Analysis on Losses Reduction with Series Capacitor Compensation Application in Distribution Network

by

Muhammad Azizi bin Mohd Wahidi

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Universiti Teknologi PETRONAS Bandar Seri Iskandar 31750 Tronoh Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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A project dissertation submitted to the Electrical and Electronics Engineering Programme Universiti Teknologi PETRONAS in partial fulfillment of the requirement for the BACHELOR OF ENGINEERING (Hons) (ELECTRICAL AND ELECTRONICS ENGINEERING)

Approved by,

(IR. MOHD FARIS BIN ABDULLAH) PROJECT SUPERVISOR

UNIVERSITI TEKNOLOGI PETRONAS TRONOH, PERAK December 2010

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MUHAMMAD AZIZI BIN MOHD WAHIDI

ABSTRACT

The capacitor compensations have been widely used all over the world in order to improve the quality of power transmission. There are lot of capacitor compensations been applied in order to achieve that objective. Two common type of capacitor compensations widely used are series capacitor and shunt capacitor. The different between those compensations is the installation configuration of capacitor in the network. The difference in configuration might produce different effect on the network. Usually shunt capacitor compensation used to improve the voltage level at the receiving area while the series capacitor compensation used to reduce power losses and increase loadability. In this study, series capacitor compensation has been focused in order to find out what is the effect if this type of compensation been installed in distribution network. The element that would be interested for this study will be the losses reduction in the particular network. Theoretically, the existence of capacitor will result the power losses reduction in the network. By comparing a network without capacitor compensation and a network with series capacitor compensation, all the result will be recorded and discussed. Next, in order to prove the theory, a program will be used to analyze the power losses. In conclusion, the effect of the existence of capacitor compensation can be determined.

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TABLE OF CONTENTS

CERTIFICATION OF APPROVALii
CERTIFICATION OF ORIGINALITYiii
ABSTRACT
ACKNOWLEDGEMENTv
LIST OF FIGURESxii
LIST OF TABLES xv
CHAPTER 1: INTRODUCTION
1.1 Background of study1
1.2 Problem statement1
1.3 Objective and scope of study2
1.3.1 Objective
1.3.2 Scope of study
CHAPTER 2: LITERATURE REVIEW
2.1 Considerations for the Application of Series Capacitors to Radial
Power Distribution Circuits [1]3
2.2 Application and Evaluation of a new concept for compact series
compensation for distribution networks [2]5
2.3 Distribution Series Capacitor Application for Improved Motor
Start and Flicker Mitigation [3]7

2.4 Series Compensation for a Hydro-Quebec Long Distribution Line	
[4]	8
2.5 Reactive Compensation Techniques for Increasing Loadability	
of Long Primary Distribution Lines [6]	9
2.6 Ferroresonance in a 13.8 kV Distribution Line [7]	10
CHAPTER 3: METHODOLOGY	11
3.1 Procedure Identification	
3.2 Project Description	
3.3 MATLAB Software	14
CHAPTER 4: RESULTS AND DISCUSSION	15
4.1 Basic parameters related	15
4.2 Losses Analysis	18
4.2.1 Case 1: Different in series capacitor compensation location	18
4.2.2 Case 2: Different in capacitor compensation value	20
4.2.3 Case 3: Different in loading	22
4.2.4 Case 4: Different in load power factor	26
4.2.5 Case 5: Overcompensation	29
4.2.6 Case 6: Network with 33 kV level	31
4.2.7 Case 7: Network with 185 mm ² size of cable	36
4.2.8 Case 8: Parallel configuration network	40
4.3 Voltage Analysis	45
4.3.1 Case 1: Different in series capacitor compensation location	45
4.3.2 Case 2: Different in capacitor compensation value	46
4.3.3 Case 3: Different in loading	47

4.3.4 Case 4: Different in load power factor	48
4.3.5 Case 5: Overcompensation	49
4.3.6 Case 6: Network with 33 kV level	50
4.3.7 Case 7: Network with 185 mm ² size of cable	51
4.3.8 Case 8: Parallel configuration network	52
4.4 Economic Analysis	53
4.5 Loadability Analysis	56
CHAPTER 5: CONCLUSION AND RECOMMENDATIONS	58
5.1 Conclusion	58
5.2 Recommendations	59
REFERENCES	
APPENDIX I : Source code for compensation location at 100 km	
and 100 % compensation value	63
APPENDIX II : Simulation for compensation location at 100 km and 100 % compensation value	64
APPENDIX III : Source code for compensation location at 50 km and 50 % compensation value	65
APPENDIX IV : Simulation for compensation location at 50 km and 50 % compensation value	66
APPENDIX V : Source code for compensation location at 100 km and 70 % compensation value	
APPENDIX VI : Simulation for compensation location at 100 km and 70 % compensation value	

APPENDIX VII : Source code for the 150 % loading and compensation
location and value are 100%
APPENDIX VIII : Simulation for the 150 % loading and compensation location and value are 100%
APPENDIX IX : Source code for the 150 % loading and compensation
location and value are 100% and 0 % respectively71
APPENDIX X : Simulation for the 150 % loading and compensation
location and value are 100% and 0 % respectively72
APPENDIX XI : Source code for the 0.8 lagging power factor load
and compensation location and value are 100%73
APPENDIX XII : Simulation for the 0.8 lagging power factor load
and compensation location and value are 100%74
APPENDIX XIII : Source code for the 0.8 lagging power factor load
and compensation location and value are
100% and 0 % respectively75
APPENDIX XIV : Simulation for the 0.8 lagging power factor load
and compensation location and value are
100% and 0 % respectively76
APPENDIX XV : Source code for the overcompensation condition
and compensation location and value are
100% and 300 % respectively77
APPENDIX XVI : Simulation for the overcompensation condition
and compensation location and value are
100% and 300 % respectively78
APPENDIX XVII : Source code for the network with 33 kV voltage level
and compensation location and value are
0% and 100 % respectively79
APPENDIX XVIII : Simulation for the network with 33 kV voltage level
and compensation location and value are
0% and 100 % respectively 80

APPENDIX XIX : Source code for the network with 33 kV voltage level
and compensation location and value are
100% and 80 % respectively
APPENDIX XX : Simulation for the network with 33 kV voltage level
and compensation location and value are
100% and 80 % respectively
APPENDIX XXI : Source code for the network with 33 kV voltage level and
500 % loading and compensation location and
value are 100%
APPENDIX XXII : Simulation for the network with 33 kV voltage level and
500 % loading and compensation location and value
are 100%
APPENDIX XXIII : Source code for the network with 33 kV voltage level
and 500 % loading and compensation location and
value are 100% and 0% respectively
1 2
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and value are 100% and 0 % respectively
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and value are 100% and 0 % respectively
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and value are 100% and 0 % respectively
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and
 APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and
APPENDIX XXIV : Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and

х

APPENDIX XXIX : Source code for the network with 185 mm ² cable size
and compensation location and value are 100%
and 400 % respectively
APPENDIX XXX : Simulation for the network with 185 mm ² cable size
and compensation location and value are 100% and
and 400 % respectively
APPENDIX XXXI : Source code for the network with parallel configuration
and 300 % loading and compensation location and
value are 100% and 100 % respectively
APPENDIX XXXII : Simulation for the network with parallel configuration
and 300 % loading and compensation location
and value are 100% and 100 % respectively
APPENDIX XXXIII : Source code for the network with parallel configuration
and 300 % loading and compensation location
and value are 100% and 0 % respectively
APPENDIX XXXIV : Simulation for the network with parallel configuration
and 300 % loading and compensation location
and value are 100% and 0 % respectively
APPENDIX XXXV : Source code for the network with parallel configuration
and compensation location and value are 100%
and 1000 % respectively97
APPENDIX XXXVI : Simulation for the network with parallel configuration
and compensation location and value are 100%
and 1000 % respectively
APPENDIX XXXVII : Gantt chart of the project
(Final Year Project 1)
APPENDIX XXXVIII : Gantt chart of the project
(Final Year Project 2) 100

