Sudan University of science and technology

College of graduate studies

Investigation and optimization of voltage deterioration in Khartoum ring

التحقق من تدهور الفولتية فى الخط الدائرى حول مظلة الخرطوم والحلول المثلى

A Thesis Submitted in partial Fulfillment of the Requirements for the Degree of M.Sc. in Electrical Engineering (power and machines)

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October 2010

قال الله تعالى

﴿١٦٣﴾ إِنَّ فِى خَلْقِ ٱلسَّمَٰوَٰتِ
وَٱلْأَرْضِ وَٱخْتِلَٰفِ ٱلَّيْلِ وَٱلنَّهَارِ وَٱلْفُلْكِ ٱلَّتِى تَجْرِى فِى
ٱلْبَحْرِ بِمَا يَنفَعُ ٱلنَّاسَ وَمَآ أَنزَلَ ٱللَّهُ مِنَ ٱلسَّمَآءِ مِن مَّآءٍ فَأَحْيَا
بِهِ ٱلْأَرْضَ بَعْدَ مَوْتِهَا وَبَثَّ فِيهَا مِن كُلِّ دَآبَّةٍ وَتَصْرِيفِ ٱلرِّيَٰحِ
وَٱلسَّحَابِ ٱلْمُسَخَّرِ بَيْنَ ٱلسَّمَآءِ وَٱلْأَرْضِ لَءَايَٰتٍ لِّقَوْمٍ
يَعْقِلُونَ ﴿١٦٤﴾

صدق الله العظيم
سورة البقرة

DEDICATION

To my father

For his supplication of succession

To my sister

She is always engaging her heart with me;

To my wife

She is always my propellant for successful.

And To all my colleagues

ACKNOWLEDGMENT

In the name of Allah, Most Gracious, and Most Merciful

Praise is to Almighty Allah (Subhanahu Wa Ta'ala) who gave me the courage and patience to carry out this work. Peace and blessing of Allah be upon his last prophet Mohammed (Sallulaho-Alaihe Wassalam) and all his companions (Sahaba), (Razi-Allaho-Anhum) who devoted their lives towards the prosperity and spread of Islam.

My deep appreciation and heart full gratitude goes to my supervisor. AUST KHAMEES ARBEESH for his kindness, constant endeavor, guidance and the numerous moments of attention he devoted throughout this work.

I sincerely appreciate the efforts that have been put by all the people above which truly cannot be describe by words. I would like to thank all the staff of Electrical Engineering Department of Sudan University of science and technology for their help. As well as people who are work in projects and planning department and load dispatch center, I would sincerely appreciate their comments, criticisms, corrections and suggestions for improving the project.

Finally, my sincere thankfulness goes to my family for their prayers and encouragement that always helped me to take the right step in life.

Abstract

The objective of this thesis is to investigate and study problems and voltage congestion facing the engineers involved into the operation of a network of the National Authority for electricity in Khartoum region. The thesis looked into the effects that advanced control techniques have on electric compensation of power generation and transmission system.

The thesis explained first the power system components of National Electricity Corporation such as the generation quantity and types, substation, transmission line and voltage control procedures which are used. It then proceeded to give a brief introduction to the location of Khartoum ring and purpose of its establishment.

A load flow studies is made for the network of the National electricity corporation by using actual value of networks (busbars voltage, loads at peak load, line parameter, capacitors and reactors rates and types, rates of generation and its MVAr limitations).

A load flow program (HADI SADAT load flow program) is applied for improving of voltage deterioration in Khartoum ring in two cases, first one is operating the costly units in minimum load and the second case is totally shutdown of costly units. Some results are obtained appear that problem which is expected, and some solutions are discussed for this problem.

The thesis studied the dependence on Marawi dam for generating electricity and possibility of shutting down the costly unit (thermal power station in KHN and GARI complex), the contribution of costly unit in reactive power compensation in Khartoum region and possibility of constructing compensation units for reactive power management.

الملخـــــص

الهدف الاساسي من هذا المشروع هو بحث دراسة المشاكل و إختناقات الفولتية التى تواجة المهندسين الذين يعملون فى تشغيل شبكة الهيئة القومية للكهرباء حول منطقة الخرطوم. وكذلك البحث يهدف الى دراسة مقدمة فى تحكم نظام التعويض للقدرة الكهربائية فى نظام إرسال وتوليدالطاقة.

