

# Chapter 5 : Conclusions and recommendations

## 5.1 Summary of work done

There are increasing concerns regarding the proposed electricity tariff structures and electricity schemes. These costs pose a great risk to the financial well-being of large electricity consumers such as the gold mining industry. The aim of this study was to accurately predict the impact of these costs risks and identify strategies that could alleviate the cost implications.

The research approach and sequence of the study is illustrated in Figure 5.1. This figure shows the steps that were taken to develop the quantified risks and opportunities. The developed modelling methodology also incorporates ISO 50001 energy management principles. The ISO compliant risk management and mitigation system developed during this study incorporates the finding of the initial modelling approach. The relevant steps and tasks related to the cost-risks modelling and management will be discussed below in relation to the Plan, Do, Check, Act steps of ISO 50001.

### **Plan**

The first step indicates the *Plan* phase where the electricity cost risks were investigated and quantified. It was found that these potential electricity cost risks could result in a predicted price increase of up to 86%, if not well managed. The potential price increase model was derived to provide useful insight into the potential cost impact and mitigation of each risk. The rules regarding the potential risks were simplified in flow diagrams or graphs to provide insight and to illustrate the potential risks. The simplified equations and graphs can be used by mine personnel as a tool to help quantify and mitigate their electricity cost risk.

The rules related to the cost increases are circumstantial. To provide insight into the possible cost impact, five possible cost-increase scenarios were derived and presented. The cost scenarios are illustrated in Table 5.1 and Figure 5.1, as described in Chapter 2.

	Consequence	Probability	Cost risk with related price increases				Total price increase for next year
			Price increase	Carbon tax	Reactive power	ECS	
<b>Scenario 1</b>	Low	High	8%	2%	0%	0%	10%
<b>Scenario 2</b>	High	Very high	8%	4%	0%	0%	12%
<b>Scenario 3</b>	High	Moderate	8%	4%	3%	0%	15%
<b>Scenario 4</b>	Very high	Very low	15%	6%	6%	47%	74%
<b>Scenario 5</b>	Very high	Very low	15%	6%	6%	59%	86%

Table 5.1: Risk scenarios for the expected price increase.

From the discussed results, it is clear that electricity must be managed accordingly and efforts should be made to reduce electricity consumption to prevent abnormal (above inflation) electricity costs. To absorb the identified highest cost risk with combined increase of 12% (Scenario two) the mine must reduce their electricity by 6%, assuming an inflation rate of 6%. The 6% reduction will also protect the mining company against ECS penalties, assuming a reference consumption from 2010 or earlier.

## Do

During the *Do* phase, the potential cost impact was determined by reviewing production and electricity data of the identified gold mining company as discussed in Chapter 3. To accurately quantify the potential electricity reduction capability of a mining company can be very resource intensive. Added to this, the mines are located at different sites throughout South Africa, resulting in complex management requirements. Benchmarking was used to identify possible reduction areas and to identify mitigation strategies. The eight selected mines were uniquely categorised according to the characteristics which influence electricity intensity in mining. This was done to ensure correct identification for possible improvements.

To reduce the electricity consumption, proven electricity saving technologies on the three highest electricity consuming services were investigated. For each of the selected services, a simplified quantification and mitigation strategy was summarised in a flow sheet which could be used by the mine personnel.

For each reviewed service, the potential and implemented projects were listed to determine the possible future electricity reduction or mitigation capability of the mining company. It was found that for the selected mining company, the combined DSM reduction is 7%. The percentage decrease for each service is illustrated in Table 5.2. The potential cost reduction in relation to load management was quantified as 1%.

Mining service	% Potential electricity reduction in main services	% Electricity reduction in relation to total power consumed
Pumping:	12%	2%
Compressed air:	10%	2%
Refrigeration:	8%	2%

Table 5.2: Possible electricity reduction through identified DSM projects.

Three mitigation scenarios were reviewed to determine the potential impact of utilising DSM funding and implementing the potential DSM projects. If the mining company was to implement Mitigation Scenario two, over the five year period R675-million would be saved in electricity costs. If the IDM funding was utilised an additional R144-million would be saved and these savings would ideally be used to fund additional DSM projects.

