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Platinum, electricity and the economy

L.C. STILWELL
Read, Swatman & Voigt (Pty) Ltd

The paper uses data from official sources (Statistics South Africa and the Department of Minerals and Energy) and the national electrical utility, Eskom, to present a profile of the consumption of electrical power by the South African platinum industry.

Using this data, the paper will examine the PGM industry's use of electrical energy in relation to the generation of revenue by that energy.

The period under review is from 1990 to 2006, as this is the extent of the data available.

Introduction

Electrical energy is vital to the development of any modern economy, especially when a core sector of that economy is a heavy industry, such as mining.

The current situation regarding the supply of electrical energy in South Africa serves to emphasize this dependency. This paper examines the relationship between the production and sale of platinum group metals (PGM) and the use of electrical energy.

South African PGM production and sales

Production

In 2006, South Africa produced three hundred and seven tons of PGM, some 57% of total world production. PGM production increased from 141,900 kilograms in 1990 to 307,528 kilograms in 2006, a factor of 2.17, or at an average annual rate of 4.65% (Table I, Figure 1).

Sales

PGM sales increased from 5.164 billion Rands in 1990 to 65.443 billion Rands in 2006, expressed in current money terms (Table II, Figure 2). This was an apparent increase of 17.2%

PGM sales increased from 5.164 billion Rands in 1990 to 20.708 billion Rands in 2006, expressed in constant 1990 money terms (Table III, Figure 3). This was a real increase of 9.1%

See later for a discussion on Current and Constant money

Tables II and III also indicate the increasing importance of the PGM industry; from 12.4% of total mining sales in 1990 to 33.5% in 2006. This percentage is the same, whether sales are expressed current or constant money terms. (Figure 4.)

Table I
PGM production 1990–2006

Year	Kilograms	Year	Kilograms
1990	141 900	1999	216 479
1991	142 861	2000	206 770
1992	152 891	2001	228 747
1993	176 167	2002	236 641
1994	183 926	2003	266 458
1995	183 097	2004	276 401
1996	188 636	2005	302 979
1997	196 651	2006	307 528
1998	199 953	2007	Not available

Source: DME
Absolute increase 217
Annual average 4.95%

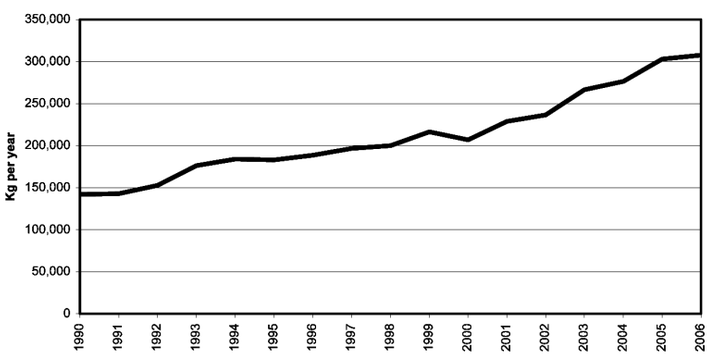

Figure 1. PGM production

Table II
PGM and total mineral (sales current money)

Year	PGM sales	Total mineral sales	PGM % of total	% increase in sales
1990	5 164 216 000	41 514 000 000	12.4%	0.0%
1991	5 692 118 086	43 386 191 668	13.1%	10.2%
1992	4 677 840 738	42 106 695 259	11.1%	-4.8%
1993	5 188 809 046	50 219 473 871	10.3%	0.2%
1994	5 809 612 866	53 603 460 015	10.8%	3.0%
1995	6 572 506 170	56 569 422 095	11.6%	4.9%
1996	7 486 247 000	63 039 584 000	11.9%	6.4%
1997	8 509 198 020	66 070 597 090	12.9%	7.4%
1998	11 929 749 372	70 761 362 928	16.9%	11.0%
1999	14 883 050 982	75 441 512 038	19.7%	12.5%
2000	27 094 627 342	98 372 168 082	27.5%	18.0%
2001	33 370 849 290	115 179 110 147	29.0%	18.5%
2002	34 828 773 244	134 765 210 562	25.8%	17.2%
2003	28 823 929 371	117 749 908 060	24.5%	14.1%
2004	33 313 242 357	125 306 868 299	26.6%	14.2%
2005	38 448 855 514	142 809 670 502	26.9%	14.3%
2006	65 443 815 635	195 454 673 521	33.5%	17.2%
2007	Not available			

