/08/17 23:00	2002/08/10 23:00	2002/07/20 23:00	2002/12/28 23:00	2002/07/20 23:00
Max (Min) / MSD	1.11	1.08	1.03	0.67	1.00

2003	Max1	Max2	Max3	Min	MSD
MW	730.50	719.66	717.25	502.44	685.61
	WEEK 31	WEEK 33	WEEK 32	WEEK 51	
From	2003/08/03 00:00	2003/08/17 00:00	2003/08/10 00:00	2003/12/21 00:00	2003/07/06 00:00
To	2003/08/09 23:00	2003/08/23 23:00	2003/08/16 23:00	2003/12/27 23:00	2003/07/12 23:00
Max (Min) / MSD	1.07	1.05	1.05	0.73	1.00

The area per sector and sector forecasts have not been completed at this time. Tables 5.2.12 and 5.2.13 show the results for the aluminium sector. Only two areas have aluminium loads. However, the area per sector loads will play an important role in the future transmission load forecasts.

Table 5.2.12 – Sector Loads

	2004
Agriculture	**1752.79**
Commercial	**2830.55**
Industrial: Aluminium	**1242.08**
Industrial: Chemical Fuel	**927.52**
Industrial: FeCr	**1114.27**
Industrial: FeMg	**460.52**
Industrial: FeSi	**141.37**
Industrial: Heavy Minerals (RBM, Namakwa S)	**360.26**
Industrial: Iron & Steel incl. Stainless	**449.67**
Industrial: Other	**4563.97**
Industrial: Paper and pulp	**347.95**
Industrial: Zinc (Zincorp, Gamsberg)	**59.26**
Mining : Coal	**384.57**
Mining : Gold	**2608.32**
Mining : Other	**490.78**
Mining : Platinum	**976.79**
Residential + Prepaid	**11327.40**
Traction	**502.88**
Losses	**944.57**
Import/Export	**0.00**
Total	**31485.53**

Note: *The sector loads are not official loads*

Table 5.2.13 – Area per Sector Loads

Area per sector 2004 loads :			
	Area 4	**Area 11**	**Total**
Industrial: Aluminium	**1199.08**	**43.00**	**1242.08**

Richards Bay has an important Aluminium Industry. Bayside Aluminium produces 180 000tons of aluminium per annum. Hillside is South Africa's most important producer of primary aluminium - 500 000 tons a year. [Billiton’s Annual Report 2002]

Figure 5.2.24 – Hillside Aluminium Smelter

Figure 5.2.25 –Richards Bay Harbour

To conclude this section, the sector and area per sector load forecasts are the last benchmark for the transmission load forecasts. The balanced load for

2025 is 50.5 GW. The TOTDX load is 46.9 GW, that includes approximately 3 GW additional load. The additional load is in Operations Research terms a surplus node. The questions of where, when and how much cannot be answered. The expected sector loads as determined from the area per sector loads can be analysed and compared with the expected sector loads to determine whether the expected growths are reflecting the same growth rates.

Lastly to produce and maintain such a load forecast involves continuous surveillance of articles, reports, etc., comparing actual results with expected results, adjustments to the ranges of the expected loads and balancing the loads.

5.3 EVALUATION

The number of loads to be considered makes the transmission load forecast extremely complex and, in the unstable environment the utility is operating, the outcome of expected loads highly uncertain. The number of distribution loads (more than a thousand loads) makes the balancing process extremely difficult. Uncertainty in the electrical market makes even a short-term load forecast (5 years) quite risky, especially when load values are close to maximum ratings.

Therefore, the balancing of loads according to the electrical load model is definitely required. The balancing of loads forces the forecaster to know the electrical networks and understand the impact of the different factors on the transmission loads.

5.4 GEOGRAPHICAL INFORMATION SYSTEM

The next development to the transmission load forecast is to display the forecast results on a geographical basis (GIS). The forecast results, and expected economical and demographically data can be combined to ensure the load forecast is more informative.

The importance of a GIS system is demonstrated with the next discussions see Figure 5.2.7. There is the possibility that to left of Kenhardt mining activities may develop. The expected load for the mine is between twenty to forty MW and the smelter hundred MW. A further possibility is that the smelter can be located at Saldanha. Immediately the planner will realise that the line from Kenhardt will not be able to handle the increased load – not all substations are shown in Figure 5.2.7. The development of the mine was first mentioned in 1972.

Any large step load increases in the area between Kimberley and Upington requires network expansions. There was an application for a large load in the area that would double the area load. Through the surveillance process (Chapter 2) possible developments is detected in the Vryburg area. The transmission network stops roughly at Mafikeng. The area north of Welkom towards Klerksdorp, is referred to as the "Bothaville gap". The depth of the gold underneath surface makes mining activities not cost-effective.

Such possible developments proof the statement in Chapter 1. "The load forecast has to be supported by a knowledge-based system, appropriate forecasting techniques and computer models. Any knowledge-based system (referred to as an expert system) essentially emulates the acquired knowledge and thought processes of an expert in arriving at decisions concerning a problem"

5.5 CONCLUSION

In conclusion: - the structuring of loads according to the electrical load model and the load balancing process add value to the transmission load forecast. The balancing of loads serves as benchmark for the loads entered between predefined ranges. The load forecast is also more informative.