LIST OF FIGURES

Figure 1 : Equivalent single-line diagram of a series compensated
network with several taps along the line4
Figure 2 : Ballefors substation distribution network
Figure 3: Distribution line segment without series capacitor and
related phasor diagram7
Figure 4: Distribution line segment with series capacitor and
related phasor diagram7
Figure 5: Voltage profile for a radial circuit with series capacitor
Figure 6: Line losses for different locations of the series capacitor9
Figure 7: Flow chart for FYP I11
Figure 8: Flow chart for FYP II
Figure 9: Circuit diagram for the series capacitor compensation at
0 % position value of 100 km long distribution line
Figure 10: Circuit diagram for the series capacitor compensation at
100 % position value of 100 km long distribution line
Figure 11: Circuit diagram for the series capacitor compensation at
others position along 100 km long distribution line
Figure 12: Circuit diagram for the series capacitor compensation at
100 % position value of 100 km long distribution line in
parallel network configuration16
Figure 13: Graph of power losses for the network with capacitor
compensation value of 100 % and 50 %

Figure 14:	Graph of power losses for the network with different	
	capacitor compensation and at location of 100 km	1
Figure 15:	Graph of real power losses to compare a network with	
	capacitor compensation and uncompensated network	
	under different loading	3
Figure 16:	Graph of reactive power losses to compare a network	
	with capacitor compensation and uncompensated network	
	under different loading24	1
Figure 17:	Graph of percentage difference to compare a network	
	with capacitor compensation and uncompensated network	
	under different loading	5
Figure 18:	Graph of real power losses to compare a network with	
	capacitor compensation and uncompensated network	
	under different power factor	7
Figure 19:	Graph of reactive power losses to compare a network	
	with capacitor compensation and uncompensated network	
	under different power factor	7
Figure 20:	Graph of percentage difference to compare a network	
	with capacitor compensation and uncompensated network	
	under different power factor	3
Figure 21:	Graph of power losses for the different value of	
	compensation)
Figure 22:	Graph of real power losses for a 33 kV network with and	
U	without compensation installed	1
Figure 23.	Graph of reactive power losses for a 33 kV network with	
119010 201	and without compensation installed	1
E: 04	-	•
Figure 24:	Graph of real power losses for a network with and with out commenced in installed with 185 mm^2 cable size	7
	without compensation installed with 185 mm ² cable size	/
Figure 25:	Graph of reactive power losses for a network with	
	and without compensation installed with 185 mm ² cable size	7

Figure 26:	Graph of power losses for the difference value of compensation in a network with 185 mm ² cable size
Figure 27:	Graph of real power losses for a network with and without compensation installed with parallel configuration
Figure 28:	Graph of reactive power losses for a network with and without compensation installed with parallel configuration 42
Figure 29:	Graph of power losses for the difference value of compensation in a network with 185 mm ² cable size
Figure 30:	Graph of voltage magnitude for the network with capacitor compensation value of 100 % and 50 %
Figure 31:	Graph of voltage magnitude for the network with capacitor compensation location at 100 %
Figure 32:	Graph of voltage magnitude to compare a network with capacitor compensation and uncompensated network
Figure 33:	Graph of voltage magnitude to compare a network with capacitor compensation and uncompensated network
Figure 34:	Graph of voltage magnitude at the load for the different value of compensation
Figure 35:	Graph of voltage magnitude at the load for a 33 kV network with and without compensation installed
Figure 36:	Graph of voltage magnitude at the load for a network with and without compensation installed with 185 mm ² cable size
Figure 37:	Graph of voltage magnitude at the load for a network with and without compensation installed with parallel configuration 52

LIST OF TABLES

Table 1: Power losses and voltage magnitude for different series
compensation location and 100 % compensation value18
Table 2: Power losses and voltage magnitude for different series
compensation location and 50 % compensation value19
Table 3: Power losses and voltage magnitude for the different in
compensation value and compensation location of 100 $\%$ 20
Table 4: Power losses and voltage magnitude for the different
loading when compensation location and value are 100 %
Table 5: Power losses and voltage magnitude for the different
loading where compensation value of 0 % (uncompensated) 23
Table 6: Power losses and voltage magnitude different between a
network without compensation and a network with series
capacitor compensation under different loading
Table 7: Power losses and voltage magnitude for different power
factor between a network without compensation and a network
with series capacitor compensation
Table 8: Power losses and voltage magnitude different between a
network without compensation and a network with series
capacitor compensation under different power factor
Table 9: Power losses and voltage magnitude for a network with series
capacitor compensation at 100 km position under
overcompensation condition
Table 10: Power losses and voltage magnitude for a 33 kV network with 21
series capacitor compensation value of 100 %

Table 11: Power losses and voltage magnitude for a 33 kV network with	
series capacitor compensation location at 100 km	2
Table 12: Power losses and voltage magnitude for a 33 kV network with	
series capacitor compensation location at 100 km and 100 %	
compensation value	3
Table 13: Power losses and voltage magnitude difference between a 33	
kV network with and without series capacitor compensation	
installed	5
Table 14: Power losses and voltage magnitude for networks with 185	
mm ² cable size and 100 km long	5
Table 15: Power losses and voltage magnitude difference between a	
network with and without series capacitor compensation	
installed with 185 mm ² cable size	3
Table 16: Power losses and voltage magnitude for a network with series	
capacitor compensation at 100 km position and 185 mm ²	
cable size)
Table 17: Power losses and voltage magnitude for networks with parallel	
configuration and 100 % compensation value41	l
Table 18: Power losses and voltage magnitude difference between a	
network with and without series capacitor compensation	
installed with parallel configuration43	3
Table 19: Power losses and voltage magnitude for a network with series	
capacitor compensation at 100 km position and with parallel	
configuration44	1
Table 20: Real power losses according to the compensation value in a	
network with 11 kV level, 1 MVA load, 100 km long and	
0.9 lagging power factor	3
Table 21: Real power losses, losses reduction and payback period	
according to the compensation value55	5

Table 22:	Real power losses, voltage regulation and total impedance	
	according to the compensation value	57
Table 23:	Value of line current according to compensation value	57

CHAPTER 1 INTRODUCTION

1.1 Background of study

The main focus of this report is to present the result of research done in two semesters on series capacitor compensation application in distribution line. Specifically, the main interest in this study is to find out the effect of losses reduction in a network with this application. By using a simulation program some result will be obtained to prove all the theories mentioned in the literature review.

In the data collection, the main element is how the existence of capacitor compensation will affect the losses reduction in distribution network. The expected result to be produced by the simulation program is the reduction of power losses. Several cases have been simulated in order to analyze every single factor affecting the losses reduction.

1.2 Problem statement

In the distribution network, the main interest is to supply the power to the customer which called load. Basically, the generation side will generate power according to the load but usually the distance between the generation and load is far. Along the distribution line, some of the power transfer will be lost and it is considered as power losses. Every loss needs to be considered because it involves money since more power needs to be generated.

The length of distribution line will influence the losses since the impedance will increase proportional to the length of the line. Theoretically, the longer the line, more power loss will be recorded.

1.3 Objective and scope of study

1.3.1 Objective

The main objective of this study is to prove that the theory on the application of capacitor compensation can affect the losses reduction is true. The study will be conducted through a software simulation. By, the end of this study the result of simulation will be used to prove the theory behind it.

1.3.2 Scope of study

The scope of the study will cover only the software simulation where different parameters will be set in order to examine the effect of capacitor compensation application.

There are several cases to be investigated in order to discuss the effect of series capacitor compensation application in the distribution network. The cases are varied in term of capacitor compensation location, compensation value, loading, load power factor, voltage level, cable size and network configuration.

Generally, the longest length of distribution cable will be 100 km. Then, for the cases of voltage level and cable size, 11 kV and 33 kV voltages level are chosen while cable with 185 mm² size is compared with another cable with 240 mm² size.

At the end of the study, brief economic studies will be carried out in order to justify whether this application is worth to be installed or not.

CHAPTER 2 LITERATURE REVIEW

2.1 Considerations for the Application of Series Capacitors to Radial Power Distribution Circuits [1]

This paper described the effect of series capacitor application in distribution network. The author compared a network without series capacitor application with a network with the application of series capacitor in order to consider the usage of this application.

