CHAPTER 4: RESULTS OF DSM INTERVENTION

4 Results of DSM intervention

4.1 Preamble

In the previous chapter the implementation of a Real-time Energy Management system was discussed and the reader was familiarised with problems that was encountered during the intervention.

The reader will now be made aware of both the DSM performance results, such as reduced load on the national power grid, as well as the financial results benefitting the client for shifting load out of the Eskom peak periods.

4.2 Performance results

The implementation of all the necessary equipment to automatically control the pumps on all the pump stations was completed in February 2012. The intervention now entered the Performance Assessment phase of the project. This had to be done by the M&V team to ensure the validity of the results. A period of three months stretching from the 1st of March 2012 until the 31st of May 2012 was used to determine the results.

Due to the nature of this project baseline scaling, explained in the following paragraph, had to be implemented by the M&V team. This had to be implemented because varying amounts of water are being pumped to the user on a daily basis.

When varying amounts of water are being pumped, varying amounts of electricity are being consumed. This means that the baseline will either be increased or decreased by a factor, depending on the amount of electricity used. This standard of calculating the savings is vital, as the production of the client may increase or decrease throughout the implementation period, resulting in more or less energy being used.

A case in point was the Rietfontein pump station. During the month of May 2012, the Matla Power station needed more water for the generation of electrical energy. This resulted in more pumping than routinely, transpiring at the pumping station, resulting in a higher electricity usage. Figure 43 illustrates how the baseline was scaled upwards by

a factor as a result. This factor is determined by dividing the actual daily power usage with the daily baseline power usage.

For example, if the baseline sum of electricity used in the day is 20 MWh and the amount of electricity used on a specific day is 22 MWh, a scaling factor of 1.1 would be calculated. This would mean that the baseline would scale upwards by a factor of 1.1 throughout the day.