Source: DME

Table III
PGM and total mineral sales (constant 1990 money)

Year	PGM sales	Total mineral sales	PGM % of total	% increase in sales
1990	5 164 216 000	41 514 000 000	12.4%	0.0%
1991	4 925 424 630	37 542 337 280	13.1%	-4.6%
1992	3 560 869 790	32 052 493 339	11.1%	-17.0%
1993	3 594 861 169	34 792 576 669	10.3%	-11.4%
1994	3 698 612 395	34 125 926 496	10.8%	-8.0%
1995	3 849 092 011	33 129 053 824	11.6%	-5.7%
1996	4 085 159 238	34 399 978 914	11.9%	-3.8%
1997	4 274 762 986	33 191 863 941	12.9%	-2.7%
1998	5 607 775 758	33 262 547 540	16.9%	1.0%
1999	6 649 540 165	33 706 218 234	19.7%	2.8%
2000	11 488 121 993	41 709 799 267	27.5%	8.3%
2001	13 386 225 259	46 202 405 584	29.0%	9.0%
2002	12 796 706 980	49 515 120 692	25.8%	7.9%
2003	10 009 292 427	40 889 402 963	24.5%	5.2%
2004	11 409 381 873	42 916 084 135	26.6%	5.8%
2005	12 736 193 327	47 305 703 354	26.9%	6.2%
2006	20 707 595 395	61 845 359 383	33.5%	9.1%
2007	Not available			

Source: DME

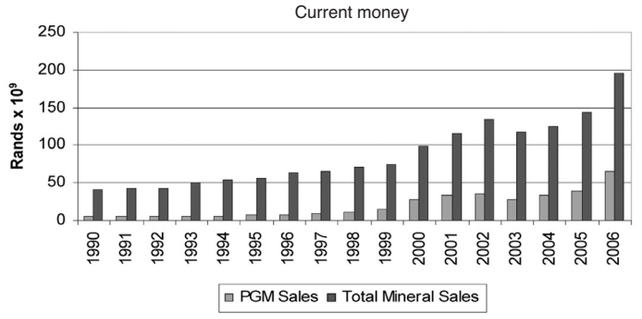

Figure 2. PGM and total mineral sales

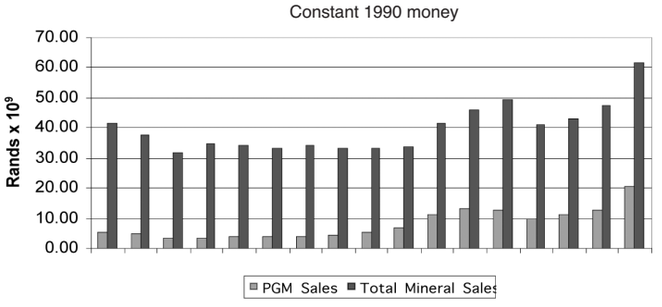

Figure 3. PGM and total mineral sales

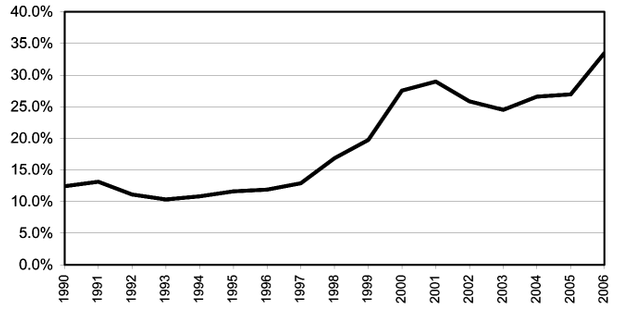

Figure 4. PGM as % of total mineral sales

Consumption of electrical power by the PGM industry

To produce its metal, and to generate its revenue, the PGM industry consumed a total 123,844 GWh, during the period under review, at the annual rates given in Table IV, and displayed in Figure 5.

Consumption increased from 4,288 GWh in 1990 to 10,712 GWh in 2007, a factor of 2.5, or an average annual rate of 5.53%

The relationship between PGM production and electrical power consumption

Inflation

To make any meaningful comparison between data involving money over a given period of time, it is necessary to either deflate or inflate the money element to either end of the time scale. Common practice is to deflate money to the base date, in this case 1990.