The author clearly emphasized that series capacitor compensation can improve the performance of transmission as well as distribution line network. Specifically, the implementation of this compensation will improve the voltage profile, reduced voltage fluctuations, higher network capacity and reduced demand for reactive power from the power system. Actually, this type of compensation is widely used all over the world with approximately 200 distribution series capacitor in-service.

$$\Delta V = V_{S} - V_{R} = R_{L}I_{L}\cos\varphi_{R} + XI_{L}\sin\varphi_{R}$$

$$= R_{L}I_{L}\cos\varphi_{R} + (X_{L} - X_{C})I_{L}\sin\varphi_{R}$$
(1)

$$\Delta V = \underline{P_R R_L + Q_R X}_{V_R} = \underline{P_R R_L + Q_R (X_L - X_C)}_{V_R}$$
(2)

The equation (1) and (2) show the present of series capacitor compensation will reduce the total reactance. It is predicted that the voltage regulation will be improved where the voltage at the receiving end is improved since the total reactance is reduced.

$$S_{R} = \overline{V_{R}} * \overline{I_{L}}$$
(3)
$$P_{loss} = R_{L} (I_{L})^{2}$$
(4)

When the total reactance is reduced, it will cause a lower line current. So, from the equation (4) it shows that power losses are reduced due to the reduction of line current.

Figure 1 shown below is a single line network with a series capacitor application installed in the network. The cable is represented by resistance and inductance.

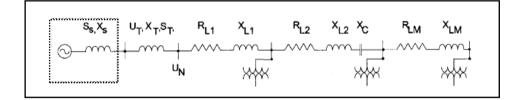


Figure 1 : Equivalent single-line diagram of a series compensated network with several taps along the line.

2.2 Application and Evaluation of a New Concept for Compact Series Compensation for Distribution Networks [2]

The author summarized that the series capacitor compensation application is suitable and cost efficient to improve voltage and loadability of the system. This application has been used since November 1990.

In the introduction part, the author stated that by reducing the reactance, the line becomes electrically shorter. The positive effects are improvement of voltage profile and reduction of losses.

Case study

A substation called Ballefors has a total peak load of 3.5 MW and the line voltage is 12 kV. But, in conjunction of increasing of demand, the load become higher which is 4.5 MW in the future. The increasing of load will cause the voltage supplied is lower than the limit set by the service provider.

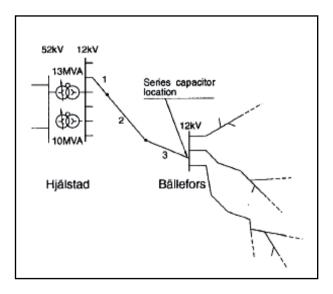


Figure 2 : Ballefors substation distribution network

Solutions

There are two possible solutions proposed by the engineers worked for the service provider. First, the problem can be solved by increase of system voltage. Instead of using 12 kV line systems, the system is upgraded to 52 kV and there are also transformers needed in order to step down the voltage at certain places. By implementing this method, the line losses would be very low and the voltage supplied is sufficient to the end user.

Next, the other solution is reactive power compensation. Since the increase of the load is not very much this method should be the better solution since the cost of installation is greatly lower compared to the first solution. Two types of compensation namely shunt and series capacitor compensations can be used to overcome this problem.

2.3 Distribution Series Capacitor Application for Improved Motor Start and Flicker Mitigation [3]

The basic theory introduced in this paper is the application of series capacitor is best explained by using the figure below.

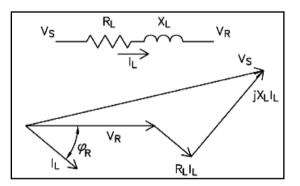


Figure 3: Distribution line segment without series capacitor and related phasor diagram

Then, when the series capacitor is installed there will be slightly different on the network and phasor diagram. The figure below is illustrated to give better explanation.

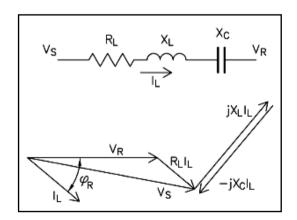


Figure 4: Distribution line segment with series capacitor and related phasor diagram

The series capacitor application will improve the voltage at the receiving end and directly it will reduce the line current. Consequently, the power losses will reduce due to the lower line current.

Next, in applying the series capacitor, the users should avoid overcompensation since it will cause the phenomenon called ferroresonance. But, it is clearly stated that higher degree of compensation will give better result in term of voltage at receiving end.

2.4 Series Compensation for a Hydro-Quebec Long Distribution Line [4]

In this paper, it is stated the existence of series capacitor compensation will cause the voltage drop per phase is decreased. This is due to the reduction of total net reactance since the capacitor will contribute the negative value of reactance as shown in **Figure 5**.

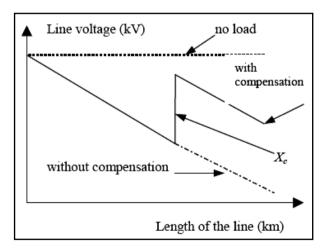


Figure 5: Voltage profile for a radial circuit with series capacitor

2.5 Reactive Compensation Techniques for Increasing Loadability of Long Primary Distribution Lines [6]

In this paper, 20 kV line voltages are used to supply remote consumer such as small village through a 150 km line.

The long distribution line will cause a huge voltage drop due to high impedance in the network. Hence, the loadability will be lower since the line current is increasing. In order to solve that problem, various compensators are applied such as voltage regulating transformers and series/shunt capacitors.

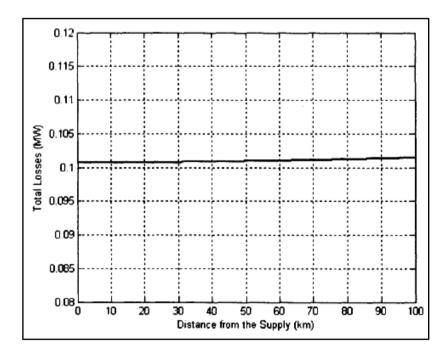


Figure 6: Line losses for different locations of the series capacitor

In series capacitor compensation, the compensation value is limited up to 100 % to avoid overcompensation situation. Besides that, it is concluded the best location for compensation in distribution network is at the receiving end while for the transmission line is at the middle. But, the system power loss is almost independent of the series capacitor location across the radial line.

2.6 Ferroresonance in a 13.8 kV Distribution Line [7]

A phenomenon where the nonlinear magnetizing reactance of a grounded and unloaded or lightly loaded transformer resonates with the distributed capacitances in lines or cables connected the transformer is called ferroresonance. When the situation occurs, the voltage is said to be distorted and produce a unstable voltage with 5 per unit high.

In distribution line, when the single-phase isolation occurs, the distribution transformer may be lightly loaded. Under this situation, an overvoltage due to ferroresonance is possible. In overhead line, the distributed capacitance alone is too small to cause ferroresonance in most cases.

CHAPTER 3 METHODOLOGY

3.1 Procedure Identification

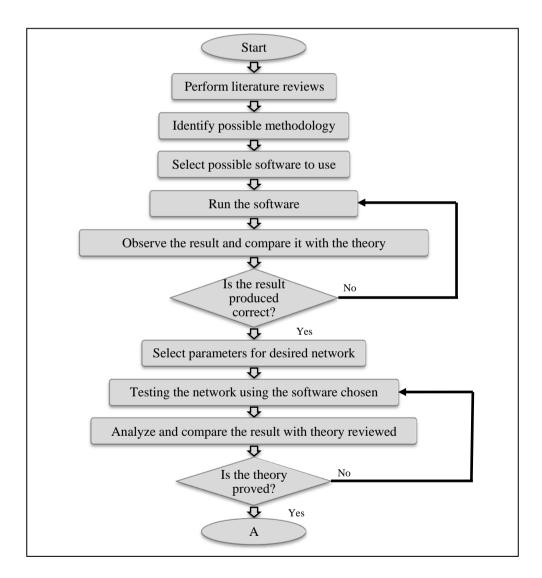


Figure 7: Flow chart for FYP I

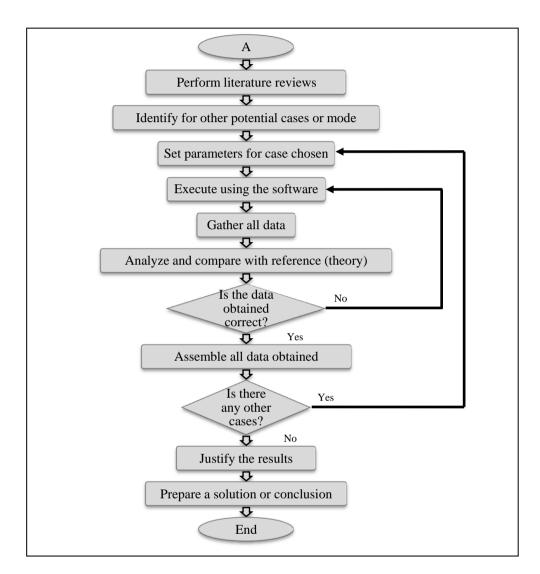


Figure 8: Flow chart for FYP II

3.2 **Project Description**

As mentioned in the scope of study, this study will focus on software simulation in order to produce result. The study will begin with the literature review where the related theories will be covered as reference.