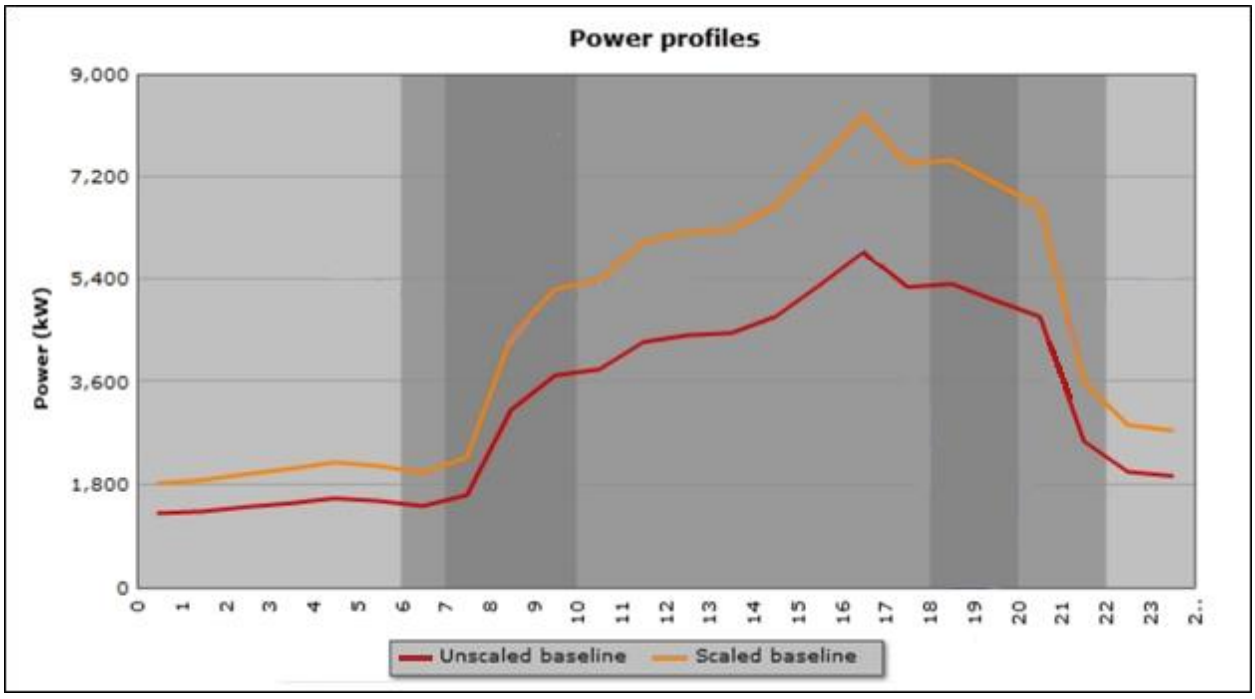

Figure 43: Rietfontein May 2012 power consumption

4.2.1 Grootdraai & Tutuka performance results

Figure 44 demonstrates the results obtained from the site by means of the REMS for the time period of the performance assessment. Appendix D provides the actual data obtained from the M&V team for all the pump stations.

It should also be mentioned that maintenance and upgrades on the Grootfontein canal took place during the assessment period. This resulted in the Grootdraai- and Grootfontein pumping stations not being able to supply water during certain periods of performance assessment. As a result, the average savings obtained from these pump stations over the performance assessment period are lower than the simulated results.