## Check

The *Check* phase consists of reporting analysis on the electricity usage or improvement for the three highest electricity consuming mining services. The goal of the developed system is to ensure sustainability through reporting and to identify possible mitigation opportunities. This was obtained through monitoring existing electricity savings projects and other uncontrolled mining services. From the reported data, possible mitigation strategies were identified for the mining services. Reports for specific mine personnel containing information related to areas of work and responsibility were sent out. The reports and analysis techniques were presented and discussed in Chapter 4.

## Act

The *Act* phase illustrated the derived strategies and decisions which resulted from the previous three phases. Potential projects were communicated to the mining company. The implemented actions from the awareness created from reporting on the hoisting TOU profile resulted in improved control and electricity cost savings as illustrated in Chapter 4.

The monthly benchmarked production and electricity relationship for the main services were listed. The importance of production monitoring was highlighted, and the benchmarks also provided the possible optimal electricity usage profile which can be used as a baseline or target.

The optimal usage could also aid in the modelling of the non-profitable production point for the electricity tariff increases, providing the best-case scenario for electricity reduction and what the expected cost impact will be from the cost risks if electricity usage was optimal.

The cost reduction impact of a single DSM project cannot always be seen on the total monthly electricity bill of a mining company due to the small resultant 1% reduction and large deviation in the consumption profile of electricity usage. However, the combined effect of projects of less than 1 MW electricity usage was proven to have the potential to reduce the impact of the future electricity cost increases.

## 5.2 Contributions to the field

The high cost risk faced by the gold mining industry resulting from potential electricity tariff increases and schemes was the incentive for this study. For the South African gold mining industry, a simplified quantification model was derived for the expected price increases of the ECS, carbon tax and predicted tariff increases. Mitigation strategies for these cost risks were modelled and developed for a gold mining company.

This study has shown that annual production and electricity benchmarking can be used to identify potential DSM projects. Monthly benchmarking was used for this study, providing a higher resolution and insight into predicting performance improvement and managing electricity use.

The developed annual benchmarked items can be used by the selected mining company to manage and implement the identified DSM projects. The monthly benchmarked results were reviewed and an optimal production point was derived which provided insight into the optimal electricity usage or target in relation to production for the mining company. The annual and monthly benchmarked results can be used for further studies on other South African gold mines.

Available technologies influence key mining aspects where incorporated into and simplified as systematic approaches for mitigation strategies. Proposed mitigation strategies were derived for the main electricity consuming services to minimise the penalties associated with possible future imposed risks. The derived methodologies can be used by personnel on the mine to quantify and identify possible electricity cost-savings projects.

The reporting structure, developed risk mitigation and benchmarking analysis was incorporated into the development of the ISO 50001 energy management system. The developed reporting system created behavioural changes as the heightened awareness created actions, resulting in electricity savings.

## 5.3 Limitations of modelling

For this study eight mines were selected, from the top ten electricity consuming mines of the selected mining company. These mines were also selected due to having available data for electricity consumption, flow and pressure of the main services. For future studies, the potential impact of electricity reduction on the other smaller electricity consuming mines could be calculated and quantified.

Only the three largest electricity consuming services were reviewed to provide an indication of possible mitigation. Other services and available strategies or technologies could be investigated to provide additional insight to potential reduction in electricity usage.

The potential electricity tariffs and schemes have not yet been approved, but there still remains the risk that they will be implemented. Should there be changes in the future electricity tariffs or schemes, the derived cost risk model can simply be updated in order to still provide detailed insight as a basis to quantify potential risks..

## 5.4 Recommendations for further work

It would be advantageous for the mining company to incorporate daily electricity and production benchmarked data to manage electricity according to production on a daily basis. The quantified potential mitigation was specifically derived for the investigated mining company. To review the possible mitigation for a platinum or other mineral mining company, the same approach could be taken with the data from those mines.

The benchmarking strategy provided targets on obtaining optimal electricity consumption for the related production. Future research should be performed to investigate possible production improvement strategies without compromising electricity efficiency.

Some studies have presented the break-even mining point, which is determined by the gold price and operational cost relationship. This could be incorporated into the risk management strategy to help with future mining development and planning.