Next, software code modification need to be carried out since the original MATLAB source code taken from the Power System Analysis text book by Hadi Saadat [5] is not suitable for the distribution network studied in this project. After several modifications, the source code is tested with parameters representing real distribution line. In the source code, the users are free to choose which type of calculation to be used such as Newton-Raphson method or Gauss-Seidal method. Hence, for this study, Newton Raphson method has been chosen due to the calculation accuracy and speed.

Then, all the data obtained are recorded in the table to be compiled in the result part. The power losses along the distribution line during each case are of interest. Graphs have been plotted according to give better view of the data.

Lastly, the discussion, conclusion and recommendation are derived from the data obtained.

3.3 MATLAB Software

Source code provided in one of power system text book will be used as a reference. In the source code, the user is free to choose which method to be used in the calculation of power flow.

In order to a get better result, software simulation will be used to compare the result expected as stated in the theory part. MATLAB will be used as a simulation program for this study. By using simulation program, a network can be created with multiple parameter depending on the user interest.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Basic parameters related

Firstly, all the parameters are set before any simulation start. The parameters are voltage, load, cable length, cable size and so on. For the calculation, per-unit system will be used to make it less complex. Besides that, the cable specification used is based on the real value obtained from the cable manufacturer.

Parameters involve,

Standard specification for the distribution cable for 240 mm²,

R = 0.161 ohm/km; X = 0.0924 ohm/km; B = 0.35 uF/kmand 185 mm² size [8];

$$R = 0.211 \text{ ohm/km}$$
; $X = 0.0962 \text{ ohm/km}$; $B = 0.31 \text{ uF/km}$

Base value used,

$$S_{base} = 1 MVA$$
; $V_{base} = 11 kV$; $Z_{base} = 121 ohm$

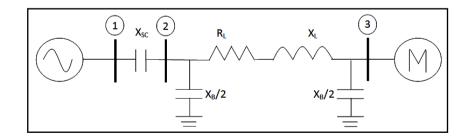


Figure 9: Circuit diagram for the series capacitor compensation at 0 % position value of 100 km long distribution line

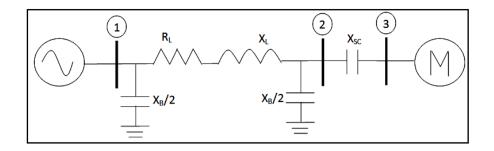


Figure 10: Circuit diagram for the series capacitor compensation at 100 % position value of 100 km long distribution line

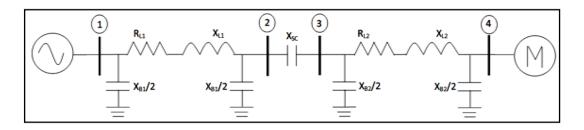


Figure 11: Circuit diagram for the series capacitor compensation at others position along 100 km long distribution line

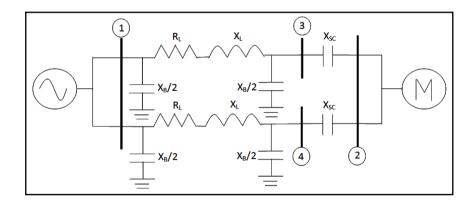


Figure 12: Circuit diagram for the series capacitor compensation at 100 % position value of 100 km long distribution line in parallel network configuration

Other parameters,

Rated load = 1 MVA ; Power factor = 0.9 lagging $P_{motor} = 0.9 MW$; $Q_{motor} = 0.436 MVAR$ Value of compensation (%) = $X_{SC}/X_L \ge 100$ %

Simulations have been carried out to analyze the power losses from the network discussed. Newton-Raphson method is chosen in power flow analysis calculation. The source code information can be referred to appendices.

4.2 Losses Analysis

4.2.1 *Case 1: Different in series capacitor compensation location*

For the first case, a single line network with 11 kV voltage level and 100 km long cable is used. The capacitor compensation is fixed at 100 % value. Then, the location of series capacitor compensation is varied from 0 % (sending end) distance up to 100 % (receiving end) distance. The networks constructed are based on **Figure 9**, **Figure 10** and **Figure 11** configuration.

The power losses and voltage profile are observed and recorded for every loacation. **Table 1** and **Table 2** below show the simulated results using Newton-Raphson method in MATLAB program.

 Table 1: Power losses and voltage magnitude for different series

 compensation location and 100 % compensation value

Compensation	Real Power	Reactive Power	Voltage Magnitude
Position	Losses, MW	Losses, MVAR	at Load, pu
0%	0.14	0.00	0.976
10%	0.14	0.00	0.976
20%	0.14	0.00	0.976
30%	0.14	0.00	0.976
40%	0.14	0.00	0.976
50%	0.14	0.00	0.976
60%	0.14	0.00	0.976
70%	0.14	0.00	0.976
80%	0.14	0.00	0.976
90%	0.14	0.00	0.976
100%	0.14	0.00	0.976

Compensation	Real Power	Reactive Power	Voltage Magnitude
Position	Losses, MW	Losses, MVAR	at Load, pu
0%	0.145	0.42	0.957
10%	0.145	0.42	0.957
20%	0.145	0.42	0.957
30%	0.145	0.42	0.957
40%	0.145	0.42	0.957
50%	0.145	0.42	0.957
60%	0.145	0.42	0.957
70%	0.145	0.42	0.957
80%	0.145	0.42	0.957
90%	0.145	0.42	0.957
100%	0.145	0.42	0.957

Table 2: Power losses and voltage magnitude for different series

compensation location and 50 % compensation value

From the tables above, it is clearly seen that the location of capacitor compensation will not affect the power losses. The data are plotted in **Figure 13.**

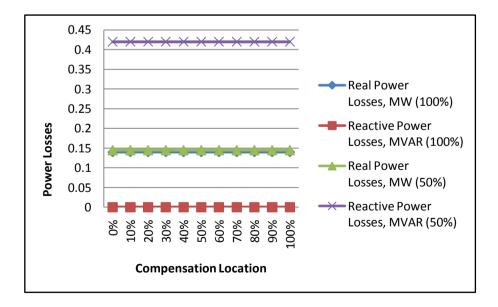


Figure 13: Graph of power losses for the network with capacitor compensation value of 100 % and 50 %

In this case, a radial network with a fix location of series capacitor compensation and different compensation value is tested. Therefore, for this case it is decided to locate the series capacitor compensation at the 100 % location (receiving end). Then, the series capacitor compensation value will be varied from 0 % to 100 %. Basically, for the 0 % of compensation value means a network without any capacitor compensation.

Similar with the previous case, all the parameters will be the same except for the compensation value. **Table 3** shows the simulated results at 10 % interval of compensation value.

Table 3: Power losses and voltage magnitude for the different in	
compensation value and compensation location of 100 %	6

Compensation	Real Power	Reactive Power	Voltage Magnitude
Value	Losses, MW	Losses, MVAR	at Load, pu
0%	0.152	0.087	0.937
10%	0.150	0.078	0.941
20%	0.149	0.068	0.945
30%	0.148	0.059	0.949
40%	0.146	0.050	0.953
50%	0.145	0.042	0.957
60%	0.144	0.033	0.961
70%	0.143	0.024	0.965
80%	0.142	0.016	0.969
90%	0.141	0.008	0.972
100%	0.140	0.000	0.976

Based on data recorded in **Table 3**, when the value of compensation is increasing, the power losses are reducing. So, the higher value of compensation will cause the reduction of power losses. Besides that, to compare a network without compensation with a network with series capacitor compensation installed, the real power losses reduction is almost 8 %.

For the reactive power losses, at 100 % compensation value the result is zero. This is because of at the first place the max value of compensation is assume to be equal with line reactance. Hence, at 100 % compensation value the reactive power will cancel each other and give zero value as the reactive power losses. **Figure 14** shows the trend of power losses with regard to different compensation value.

The simulated data are in the pattern of decreasing for power losses. Basically, when the series capacitor is installed in a network, the total reactance of the network will be reduced and it causes the line current to be lower. The lower of line current will cause the power losses to be reduced.