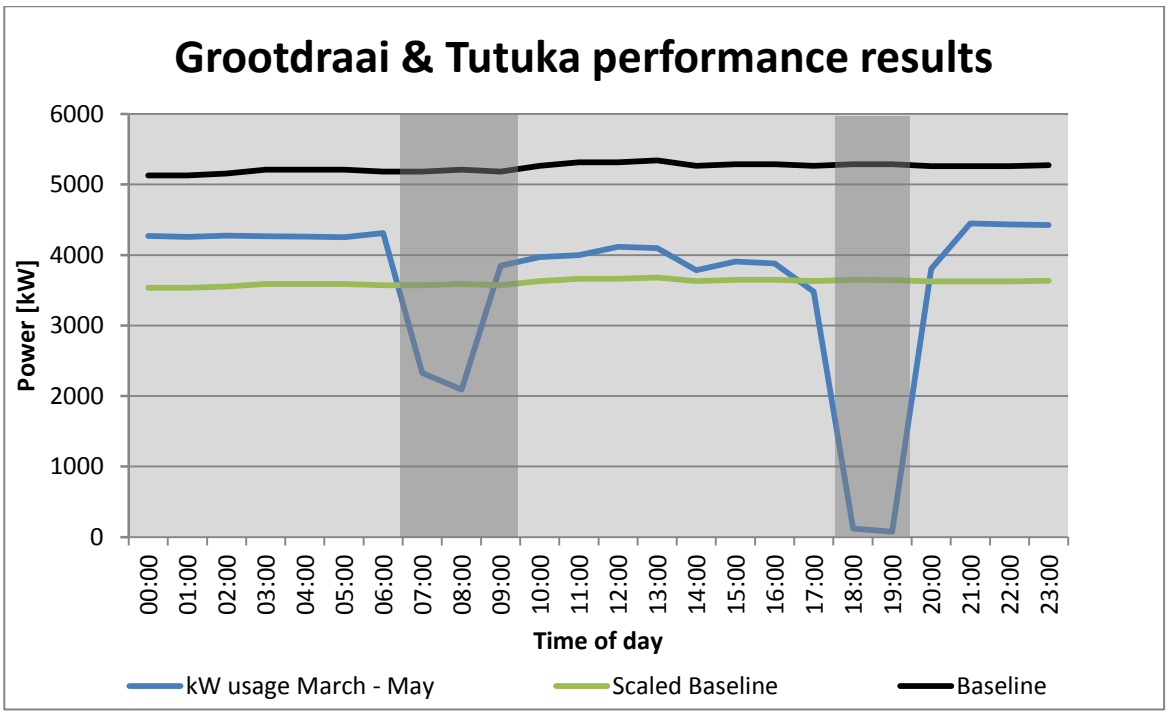

Figure 44: Grootdraai& Tutuka performance results

Figure 44 illustrates that a reduced amount of pumping occurred during the peak hours from 18H00 to 20H00 and that the load was shifted into the other times of day when the price of electricity was cheaper. A further load shift was distinguished in the morning peak period as a result of the Grootfontein pumping schedule, as described in section 3.4. By comparing the scaled baseline to the original baseline in Figure 44, it is clear that less pumping occurred on a daily basis than when the baseline was originally calculated. The baseline has thus scaled down, and an average evening load shift of 3.65 MW has been achieved for the hours between 18H00 and 20H00.

4.2.2 Grootfontein performance results

As with the performance results of Grootdraai &Tutuka, the power data was obtained for both the Grootfontein and Rietfontein pumping stations. Figure 45 illustrates that for the Grootfontein pump station, the power usage during the evening peak period was shifted into the cheaper times of day, resulting in an average daily saving of 3.09 MW. The reader will notice that the baseline has scaled down because of the maintenance work done on the canal during the assessment period.

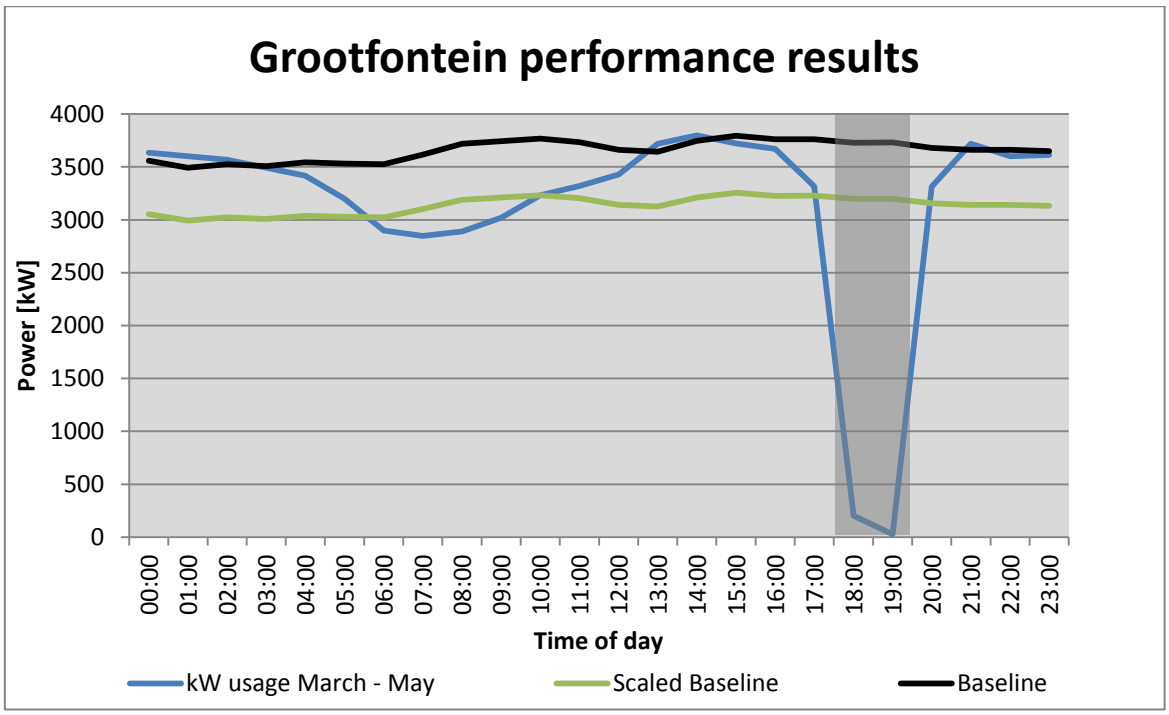

Figure 45: Grootfontein performance results

4.2.3 Rietfontein performance results

Results for the Rietfontein pump station are illustrated in Figure 46. In the case of Rietfontein, the baseline of the pump station has scaled upwards because of a higher demand for water by the Matla Power station during the assessment period. This meant that a higher load shift was possible on this pumping station, which resulted in an average load shift of 5.86 MW out of the evening peak period on a typical weekday.