فى هذا البحث تم شرح مكونات نظام القدرة للهيئة القومية للكهرباء بدءا بكمية الطاقة المولدة وأنواع محطات التوليد المستخدمة ثم المحطات التحويلية و الخطوط الناقلة للطاقة و النظم المستخدمة فى التحكم فى الجهدالمرسل. بعد ذلك تناول البحث الخط الدائرى الناقل للكهرباء حول منطقة الخرطوم من حيث الموقع والدواعى و الأسباب التى أدت إلى إنشاءة. كذلك تم عمل دراسة لإنسياب الحمولة فى شبكة الهيئة القومية للكهرباء و ذلك بأخذ القيم الحقيقية لبرامترات شبكة الهيئة القومية للكهرباء(جهود الباسبارات وأنواعها, أحمال الشبكة فى حالة الحمولة القصوى, بارامترات الخطوط, سعات المكثفات و المحاثات وسعات التوليد و أنواعه وكذلك محددات مساهمة كل محطة توليد من القدرة الرد فعلية).

لإثبات مشكلة تدهور الفولتية فى شبكة حلقة الخرطوم بواسطة برنامج إنسياب الحمولة أخذت حالتين, الأولى عندما يتم تشغيل الوحدات ذات التكلفة التشغيلية العالية (المحطات الحرارية) بأقل أحمال ممكنة و الثانية عند إيقاف تلكم المحطات نهائيا (اى الأعتماد الكلى الطاقة الكهربائية المنتجة من الطاقة المائية) وقدمت نتائج لهذه الحالات تظهر بوضوح ما ذهبنا إليه و توقعناه انفا. وتم تقديم بعض الحلول لهذه المشكلة. البحث ايضا تناول إحتمالية الأعتماد الكلى توليد الطاقة الكهربائية من خزان سد مروى وإمكانية تقليص او إيقاف الوحدات الحرارية ذات التكلفة التشغيلية العالية ودراسة أثرها في القدرة الرد فعلية فى مركز الأحمال (منطقة الخرطوم)

List of Abbreviations

Bus No	Abbreviation	Meaning of abbreviation
1	RUS	Ruseires power station
2	MUG	Al mujahdeen substation
3	OMD	Omdurman substation
4	MHD	Al mahidia substation
5	IZG	Al zirgab substation
6	IBAB	Id Babikir Substation
7	KHN	Khartoum North power station
8	KUKU	Kuku Substaion
9	KLX	Kilo X substation
10	LOM	Local Market substation
11	SHG	Al Shajara Substation
12	SENJ220	Sennar junction substation 220 side
13	MAR220	Marinjan substation side 220
14	GIAD220	Giad substation side 220
15	JAS220	Jable Aowlia substation side 220
16	MRK220	Markhiat substation side 220
17	MHD220	Al Mahadia substation side 220
18	KLX	Kilo X substation side 220
19	KBA220	Al Kabashi substation side 220
20	IBAB	Id Babikir Substation side 220
21	GAR	Gari complex power station
22	FRZ	Free Zone substation side 220

23	MAR110	Marinjan substation side 110
24	HAS	Al Hasahisa substation
25	GAD110	Giad substation 110 side
26	BAG	Al Bagear substation
27	HAG	Hag Abdalla substation
28	SENJ110	Sinnar Junction 110 side
29	SENP	Sinnar hydro power station
30	JAS110	Jable Aowlia substation 110 side
31	JAP	Jable Aowlia hydro power station
32	MHDTRA1	Mahidia transformer 1
33	IBABTRA1	Id babikir substation transformer 1
34	KLXTRA1	Kilo X substation transformer 1
35	IBABTRA2	Id babikir substation transformer 2
36	MARTRA1	Marijan substation transformer 1
37	SENJTRA1	Sinnar junction substation transformer 1
38	JABTRA1	Jabl aowlia substation transformer 1
39	MWP500	Marawi hydro power station
40	MRK500	Markhiat substation side 500Kv
41	MWSS220	Marawi substation side 220
42	KBA500	Kabashi substation transformer side 500Kv
43	KLXTRA2	Kilo X substation transformer 2
44	KLXTRA3	Kilo X substation transformer 3
45	MARTRA2	Marijan substation transformer 2
46	SENJTRA2	Sinnar Junction transformer 2
47	JASTRA2	Jabl Aowlia substation transformer 2

48	KBATRA1	Kabashi substation transformer 1
49	MRKTRA1	Makhiat substation transformer 1
50	MHDTRA2	Mahidia substation transformer 2
51	KBATRA2	Kabashi substation transformer 2
52	MRKTRA2	Markhiat substation transformer 2
53	JIADTRA1	Jiad substation transformer1

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