



**GENERATION RESERVE OPTIMISATION MODEL INCORPORATING  
DEMAND MARKET PARTICIPATION**

By

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## SUMMARY

**Title:** Generation reserve optimisation model incorporating Demand Market Participation

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The basic function of a power system is to supply customers, both large and small, with electrical energy as economically as possible and with an accepted degree of reliability and quality. The objective of this study is to determine the optimal operating reserve to be scheduled by the national control room for the South African supply industry on a day-ahead basis. The different methods used to determine the optimal reserve was studied. Comparisons were made and the best method was identified. The South African reserve market was studied and a model was constructed using the reliability cost-worth method to determine the optimal operating reserve. The reserve market included thermal generation, pumped storage, demand market participation (DMP) and interruptible load (IL). The DMP and IL customers were modelled as dummy generators and the cost to supply reserve by the utility is compared to the cost of unserved energy to the economy. The total minimal cost to the economy and utility is used as the optimal reserve level. The contribution to this field of study is to:

- Determine the optimal operating reserve level for the South African supply industry;
- Model DMP and IL customers as dummy generators; and
- Include DMP and IL in the reserve optimisation using the reliability cost-worth method.

**Keywords:** Reserve optimisation, Reliability cost-worth method, Demand Market Participation. Interruptible Load and Dummy generator.

## OPSOMMING

**Titel:** Generation reserve optimisation model incorporating Demand Market Participation

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Die basiese funksie van 'n kragstelsel is om elektriese energie aan die verbruikers te verskaf so goedkoop as moontlik en met 'n aanvaarbare betroubaarheidvlak en kwaliteit. Die doel van die studie is om die optimale reserwe vir die Suid Afrikaanse elektrisiteits bedryf te bepaal. Verskillende metodes was bestudeer en die beste metode vir die Suid Afrikaanse reserwe mark gekies. Die betroubare koste-waarde metode is gebruik om 'n model te bou vir die Suid Afrikaanse reserwe mark. Die reserwe mark bevat termiese generasie, gestoorde-hidro generasie, aanvraag mark deelname en afgooibare las. Die twee laas genoemde verbruikers word gemodelleer as fiktiewe generators en in die betroubare koste-waarde metode gebruik om die optimale reserwe te bepaal. Die koste om ekstra reserwe beskikbaar te stel word afgespeel teen die koste om die reserwe nie beskikbaar te he nie. Die totale koste word gebruik om die optimale reserwe te bepaal. Die bydra tot die studieveld is:

- Om die optimale reserwe te bepaal vir die Suid Afrikaanse elektrisiteits bedryfs;
- Die aanvraag mark deelname en afgooibare las kliente te modelleer as fiktiewe generators; en
- Hulle in die model in te sluit wanneer die optimale reserwe bepaal word met behulp van die betroubare koste-waarde metode.

**Kernwoorde:** Optimale reserwe, betroubare koste-waarde metode, die aanvraag mark deelname, afgooibare las en fiktiewe generators.