Statistics South Africa, (StatsSA) the government agency responsible in terms of the Statistics Act of 1999 for the collection, production and dissemination of official statistics, defines the annual inflation rate as:

'The change in the Consumer Price Index, or CPI for all items in the relevant month of a current year compared with the CPI for all items of the same month in the previous year'. [StatsSA 2001].

StatsSA also compiles an annual average change in the CPI. In order to ensure the indices remain manageable in size, StatsSA changes the base year every five years. Table V contains Consumer Price Indices, with a base year of 2000, for all expenditure groups for the metropolitan areas for the month of January each year. [StatsSA 2001]

The figures in the right hand column of Table V show the annual change in the CPI from the 1990 base year. For instance a January 1990 Rand had 3.4 times the buying power of a January 2007 Rand, or 2.1 that of a January 1998 Rand.

Therefore, to express Rands generated in years after 1990 (the current Rands) to constant 1990 terms, it is necessary to divide the current Rands by the factors in the right-hand column of Table V.

Applying these factors to the data in Table VI, we can express the revenue generated per kilogram PGM produced and the revenue generated per kilowatt-hours consumed in terms of a constant 1990 Rand, as shown in Table VII

Data in current, or nominal money terms

The data contained in Table VI indicates that:

- The Rands generated each year (the current Rands) per kilogram PGM sold increased at 11.67% per annum, or a factor of 5.85, from R36,393 in 1990 to R212,806 in 2006.
- kWh used to produce one kilogram PGM increased at 0.89% per annum, or a factor of 1.15, from 3,0218 kWh/kg in 1990 to 34,813 kWh/kg in 2006.

Table IV
Electricity consumed by the PGM sector

Year	GWh	Year	GWh
1990	4 288	1999	6 282
1991	4 540	2000	6 611
1992	4 782	2001	7 291
1993	5 010	2002	7 899
1994	5 089	2003	9 164
1995	5 260	2004	9 464
1996	5 433	2005	9 857
1997	5 650	2006	10 706
1998	5 846	2007	10 712

Source: ESKOM

Absolute increase 2.50
Annual average 5.535%
Total GWh 123, 884

Table V
Consumer price index

Year	CPI base year 2000 = 100	Annual change from January 1990
1990	42.4	1.0
1991	49.0	1.2
1992	55.7	1.3
1993	61.2	1.4
1994	66.6	1.6
1995	72.4	1.7
1996	77.7	1.8
1997	84.4	2.0
1998	90.2	2.1
1999	94.9	2.2
2000	100.0	2.4
2001	105.7	2.5
2002	115.4	2.7
2003	122.1	2.9
2004	123.8	2.9
2005	128.0	3.0
2006	134.0	3.2
2007	143.5	3.4

Source: StatsSA 2001

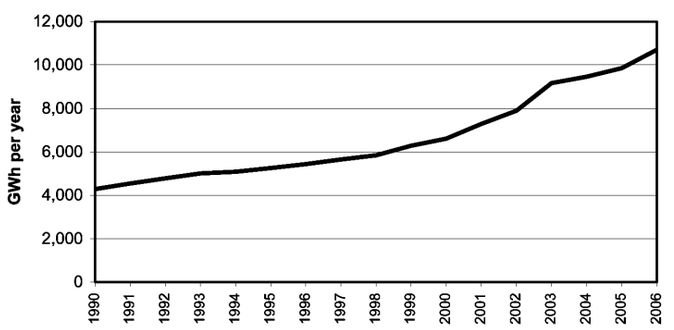

Figure 5. Electricity consumption

Table VI
Revenue and power (current money)

Year	PGM (kilograms)	PGM sales (current Rbn)	Power consumed (GWh)	Current rands per kg produced	kWh used per kg produced	Current rands generated per kWh used
1990	141 900	5.164	4 288	36 393	30 218	1.204
1991	142 861	5.692	4 540	39 844	31 779	1.254
1992	152 891	4.678	4 782	30 596	31 277	0.978
1993	176 167	5.189	5 010	29 454	28 439	1.036
1994	183 926	5.810	5 089	31 587	27 669	1.142
1995	183 097	6.573	5 260	35 896	28 728	1.250
1996	188 636	7.486	5 433	39 686	28 802	1.378
1997	196 651	8.509	5 650	43 271	28 731	1.506
1998	199 953	11.930	5 846	59 663	29 237	2.041
1999	216 479	14.883	6 282	68 751	29 019	2.369
2000	206 770	27.095	6 611	131.038	31 973	4.098
2001	228 747	33.371	7 291	145 885	31 874	4.577
2002	236 641	34.829	7 899	147 180	33 380	4.409
2003	266 458	28.824	9 164	108 174	34 392	3.145
2004	276 401	33.313	9 464	120 525	34 240	3.520
2005	302 979	38.449	9 857	126 903	32 534	3.901
2006	307 528	65.444	10 706	212 806	34 813	6.113
Factor	2.17	13.99	2.50	5.85	1.15	5.08
Annual av.	4.95%	17.93%	5.89%	11.67%	0.89%	10.69%