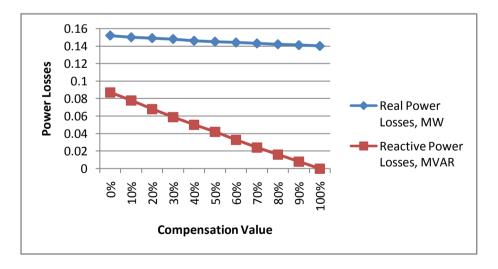


Figure 14: Graph of power losses for the network with different capacitor compensation and at location of 100 km

By varying the loading, the power losses are analyzed. The location and value of series capacitor compensation is set to be unchanged in this case. But, the loading is varied from a range of 50 % to 170 % where the 100 % load is set to be 1 MVA. On the other hand, a network without any compensation is also analyzed in order to see the difference between those two network.

Table 4 and **Table 5** show the simulated data for a compensated network and uncompensated network respectively. From the data in the table, power losses and voltage magnitude are changing when the loading is varied.

Table 4: Power losses and voltage magnitude for the different loading when compensation location and value are 100 %

	Real Power	Reactive Power	Voltage Magnitude
Loading	Losses, MW	Losses, MVAR	at Load, pu
50%	0.031	0.00	1.042
70%	0.063	0.00	1.017
100%	0.140	0.00	0.976
120%	0.214	0.00	0.946
150%	0.374	0.00	0.895
170%	0.525	0.00	0.856

Figure 15 and Figure 16 are plotted based on simulated data recorded in Table 4.

	Real Power	Reactive Power	Voltage Magnitude
Loading	Losses, MW	Losses, MVAR	at Load, pu
50%	0.032	0.018	1.025
70%	0.066	0.038	0.992
100%	0.152	0.087	0.937
120%	0.239	0.137	0.895
150%	0.446	0.256	0.820
170%	0.674	0.387	0.755

Table 5: Power losses and voltage magnitude for the different loading where compensation value of 0 % (uncompensated)

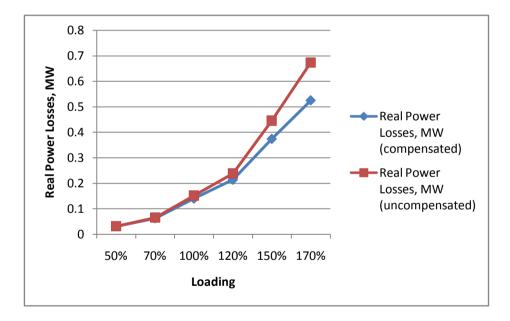


Figure 15: Graph of real power losses to compare a network with capacitor compensation and uncompensated network under different loading

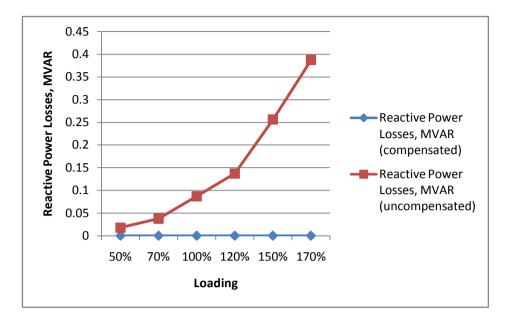


Figure 16: Graph of reactive power losses to compare a network with capacitor compensation and uncompensated network under different loading

Obviously, when the loading is increased power losses will be increased as well. But, to compare a network with compensation and a network without any compensation, the power losses are higher in the latter. In comparison, **Table 6** below shows the difference between a network without any compensation and a network with series capacitor compensation installed.

Table 6: Power losses and voltage magnitude different between anetwork without compensation and a network with seriescapacitor compensation under different loading

Loading	MW losses difference,%	MVAR losses difference,%	Voltage Magnitude Difference, %
50%	3.13	100.00	1.66
70%	4.55	100.00	2.52
100%	7.89	100.00	4.16
120%	10.46	100.00	5.70
150%	16.14	100.00	9.15
170%	22.11	100.00	13.38

Data in **Table 6** shows that the higher loading value will give better power losses reduction. But, for the value of loading at 200 % and above, the simulation did not converging. This is because of the source is now incapable to supply the load.

To explain on the reactive power (MVAR) losses difference, the values are shown 100 % since the compensated network tested for a compensation value of 100 % that resulting zero reactive power losses. The graph below plots the simulated data in **Table 6**.

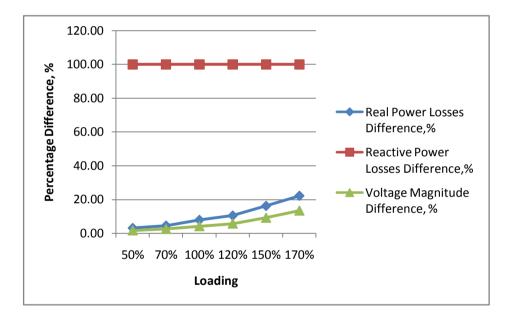


Figure 17: Graph of percentage difference to compare a network with capacitor compensation and uncompensated network under different loading

Different in load power factor illustrated by changing the value of load power factor while the other parameters are remain the same such as the line length, loading, voltage level and so on. The previous cases, the load power factor is set to be 0.9 power factor lagging while for this case the value of power factor is changing from lagging 0.7 to 1.0 power factor. **Table 7** below shows the simulated data after simulations are done.

 Table 7: Power losses and voltage magnitude for different power

 factor between a network without compensation and a network

 with series capacitor compensation

	1	I MVA Load	
Power	Real Power	Reactive Power	Voltage
Factor	Losses, MW	Losses, MVAR	Magnitude
0.70	0.132	0.00	1.003
0.75	0.141	0.00	0.996
0.80	0.136	0.00	0.989
0.85	0.138	0.00	0.983
0.90	0.140	0.00	0.976
0.95	0.142	0.00	0.969
1.00	0.144	0.00	0.962
	1 MVA Loa	d with no compensation	on
Power	Real Power	Reactive Power	Voltage
Factor	Losses, MW	Losses, MVAR	Magnitude
0.70	0.150	0.086	0.942
0.75	0.160	0.092	0.936
0.80	0.151	0.087	0.937
0.85	0.152	0.087	0.936
0.90	0.152	0.087	0.937
0.95	0.151	0.086	0.940
1.00	0.145	0.083	0.958

In order to analyze the result in **Table 7**, two graphs are plotted in **Figure 18** and **Figure 19**.

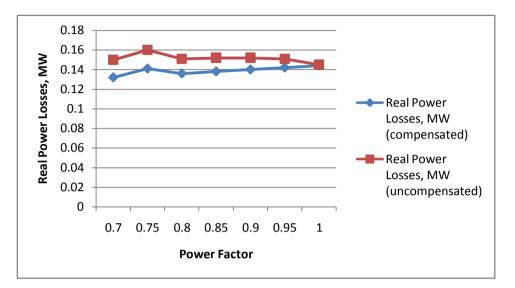


Figure 18: Graph of real power losses to compare a network with capacitor compensation and uncompensated network under different power factor

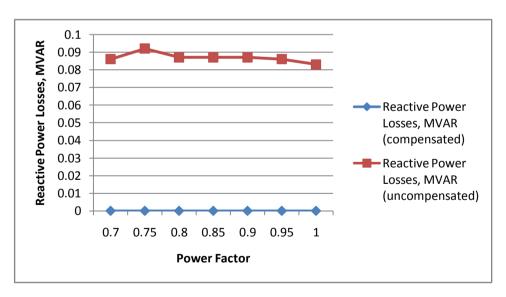


Figure 19: Graph of reactive power losses to compare a network with capacitor compensation and uncompensated network under different power factor

From the graphs plotted, it is obvious that a network with series capacitor compensation will reduce the power losses. The power losses are better in a compensated network for all power factor values except for 1.0 power factor where the power losses are the same. This is due to not reactive load during unity power factor.

 Table 8 below shows the difference in percentage of power losses and voltage magnitude in those two networks.