The reader will also observe how the load was shifted out of the more expensive periods of the day and into the off-peak periods between 21H00 and 07H00.

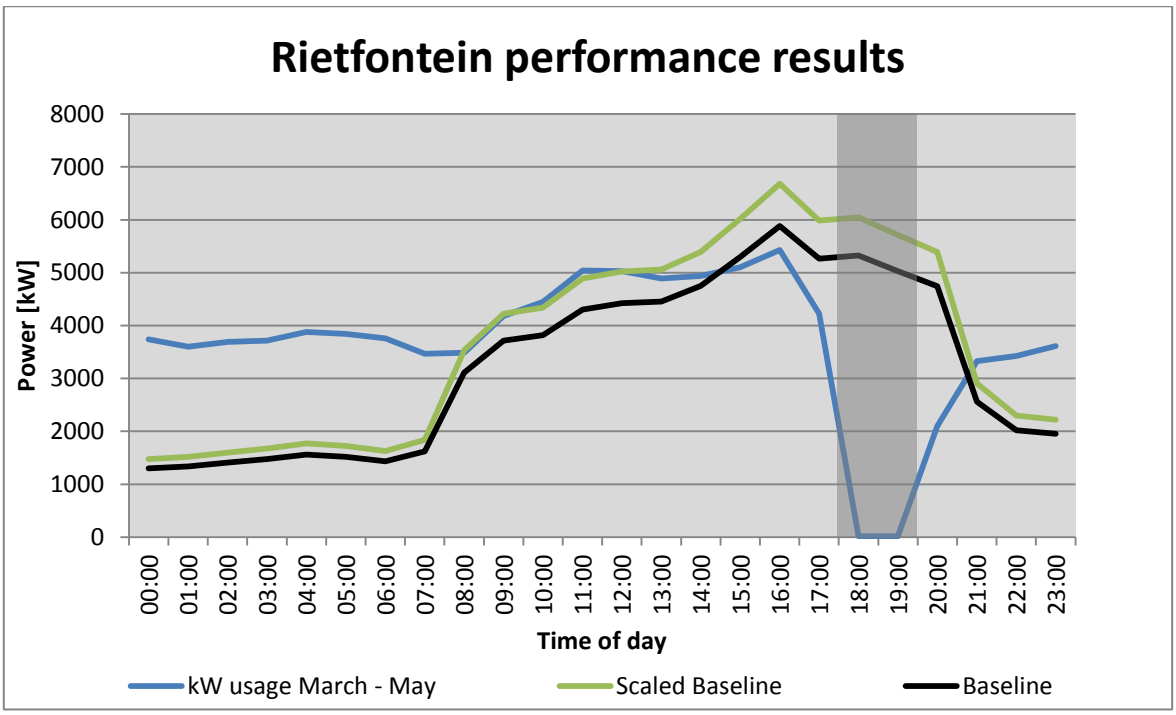

Figure 46: Rietfontein performance results

It is evident that this intervention has contributed to easing the load exerted on the national grid during the weekday evening peak times. An average total of **12.6 MW** for the hours between 18H00 and 20H00 was shifted into other times of the day where the load exerted on the national grid is much lower.

4.2.4 Actual results vs. simulated results

A comparison between the results obtained from the REMS simulation and the actual results achieved by the pumping stations during the performance assessment period can, are displayed in Table 9.

Table 9: Simulated vs. actual results

Pumping station	Average simulated result [MW]	Actual average result [MW]	Reason for over/under performance
Grootdraai & Tutuka	5.0	3.65	Maintenance work done on Grootfontein canal
Grootfontein	3.5	3.09	Maintenance work done on Grootfontein canal
Rietfontein	5.0	5.86	High water demand from Matla Power station

Total	**13.5**	**12.6**	

4.3 Financial results

An additional result to shifting an average of 12.6 MW load out of the evening peak periods, is the financial savings achieved by implementing the intervention.