Source: DME & ESKOM

Table VII
Revenue and power (constant 1990 money)

Year	PGM (kilograms)	PGM sales (current Rbn)	Power consumed (GWh)	Current rands per kg produced	kWh used per kg produced	Current rands generated per kWh used
1990	141 900	5.164	4 288	36 393	30 218	1.204
1991	142 861	4.925	4 540	34 477	31 779	1.085
1992	152 891	3.561	4 782	23 290	31 277	0.745
1993	176 167	3.595	5 010	20 406	28 439	0.718
1994	183 926	3.699	5 089	20 109	27 669	0.727
1995	183 097	3.849	5 260	21 022	28 728	0.732
1996	188 636	4.085	5 433	21 656	28 802	0.752
1997	196 651	4.275	5 650	21 738	28 731	0.757
1998	199 953	5.608	5 846	28 045	29 237	0.959
1999	216 479	6.650	6 282	30 717	29 019	1.059
2000	206 770	11.488	6 611	55 560	31 973	1.738
2001	228 747	13.386	7 291	58 520	31 874	1.836
2002	236 641	12.797	7 899	54 076	33 380	1.620
2003	266 458	10.009	9 164	37 564	34 392	1.092
2004	276 401	11.409	9 464	41 278	34 240	1.206
2005	302 979	12.736	9 857	42 037	32 534	1.292
2006	307 528	20.708	10 706	67 336	34 813	1.934
Factor	2.17	4.01	2.50	1.85	1.15	1.61
Annual av.	4.95%	9.07%	5.89%	3.92%	0.89%	3.01%

Source: DME, ESKOM & StatsSA

This indicates an annual average decrease in the efficient use of electricity of 0.89% per annum.

- The revenue generated per kilowatts consumed, in current money terms, increased at 10.69% per annum, or a factor of 5.08, from R1.204/kWh in 1990 to R6.113/kWh in 2006.

These observations are, however, misleading because, as discussed previously, one of the elements, money, is subject to inflationary pressure, i.e., it loses value over time. The other elements, mass and kilowatt-hours, will remain constant throughout time. In other words, a Rand generated in 2006 does not have the same value as a Rand generated in 1990, but a kilogram of platinum produced in 1990 has exactly the same mass as a kilogram produced in 2006, or any other time, and a kilowatt-hour consumed in 1990 contains exactly the same amount of energy as a kilowatt hour consumed in 2006

Data in constant, or Real 1990 money terms

The data contained in Table VII indicates that:

- The constant 1990 Rands generated each year per kilogram PGM sold increased at 3.92% per annum, or a factor of 1.85, from R36,393 in 1990 to R67,336 in 2006.
- kWh used to produce one kilogram PGM increased at 0.89% per annum, or a factor of 1.15, from 30,218 kWh/kg in 1990 to 34,813 kWh/kg in 2006.

This indicates an annual average decrease in the efficient use of electricity of 0.89% per annum, the same as that calculated for the current money case.

- The revenue generated per kilowatts consumed, in constant 1990 money terms, increased 3.01% per annum, or a factor of 1.61, from R1.204/kWh in 1990 to R1.934/kWh in 2006.

Figures 6 and 7 show the factors revenue per kilogram and revenue per kilowatt-hour in both current and constant 1990 money terms. Figure 8 shows the consumption of electricity in terms of kilograms produced, neither of which, as mentioned earlier, is not subject to inflationary pressure.

Observations

In 1990, 1kWh produced 0.033 g PGM (Table VIII) and earned R1.204 (Table VII).

In 2006, 1kWh produced 0.029g PGM (Table VIII) and earned R1.934 when expressed in constant 1990 money terms (Table VII).

According to these figures, production of PGM per kWh consumed decreased by a factor of 0.83, or -1.19% per annum, while the money earned for each kWh consumed increased by a factor of 1.61, or 3.01% per annum.