Table 8: Power losses and voltage magnitude different between anetwork without compensation and a network with seriescapacitor compensation under different power factor

Power	MW losses	MVAR losses	Voltage Magnitude
Factor	difference,%	difference,%	Difference, %
0.70	12.00	100.00	6.48
0.75	11.88	100.00	6.41
0.80	9.93	100.00	5.55
0.85	9.21	100.00	5.02
0.90	7.89	100.00	4.16
0.95	5.96	100.00	3.09
1.00	0.69	100.00	0.42

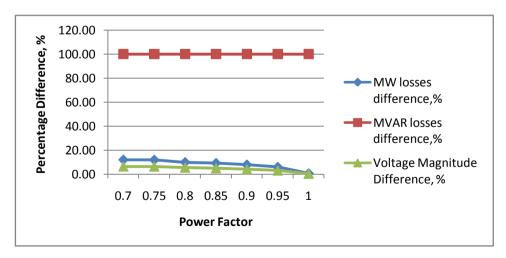


Figure 20: Graph of percentage difference to compare a network with capacitor compensation and uncompensated network under different power factor

Overcompensation happens where the value of series capacitor compensation is very high and the data calculated is no longer significant. Theoretically, the higher value of compensation will give better power losses reduction but it is valid up to some value of compensation only. After that, the network probably will expose to a phenomenon called ferroresonance which the voltage magnitude at the load is 4 or 5 times higher than the normal value. The procedures in Case 2 are repeated but the value of compensation is extended instead of 100 %. **Table 9** shows the simulated data obtained.

Table 9: Power losses and voltage magnitude for a network with series capacitor compensation at 100 km position under overcompensation condition

Compensation	Real Power	Reactive Power	Voltage
Value	Losses, MW	Losses, MVAR	Magnitude
100%	0.140	0.000	0.976
200%	0.131	-0.075	1.007
300%	0.125	-0.144	1.032
400%	0.120	-0.207	1.052
500%	0.117	-0.268	1.067
600%	0.114	-0.328	1.078
700%	0.113	-0.390	1.085
800%	0.113	-0.453	1.086
900%	0.114	-0.523	1.081

From the result shown in **Table 9**, when the value of compensation is increased, the power losses are reduced. Therefore, this is the advantage of installing this application in a distribution network which is to reduce power losses. But, for the value of compensation 600 % and higher, the power losses reduction is slowing down. For the value after 800 %, the real power losses are increased back to 0.114 MW. **Figure 21** below shows the pattern of changes for this case.

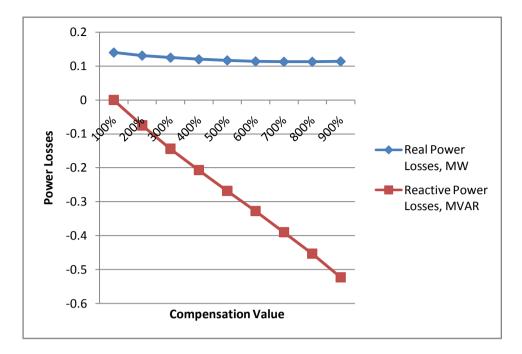


Figure 21: Graph of power losses for the different value of compensation

If the user wishes to maximize their reduction of power losses, overcompensation test need to be considered to avoid a problem such as ferroresonance. For this case, the compensation value suggested is not more than 800 % since the value more than that will result the power losses to be higher.

Other than that, from the value of voltage magnitude recorded, there is no sign of ferroresonance since the value is not 4 or 5 times higher than usual. But, it is assume that after the value of 800 %, the network might experience some problem such as ferroresonance as discussed in literature review part. In this case, a network with a voltage level of 33 kV will be tested to examine whether the series capacitor compensation can affected the power losses in the network. Previously, the voltage level used is 11 kV and the others parameters are the same as stated earlier.

For this case, the main procedure is to compare a network with capacitor compensation and a network without any compensation installed. The other parameters are the same such as loading, power factor and so on. Then, a few potential factors that can affect the power losses are analyze such as the location of the compensation installed, value of compensation and variation of loading.

After several simulations have been carried out, tables below show the simulated data of the power losses and voltage magnitude at the load.

Table 10: Power losses and voltage magnitude for a 33 kV network with	
series capacitor compensation value of 100 %	

Compensation	Real Power	Reactive Power	Voltage
Location	Losses, MW	Losses, MVAR	Magnitude
0%	0.015	0.00	0.986
10%	0.015	0.00	0.986
20%	0.015	0.00	0.986
30%	0.015	0.00	0.986
40%	0.015	0.00	0.986
50%	0.015	0.00	0.986
60%	0.015	0.00	0.986
70%	0.015	0.00	0.986
80%	0.015	0.00	0.986
90%	0.015	0.00	0.986
100%	0.015	0.00	0.986

Compensation	Real Power	Reactive Power	Voltage
Value	Losses, MW	Losses, MVAR	Magnitude
0%	0.015	0.010	0.982
10%	0.015	0.009	0.983
20%	0.015	0.008	0.983
30%	0.015	0.007	0.983
40%	0.015	0.006	0.984
50%	0.015	0.005	0.984
60%	0.015	0.004	0.985
70%	0.015	0.003	0.985
80%	0.015	0.002	0.986
90%	0.015	0.001	0.986
100%	0.015	0.000	0.986

Table 11: Power losses and voltage magnitude for a 33 kV network with series capacitor compensation location at 100 km

Based on **Table 10** and **Table 11**, there are no changes on the power losses for the range 0 % to 100 %. In other word, the change in compensation location and value will not affect the power losses for the range of 0 % to 100 %.

The value of loading is change from 100 % up to 1200 % to observe if there are any changes in power losses. **Table 12** shows the simulated data after simulations are done. From the table, in can be seen that the power losses reduction only occur for the loading value greater than 170 %. Besides that, a few graphs have been plotted to show the pattern of changes.

Table 12: Power losses and voltage magnitude for a 33 kV network with
series capacitor compensation location at 100 km and 100 $\%$
compensation value

1 MVA Load			
	Real Power	Reactive Power	Voltage
Loading	Losses, MW	Losses, MVAR	Magnitude
100%	0.015	0.00	0.986
120%	0.022	0.00	0.984
150%	0.035	0.00	0.980
170%	0.045	0.00	0.977
200%	0.063	0.00	0.973
300%	0.145	0.00	0.958
400%	0.266	0.00	0.943
500%	0.429	0.00	0.928
600%	0.640	0.00	0.912
700%	0.905	0.00	0.895
800%	1.230	0.00	0.877
900%	1.626	0.00	0.858
1000%	2.103	0.00	0.838
1200%	3.374	0.00	0.794
		with no compensatior	
	Real Power	Reactive Power	Voltage
Loading	Losses, MW	Losses, MVAR	Magnitude
100%	0.015	0.010	0.982
120%	0.022	0.014	0.979
150%	0.035	0.023	0.973
170%	0.045	0.030	0.969
200%	0.064	0.042	0.964
300%	0.149	0.097	0.944
400%	0.277	0.181	0.924
500%	0.453	0.296	0.903
600%	0.686	0.448	0.881
700%	0.987	0.643	0.857
800%	1.369	0.893	0.831
900%	1.854	1.209	0.804
1000%	2.473	1.613	0.773
1200%	4.362	2.845	0.699

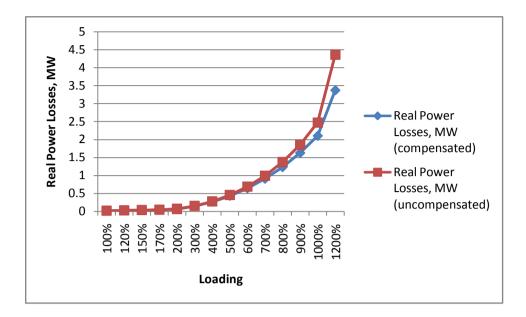


Figure 22: Graph of real power losses for a 33 kV network with and without compensation installed

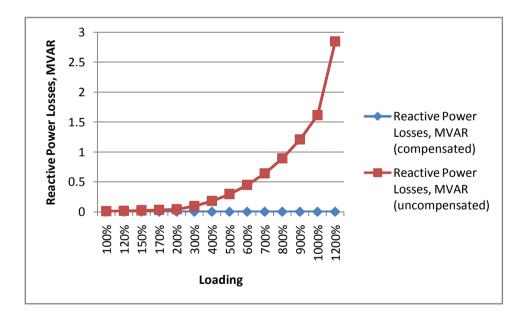


Figure 23: Graph of reactive power losses for a 33 kV network with and without compensation installed

For the changes in the network with and without compensation installed, a table is provided to show the difference in percentage.