The reader should take note that energy consumption remained the same over a 24 hour period. The financial saving is achieved by altering the time of peak electricity usage into the cheaper Eskom off-peak times, as provided in the 2012/2013 Eskom Tariff Brochure found in Appendix A.

For the Grootdraai &Tutuka pumping station a total financial saving of **R 181 000.00** has been achieved during the 3 month performance assessment period by scheduling the time of pumping out of the peak hours of the day. If these savings are to be maintained, the pumping station is expected to have an estimated annual saving of **R1 598 000.00**. Appendix E contains tables which demonstrates how this amount was calculated, taking into account the different TOU prices. The financial calculations for all the pumping stations are found in Appendix E

As for the Grootfontein and Rietfontein pump stations, the financial saving achieved during the 3 month performance assessment periods are **R129 000.00** and **R252 000.00** respectively. An annual saving of **R1 141 000.00** and **R2 026 000.00** are expected for these sites if the intervention is to be maintained.

This calculates to a combined financial saving of **R562 000.00** for the Usutu-Vaal system during the period of performance assessment. An annual saving of **R4 765 000.00** is expected as a result of the intervention, calculating to a payback period of less than two years.

4.4 Applications to other water schemes

Due to the positive results obtained from implementing this intervention, it would be advisable to investigate the opportunities of possible DSM projects on other water schemes throughout the country. Other interventions could be easily identified due the

vast amount of storage capacities and pump installed capacities found on other water transfer sites [49].

One such water scheme is the Usutu water scheme. The Usutu water scheme is different to the Usutu-Vaal water scheme used for this intervention. This water scheme includes the Jericho, Kliphoek and Candem pumping stations. Table 10 provides the user with information regarding the pumps operating at these pumping stations.

Table 10: Usutu pump installed capacities

	Pump no:	Installed capacity [kW]
Jericho	1,2,4 and 5 3 and 6	3 455 3 650
Kliphoek	1,2,3 and 4	2 400
Candem	1,2 and 3	2 813

The pumps located at the Kliphoek pump station are used as booster pumps for the Jericho pump station. Water is extracted from the Jericho dam and pumped towards the Onverwacht reservoirs via the Kliphoek pumping station. The water flow-rates measured in the columns for different amounts and combinations of pumps are illustrated in Table 11. The pumps located at Kliphoek pump station are named K1-K4. Note that only 4 pumps may be operational at the Jericho pump station at any given time and that it is possible for the Jericho pump station to bypass the Kliphoek pump station. This will entail that none of the booster pumps at Kliphoek pumping station is running, as seen in Table 11.

Table 11: Jericho and Kliphoek pump flow values [m^3/s]

Kliphoek pumps		Jericho no of pumps running			
		1	2	3	4
	None	0.9 m^3/s	1.72 m^3/s	2.02 m^3/s	2.2 m^3/s
	K1	-	1.66 m^3/s	2.8 m^3/s	3 m^3/s
	K1 & K3	-	-	-	3.3 m^3/s

Onverwacht reservoirs gravity feeds water to the Candem reservoir from where it is pumped to the Rietspruit reservoirs. This water is then fed to the Davel and Kriel reservoirs respectively. The water flow rates for different combinations of pumps

running on the Candem pump station are illustrated in Table 12. Table 13 contains the relevant dams and their respective capacities.