The weekly reporting system only started from June 2013. Continual improvement is being implemented on the reporting and management system, with a maintenance agreement also included. The true impact of this study can only be measured at a later stage but results to date have been positive. Future measurement and reviewing of the results obtained should provide useful insight in the benefits of an ISO 50001 risk management and reporting system developed for a South African gold mining company.

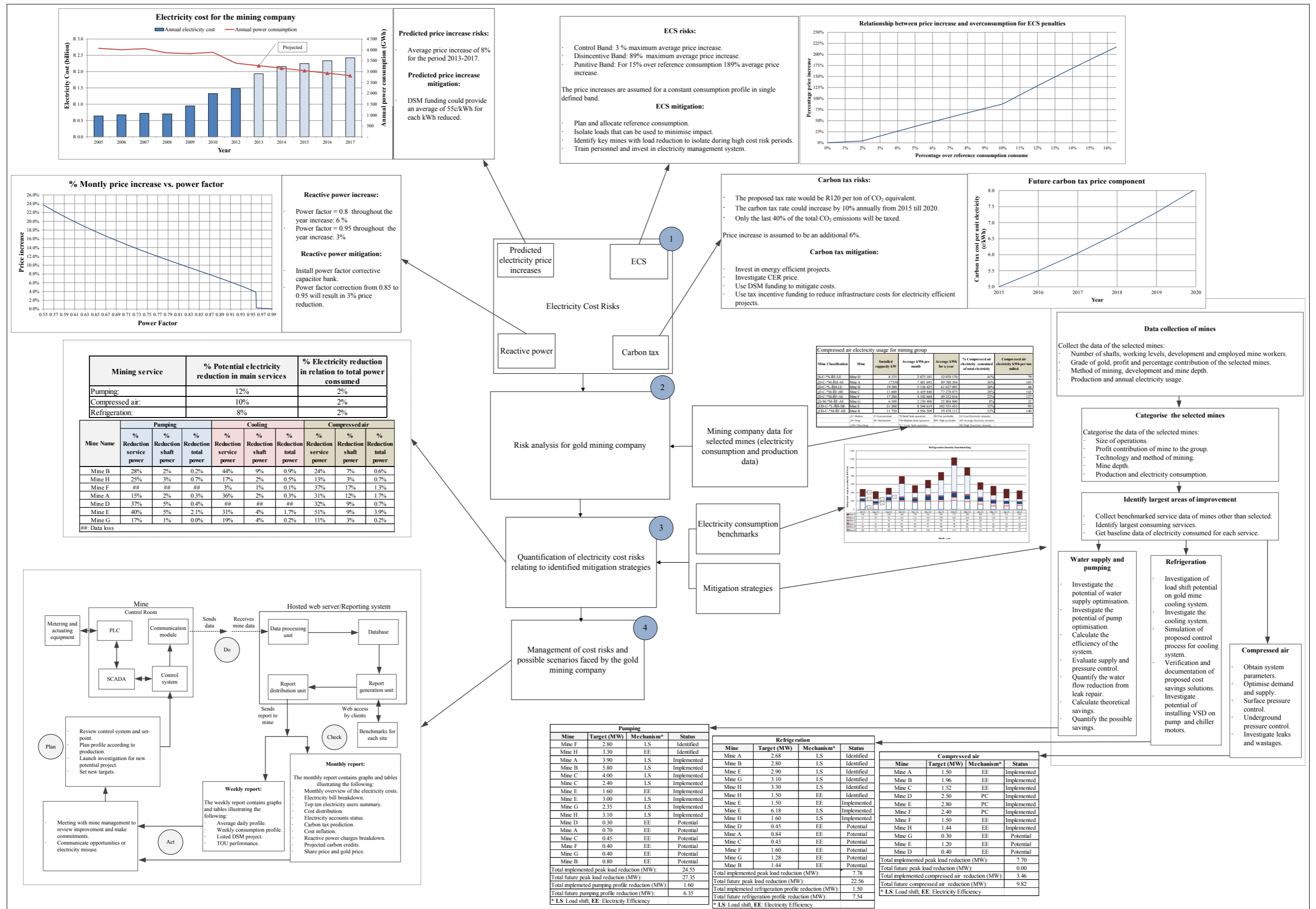


Figure 5.1: Cost risk model with derived simplification steps.