## TABLE OF CONTENTS

<b>GENERATION RESERVE OPTIMISATION MODEL INCORPORATING DEMAND MARKET PARTICIPATION .....</b>	<b>1</b>
<b>SUMMARY .....</b>	<b>2</b>
<b>OPSOMMING.....</b>	<b>3</b>
<b>LIST OF ABBREVIATIONS .....</b>	<b>7</b>
<b>CHAPTER 1 .....</b>	<b>9</b>
<b>INTRODUCTION.....</b>	<b>9</b>
1.1 BACK GROUND AND INTRODUCTION.....	9
1.2 ADEQUACY EVALUATION .....	12
1.3 RESEARCH QUESTIONS AND OBJECTIVES .....	14
1.4 ORIGINAL CONTRIBUTION .....	15
1.5 OUTLINE OF THE THESIS .....	15
<b>CHAPTER 2 .....</b>	<b>17</b>
<b>METHODS FOR DETERMINING THE OPTIMAL GENERATOR RESERVE .....</b>	<b>17</b>
2.1 RESERVE LEVELS USED BY DIFFERENT UTILITIES.....	17
2.1.1 Eskom.....	17
2.1.2 SAPP .....	18
2.1.3 New York Power Pool (NYPP) .....	18
2.1.4 California Independent System Operator (CAISO) .....	18
2.1.5 PJM Pool .....	19
2.1.6 MAIN.....	19
2.1.7 Ontario Hydro (Canada) .....	19
2.1.8 England and Wales (National Grid Co.) .....	19
2.1.9 NORDEL (Scandinavian Pool).....	20
2.1.10 Australia and New Zealand.....	20
2.2 OVERVIEW OF THE CURRENT LITERATURE.....	20
2.3 COMPARING THE RELIABILITY COST/RELIABILITY WORTH METHOD .....	22
2.4 UNIT COMMITMENT (UC) .....	22
2.5 CONCLUDING REMARKS .....	23
<b>CHAPTER 3 .....</b>	<b>25</b>
<b>THE GENERATOR RESERVE OPTIMISATION MODEL.....</b>	<b>25</b>
3.1 THE GENERATING CAPACITY MODEL .....	28
3.2 LOSS OF LOAD INDICES .....	30
3.2.1 Loss of Load Expected (LOLE).....	30
3.2.2 Loss of Expected Energy (LOEE) .....	31
3.3 RELIABILITY COST AND RELIABILITY WORTH .....	32
3.4 MODEL I.....	35
3.4.1 Theoretical testing of the model.....	38



3.4.2	<i>The 11 unit generating system</i> .....	41
3.5	THE SOUTH AFRICAN RESERVE MARKET .....	46
3.5.1	<i>DMP</i> .....	47
3.6	MODEL II .....	47
3.6.1	<i>The test system</i> .....	49
3.7	CONCLUDING REMARKS .....	53
<b>CHAPTER 4</b>	.....	<b>55</b>
<b>MODEL VALIDATION AND COMPARISON</b>	.....	<b>55</b>
4.1	THE TEST SYSTEM.....	55
4.2	VALIDATION METHOD .....	56
4.3	COMPARING THE MODEL WITH [7].....	56
4.4	COMPARING THE GROM WITH [3] .....	63
4.5	CONCLUDING REMARKS .....	69
<b>CHAPTER 5</b>	.....	<b>70</b>
<b>PERFORMANCE ASSESMENT OF THE GENERATOR RESERVE OPTIMISATION MODEL</b>	.....	<b>70</b>
5.1	ANALYSIS OF OPTIMISATION TECHNIQUES ON THE MODEL .....	70
5.1.1	<i>The base case</i> .....	74
5.1.2	<i>Case 1. Use matrix-indexing techniques</i> .....	76
5.1.3	<i>Case 2. Incorporate reserve provided by the last unit when the reserve unit is scheduled</i> .....	79
5.1.4	<i>Case 3. Increase the reserve capacity step</i> .....	81
5.1.5	<i>Case 4. Reducing the size of COPT</i> .....	83
5.2	SENSITIVITY ANALYSIS .....	87
5.2.1	<i>Sensitivity to a change in IEAR</i> .....	89
5.2.2	<i>Sensitivity to change in the capacity step size</i> .....	90
5.2.3	<i>Sensitivity to a change in FOR</i> .....	92
5.3	COMPARING THE MODEL WITH THE OLD ESKOM MODEL.....	94
5.3.1	<i>Case 1: Off-peak scenario</i> .....	95
5.3.2	<i>Case 2: Normal load scenario</i> .....	99
5.3.3	<i>Case 3: Peak load scenario</i> .....	101
5.4	CONCLUDING REMARKS .....	103
<b>CHAPTER 6</b>	.....	<b>105</b>
<b>THE GRAPHICAL USER INTERFACE (GUI) FOR THE RESERVE OPTIMISATION MODEL</b>	.....	<b>105</b>
6.1	THE MODEL LAYOUT, ENTERING VARIABLES AND THE EXECUTION OF THE MODEL.....	105
6.2	CONCLUDING REMARKS .....	110
<b>CHAPTER 7</b>	.....	<b>111</b>
<b>SUMMARY AND CONCLUSIONS</b>	.....	<b>111</b>
7.1	WORK PRESENTED.....	111
7.2	ORIGINAL CONTRIBUTION .....	113
7.3	FUTURE RESEARCH.....	113
<b>CHAPTER 8</b>	.....	<b>115</b>