Table 13: Power losses and voltage magnitude difference between a 33

kV network with and without series capacitor compensation installed

Loading	MW losses difference,%	MVAR losses difference,%	Voltage Magnitude Difference, %
100%	0.00	100.00	0.41
200%	1.56	100.00	1.56
300%	2.68	100.00	2.68
400%	3.97	100.00	3.97
500%	5.30	100.00	5.30
600%	6.71	100.00	6.71
700%	8.31	100.00	8.31
800%	10.15	100.00	10.15
900%	12.30	100.00	12.30
1000%	14.96	100.00	14.96
1200%	22.65	100.00	22.65

By using the different size of cable, a network with and without series capacitor compensation are analyzed. Previously, a cable with 240 mm² size is used but for this time the cable size is reduced to 185 mm². Basically, the smaller size of cable will cause the impedance of the cable to be increased.

For this case, only loading and overcompensation conditions have been discussed since compensation location will not affect power losses. Meaning that at every location the power losses will be the same.

The table below shows the simulated data for different loading. Theoretically, a network with series capacitor compensation will have a losses reduction compared with a network without any compensation installed.

Table 14: Power losses and voltage magnitude for networks with 185 mm² cable size and 100 km long

1 MVA Load			
	Real Power	Reactive Power	Voltage
Loading	Losses, MW	Losses, MVAR	Magnitude
50%	0.042	0.00	1.023
70%	0.088	0.00	0.987
100%	0.203	0.00	0.928
120%	0.323	0.00	0.881
150%	0.622	0.00	0.794
	1 MVA Load	with no compensation	l
	Real Power	Reactive Power	Voltage
Loading	Losses, MW	Losses, MVAR	Magnitude
50%	0.043	0.020	1.005
70%	0.093	0.042	0.96
100%	0.224	0.102	0.883
120%	0.374	0.170	0.819
150%	0.867	0.395	0.673

Based on the data, a network with a compensation installed is obviously better in term of power losses compared with a network without any compensation. Graphs are plotted to show the pattern of changes while a table showing the differences between those two networks is provided as well.

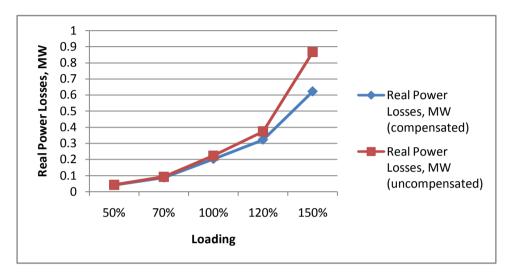


Figure 24: Graph of real power losses for a network with and without compensation installed with 185 mm² cable size

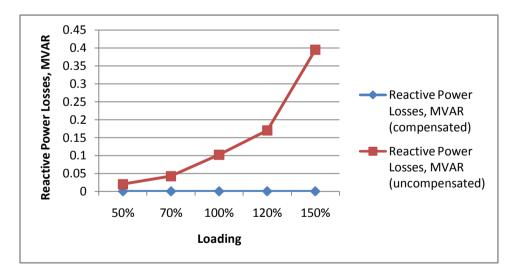


Figure 25: Graph of reactive power losses for a network with and without compensation installed with 185 mm² cable size

Table 15: Power losses and voltage magnitude difference between a network with and without series capacitor compensation installed with 185 mm² cable size

Looding	MW losses	MVAR losses	Voltage Magnitude Difference, %
Loading	difference,%	difference,%	Difference, %
50%	2.33	100.00	1.79
70%	5.38	100.00	2.81
100%	9.38	100.00	5.10
120%	13.64	100.00	7.57
150%	28.26	100.00	17.98

From the data show in **Table 15**, the real power losses differences are better in the higher loading. Similarly the voltage magnitude difference is almost 20 %.

The overcompensation is being simulated to observe the effect on power losses if the value of compensation is changed. The table below shows the simulated data obtained from the simulations.

Table 16: Power losses and voltage magnitude for a network with series capacitor compensation at 100 km position and 185 mm² cable size

Compensation Value	Real Power Losses, MW	Reactive Power Losses, MVAR	Voltage Magnitude
100%	0.203	0.000	0.928
200%	0.188	-0.086	0.962
300%	0.178	-0.163	0.989
400%	0.171	-0.234	1.009
500%	0.166	-0.304	1.024
600%	0.164	-0.373	1.032

The value of compensation allowed is not more than 600 %. Graphs have been plotted to show the pattern of changes as shown in **Table 16**.

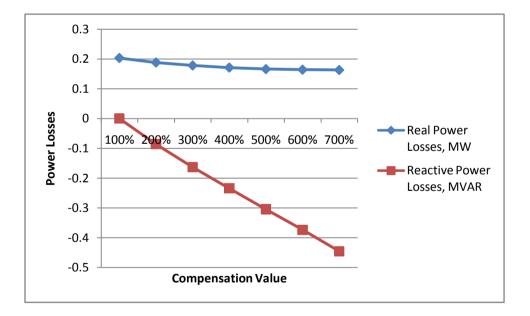


Figure 26: Graph of power losses for the difference value of compensation in a network with 185 mm² cable size

In previous cases, the configuration used is called radial or spur system. It is of interest to investigate what happen when the network is cable. This network will have 11 kV source, 100 km long cables and a 1 MVA load at the end of the cable.

The position of compensation location will not affect the losses reduction. Only the value of series capacitor compensation will affect the losses reduction. For this case, there will be two series capacitor compensation at each cable. So, a loading test and overcompensation simulation is done to analyze the losses reduction.

Table 17 below shows the simulated data under different loading where a network with series capacitor compensation is compared with a network without any compensation installed. Then, the value of loading is varied from 50 % to 300 %.

From the data in **Table 17**, the network with compensation installed will give better losses reduction. To show the pattern of changes, **Figure 27** and **Figure 28** are drawn.

Then, **Table 18** shows the differences in losses reduction and voltage magnitude in percentage. Obviously, the higher value of loading will give higher percentage difference.

1 MVA Load			
	Real Power	Reactive Power	Voltage
Loading	Losses, MW	Losses, MVAR	Magnitude
50%	0.014	0.00	1.072
70%	0.029	0.00	1.060
100%	0.061	0.00	1.042
120%	0.090	0.00	1.030
150%	0.147	0.00	1.010
170%	0.194	0.00	0.997
200%	0.280	0.00	0.976
300%	0.748	0.00	0.895
	1 MVA Load	with no compensation	l
	Real Power	Reactive Power	Voltage
Loading	Losses, MW	Losses, MVAR	Magnitude
50%	0.015	0.008	1.064
70%	0.030	0.017	1.049
100%	0.063	0.036	1.025
120%	0.094	0.054	1.009
150%	0.155	0.089	0.983
170%	0.206	0.118	0.965
200%	0.303	0.174	0.937
300%	0.891	0.511	0.820

Table 17: Power losses and voltage magnitude for networks with parallelconfiguration and 100 % compensation value

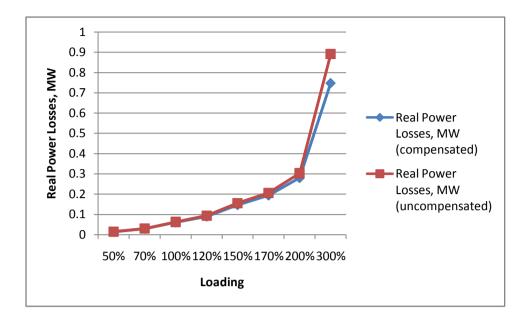


Figure 27: Graph of real power losses for a network with and without compensation installed with parallel configuration

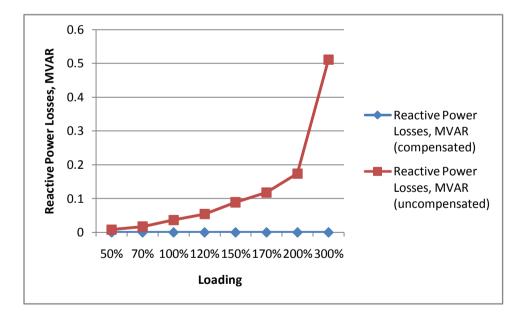


Figure 28: Graph of reactive power losses for a network with and without compensation installed with parallel configuration

 Table 18: Power losses and voltage magnitude difference between a network with and without series capacitor compensation installed with parallel configuration

	MW losses	MVAR losses	Voltage Magnitude
Loading	difference,%	difference,%	Difference, %
50%	6.67	100.00	0.75
70%	3.33	100.00	1.05
100%	3.17	100.00	1.66
120%	4.26	100.00	2.08
150%	5.16	100.00	2.75
170%	5.83	100.00	3.32
200%	7.59	100.00	4.16
300%	16.05	100.00	9.15

Next, **Table 19** shows the simulated data after overcompensation condition has been performed. Similarly, overcompensation test will be stopped after the simulation is not converged. **Figure 29** shows a graph based on the data in **Table 19**.