The apparent increase in the earning power of 1 kWh was, however, due to the real increase in the PGM price. This increased from R36393/kg to R67336/kg, i.e., a factor of 1.85 or 3.92% per annum

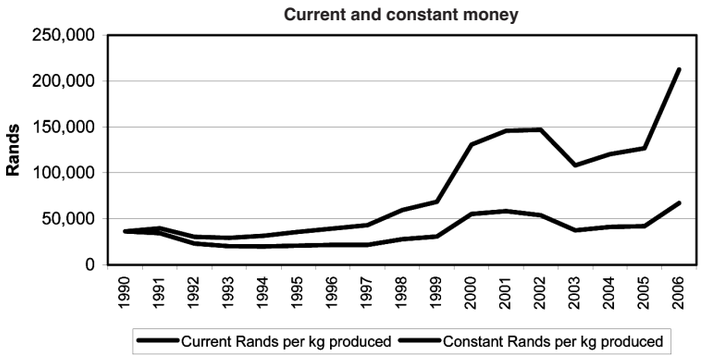

Figure 6. Revenue per kilogram

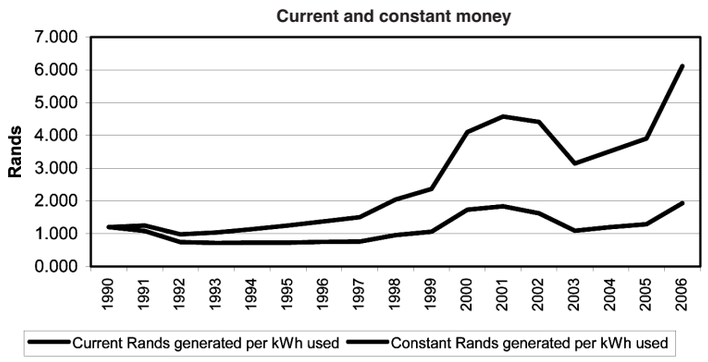

Figure 7. Revenue per KWH

Figure 8. Electrical power consumed per kg PGM produced

Table VIII
Production efficiency

Year	Grams per kWh	Year	Grams per kWh
1990	0.033	1999	0.034
1991	0.031	2000	0.031
1992	0.032	2001	0.031
1993	0.035	2002	0.030
1994	0.036	2003	0.029
1995	0.035	2004	0.029
1996	0.035	2005	0.031
1997	0.035	2006	0.029
1998	0.034	2007	n/a

Source: Table VII

Figure 9 illustrates the data contained in Table IX. As would be expected, it shows a strong correlation between the earning power of 1 kWh (R/kWh) and the PGM price (R/kg). However, there is almost no correlation between these factors and the amount of electricity consumed.

The industry reduced its consumption of electricity during the period from 1991 to 1993, since when consumption has increased slightly but steadily

Conclusions

The purpose of this paper is to examine the use of electrical energy by the PGM industry in relation to the generation of revenue by that energy

We have established the relationship between the Rand and a kilogram PGM, and that between a kilo Watt-hour and a kilogram PGM during the period from 1990 to 2006, as we saw in Figures 7 and 8.

We can find the relationship between a kilo Watt-hour consumed by the PGM industry and the money generated as a result as follows: (Figure 10).

$$\frac{\text{Rands. kg-1}}{\text{kWh. Kg-1}} = \text{Rands. kWh-1}$$

The Rand generating power of a kWh therefore increased from 1.204 in 1990 to 1.934 in 2006, but if we compare the percentage changes in these three ratios between 1990 and

Table IX
Annual compound increases

Year	R_1 (% p.a.)	R_2 (% p.a.)	R_3 (% p.a.)
1990	0.0%	0.0%	0.0%
1991	-5.3%	5.2%	-9.9%
1992	-20%	1.7%	-21.4%
1993	-17.5%	-2.0%	-15.9%
1994	-13.8%	-2.2%	-11.9%
1995	-10.4%	-1.0%	-9.5%
1996	-8.3%	-0.8%	-7.6%
1997	-7.1%	-0.7%	-6.4%
1998	-3.2%	-0.4%	-2.8%
1999	-1.9%	-0.4%	-1.4%
2000	4.3%	0.6%	3.7%
2001	4.4%	0.5%	3.9%
2002	3.4%	0.8%	2.5%
2003	0.2%	1.0%	-0.7%
2004	0.9%	0.9%	0.0%
2005	1.0%	0.5%	0.5%
2006	3.9%	0.9%	3.0%