Table 12: Candem pump flow values [m^3/s]

Number of pumps	1	2	3	4
Flow [m^3/s]	0.89-0.98	1.77-1.95	2.155	2.5-2.52
Flow with Booster Pumps at Kliphoek [m^3/s]	1	2	2.55-2.8	3-3.33

Table 13: Usutu dam capacities and max/min allowable dam level

DAM	CAPACITY [m^3]	MINIMUM LEVEL %	MAXIMUM LEVEL %
Jericho dam	59 500 000	85	100
Onverwacht res1	103 500	85	100
Onverwacht res2	54 518	85	100
Onverwacht res3	45 518	85	100
Candem res1	133 000	85	100
Candem res2	98 000	85	100
Candem res3	112 100	85	100
Rietspruit res1	31 400	85	100
Rietspruit res2	31 400	85	100
Davel res1	21 600	85	100
Davel res2	21 600	85	100
Kriel	679 500	85	100

Due to the accuracy of the simulations obtained from the Usutu-Vaal pumping system, a similar initial simulation can be done on the Usutu system to determine an expected saving for the pumping stations. This is illustrated in Figure 45 where the reader will be able to ascertain that an average load shift of 8.75 MW out of the Eskom evening peak could be achieved. According to the Eskom 2012/2013 tariff structures as found in Appendix A, this translates to an average annual financial saving of R3.1 million.

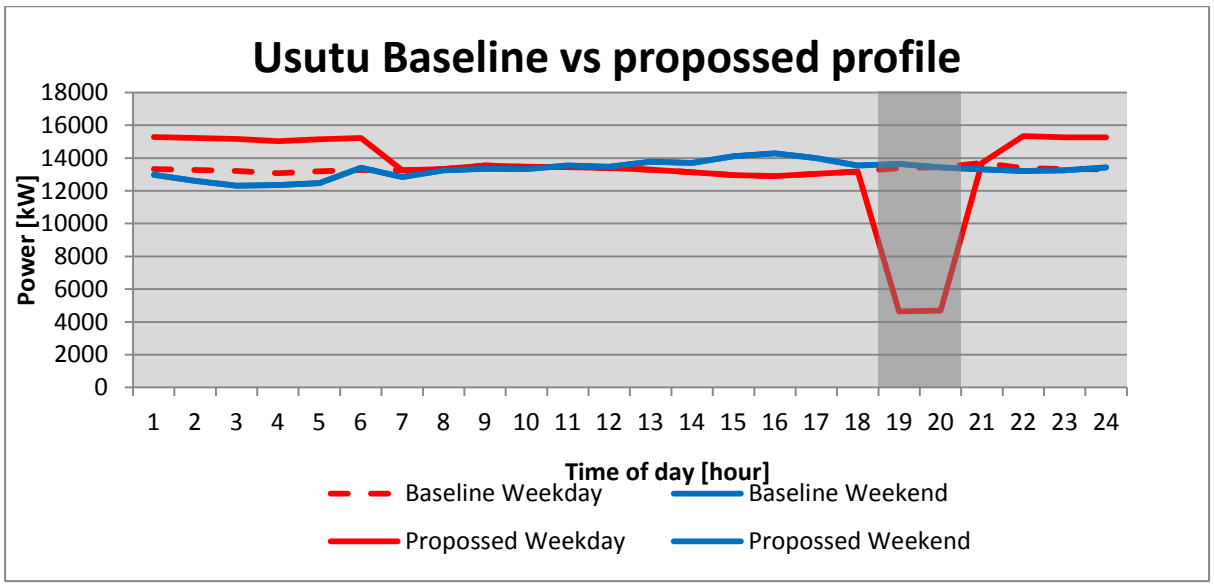

Figure 47: Usutu baseline vs. proposed profile

4.5 Conclusion

This chapter started off by presenting the performance- and financial results for both Eskom and the Department of Water Affairs during the time period of the M&V Performance assessment between 1 March 2012 and 31 May 2012.

A average load of 12.6 MW for the combined Usutu-Vaal pumping scheme was shifted out of the Eskom evening peak period into cheaper times of the day during performance assessment. This resulted in a saving of R562 000.00 and an expected annual saving of R4 765 000.00, if the intervention and REMS are properly maintained.

This was followed by the possibility of an intervention on the Usutu pump station situated at the Jericho dam, Mpumalanga.