<b>REFERENCES.....</b>	<b>115</b>
<b>ADDENDUM A1.....</b>	<b>119</b>
<b>ADDENDUM A2: THE OLD ESKOM MODEL .....</b>	<b>123</b>
A2.1 INTRODUCTION.....	123
A2.2 THE MODEL ASSUMPTIONS .....	124
A2.3 THE MODEL .....	130
A2.4 THE MODEL INPUT DATA .....	133
A2.5 THE MODEL VARIABLES.....	138
A2.6 THE LOAD VARIABLES .....	138
A2.7 THE SCHEDULED UNIT VARIABLES.....	138
A2.7.1 <i>The capacity-in table variables .....</i>	<i>139</i>
A2.7.2 <i>Scheduled unit capacity-in table variables .....</i>	<i>140</i>
A2.8 SCHEDULED UNIT RELIABILITY VARIABLES .....	140
A2.8.1 <i>Scheduled unit cost result variables.....</i>	<i>141</i>
A2.8.2 <i>Synchronised reserve variables.....</i>	<i>141</i>
A2.8.3 <i>Synchronized reserve reliability variables.....</i>	<i>142</i>
A2.8.4 <i>Synchronized reserve cost result variables.....</i>	<i>142</i>
A2.8.5 <i>Reserve resource variables .....</i>	<i>143</i>
A2.8.6 <i>Reserve resource reliability variables.....</i>	<i>143</i>
A2.8.7 <i>Reserve resource cost result variables.....</i>	<i>144</i>
A2.8.8 <i>Marginal reliability and marginal cost variables.....</i>	<i>144</i>
A2.8.9 <i>System result variables.....</i>	<i>145</i>
A2.9 SCHEDULING THE UNITS AND OPTIMISING THE RESERVE.....	145
A2.10 SENSITIVITY ANALYSIS.....	147
A2.10.1 <i>Effect of changing the capacity of Emergency Resources.....</i>	<i>147</i>
A2.10.2 <i>The effect of load forecast error.....</i>	<i>148</i>
A2.10.2 <i>Effect The effect of hourly load shape for daily variations .....</i>	<i>148</i>
A2.10.3 <i>The effect of reserve cost .....</i>	<i>149</i>
A2.11 COST SAVINGS INCURRED.....	149
A2.12 IMPROVEMENTS TO BE MADE.....	150
<b>ADDENDUM A3.....</b>	<b>151</b>
A3.1 HOW TO USE THE MODEL.....	151
<b>LIST OF TABLES .....</b>	<b>154</b>
<b>LIST OF FIGURES .....</b>	<b>156</b>

## LIST OF ABBREVIATIONS

ACE	–	Area Control Error
AGC	–	Automatic Governor Control
CAISO	–	California ISO
COPT	–	Capacity outage probability table
DCS1	–	Disturbance Control Standard
DMP	–	Demand market participation
DPLVC	–	Daily peak load variation curve
DSM	–	Demand side management
EENS	–	Expected energy not supplied
EIR	–	Energy index of reliability
F.C.	–	Fixed cost
F&D	–	Frequency and Duration
FOR	–	Forced outage rate
GROM	–	Generation Reserve Optimisation Model
GUI	–	Graphical User Interface
GUIDE	–	Graphical User Interface Development Environment
HLI	–	Hierarchical level I
HLII	–	Hierarchical level II
HVDC	–	High Voltage Direct Current
IEAR	–	Interruptible energy assessment rate
IL	–	Interruptible load
JIT	–	Just in time
LDC	–	Load duration curve
LOLE	–	Loss of Load Expected
LOEE	–	Loss of Expected Energy
LOLH	–	Loss of load hours
LOLP	–	Loss of Load Probability
MCR	–	Maximum capacity rating
MW	–	Mega Watt
MWh	–	Mega Watt hour
NERC	–	North American Electric Reliability Council



NYPP	–	New York Power Pool
ORR	–	Outage Replacement Rate
RTP	–	Real time pricing
SAPP	–	Southern African Power Pool
SMP	–	System Marginal Price
TOU	–	Time of use
UE	–	Unserved energy
V.C	–	Variable cost