Where:
R_1 = Annual compound increase in constant rands/kg
R_2 = Annual compound increase in kWh/kg
R_3 = Annual compound increase in constant rands/kWh

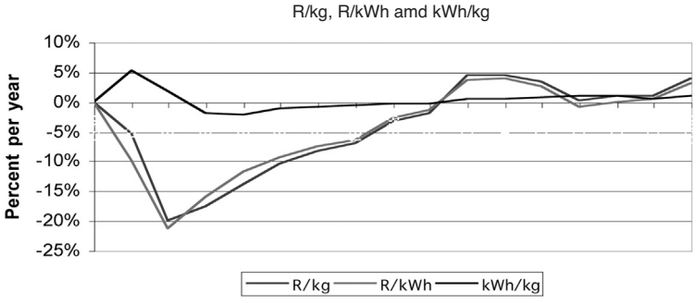

Figure 9. Annual compound rate of increase

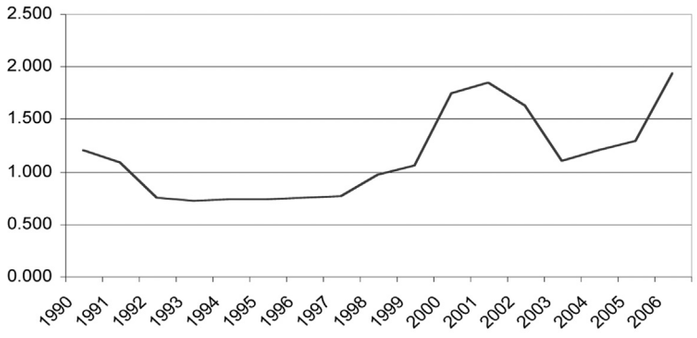

Figure 10. Constant rands per kg per kWh

2006 (Figure 11), it becomes apparent that the increased money generating power of a kilowatt is due solely to the increase in the PGM price, and not to an increase in the efficient use of electricity.

This observation leads to the following questions:

- Is there a correlation between the cost of electricity and the PGM price?
- Does an increase in PGM price mean that the industry extracts lower grades, with a concomitant increase in the electricity consumed?
- Why was the industry able to reduce its consumption of electricity between 1991 and 1993
- Why has the production efficiency of 1 kWh dropped from 0.034 g in 1990 to 0.029 gram in 2006, a fall of 14.7%?

The conclusion is therefore that the PGM industry pays little or no attention to the manner in which it consumes electrical energy. The consequences of this indifference manifested themselves very forcibly during the earlier part of this year.

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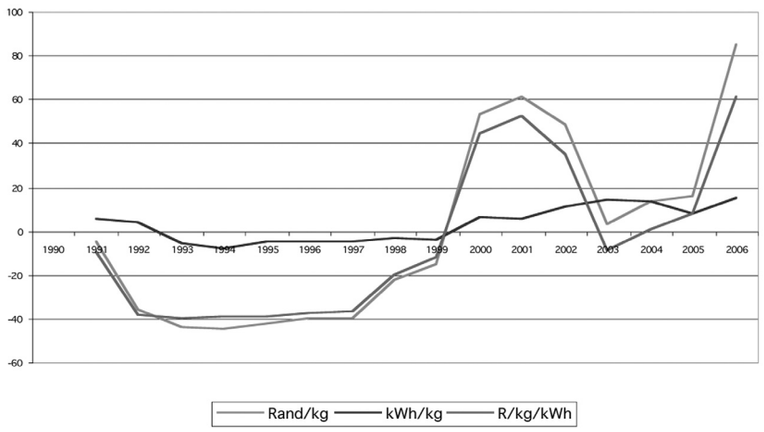

Figure 11. Percentage changes from 1990 base

Lancelot Charles Stilwell

Mining Consultant, Read, Swatman & Voigt (Pty) Limited

I have spent my entire working life in the mineral industry, having worked on various mines as a Surveyor, Shift Boss, Mine Overseer and Mine Manager. I have also worked as a Project Manager on large surface and underground projects. Attended Camborne School of Mines from 1969 to 1972, and obtained my Ph.D. from the University of the Witwatersrand in 1999. I joined Read Swatman & Voigt in 2001.