From the result obtained, it can be seen that the changes in losses reduction is not very much compared with the previous cases. But, the network is said to be better in term of losses reduction if a higher value of series capacitor compensation is installed.

Table 19: Power losses and voltage magnitude for a network with series capacitor compensation at 100 km position and with parallel configuration

Compensation	Real Power	Reactive Power	Voltage
Value	Losses, MW	Losses, MVAR	Magnitude
100%	0.061	0.000	1.042
200%	0.059	-0.034	1.057
300%	0.058	-0.067	1.071
400%	0.057	-0.098	1.084
500%	0.055	-0.127	1.096
600%	0.054	-0.156	1.106
700%	0.053	-0.184	1.115
800%	0.053	-0.212	1.124
900%	0.052	-0.239	1.131
1000%	0.051	-0.266	1.138
1200%	0.050	-0.319	1.149

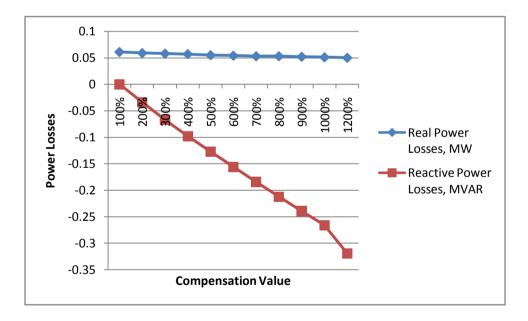


Figure 29: Graph of power losses for the difference value of compensation in a network with 185 mm² cable size

4.3 Voltage Analysis

4.3.1 *Case 1: Different in series capacitor compensation location*

For a network with series capacitor compensation installed, the location of compensation will not change the voltage magnitude at the load. To prove the statement, **Figure 30** shows the voltage magnitude when the series capacitor compensation location is set to be at 100 km and 50 km.

The results obtained are due to the voltage magnitude depends on the voltage source and total impedances where for this case although the location of compensation is changing but the voltage source and total impedance are the same.

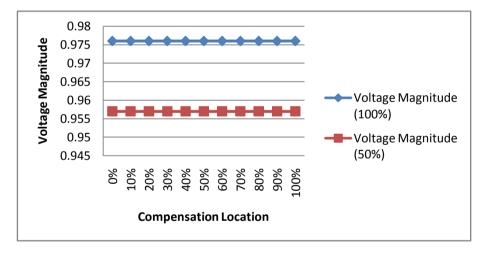


Figure 30: Graph of voltage magnitude for the network with capacitor compensation value of 100 % and 50 %

Base on Case 2 in previous part, the value of series capacitor compensation is changed and the data is collected from the simulation. Then, **Figure 31** shows the effect on voltage magnitude at the load after the simulation is done.

When the value of series capacitor is increased, the voltage magnitude at the load is increased as well. In other word, the higher value of capacitor compensation will result the voltage magnitude to be increased.

The increasing of voltage magnitude is due to the total impedance has been reduced. Therefore, the reduction of total impedance will cause the voltage at the load to be improved.

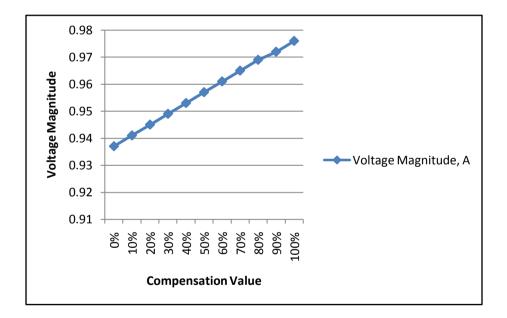


Figure 31: Graph of voltage magnitude for the network with capacitor compensation location at 100 %

4.3.3 *Case 3: Different in loading*

For this case, when the loading is changing the voltage magnitude at the load will decreasing. Meaning to say, the increase of loading will cause the voltage at the load to be lower.

Then, a network with compensation installed is compared with a network without any compensation installed. The series capacitor compensation application has improved the voltage magnitude. It is proven by the graph in **Figure 32**. Similar with the previous cases, the present of series capacitor compensation will reduce the total impedance and cause the voltage magnitude to be improved.

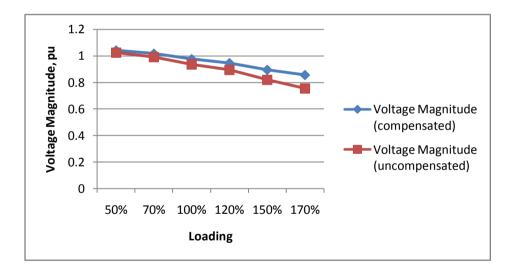


Figure 32: Graph of voltage magnitude to compare a network with capacitor compensation and uncompensated network

From the graph drawn below, the present of series capacitor compensation has improved the voltage magnitude. As an example, at 0.9 power factor value, the voltage magnitude in the compensated network is higher compared with the voltage magnitude in the uncompensated network.

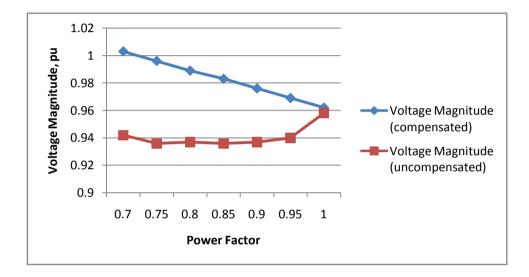


Figure 33: Graph of voltage magnitude to compare a network with capacitor compensation and uncompensated network

To extend the analysis on compensation value affecting the voltage magnitude, overcompensation simulation has been done. A compensated network is tested with the value of series capacitor compensation is ranging from 100 % to 900 %.

From the graph drawn, the voltage magnitude at the load in the increasing trend and after certain level which is at 700 % the voltage magnitude is decreasing.

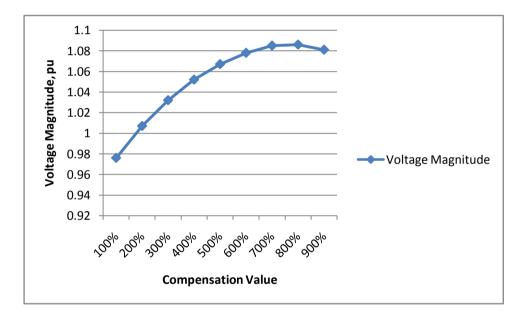


Figure 34: Graph of voltage magnitude at the load for the different value of compensation

By using a 33 kV voltage source, a compensated network is compared with uncompensated network whether the loading different will affect the voltage magnitude or not.

Based on the graph drawn below, the compensated network give better voltage magnitude at the load compared with the uncompensated network. But, comparing the 11 kV network and 33 kV network, the voltage magnitude different are greater for the 11 kV network.

As an example, in 11 kV network, the voltage magnitude percentage different between compensated network and uncompensated network at 100 % loading is 4.16 % while in 33 kV the percentage difference is about 0.41 %.

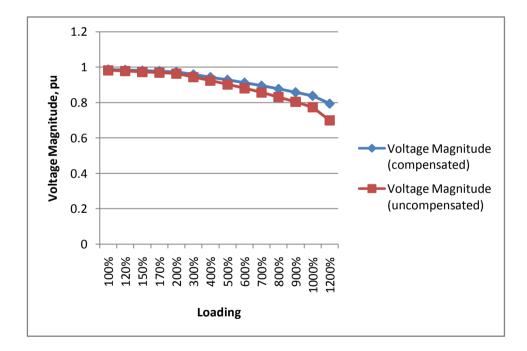


Figure 35: Graph of voltage magnitude at the load for a 33 kV network with and without compensation installed

Previously, the cable of 240 mm^2 sizes is used as the cable but for this case the 185 mm² sizes of cable will be used. Basically, from the data collected and graph drawn below, the present of series capacitor compensation has improved the voltage magnitude at the load.

But, the difference can be explained where the smaller size of cable will increase the total impedance of the network. For example, the voltage magnitude percentage difference for this case is about 5.1 % at 100 % loading while for the network with 240 mm² the percentage difference is about 4.16 %.

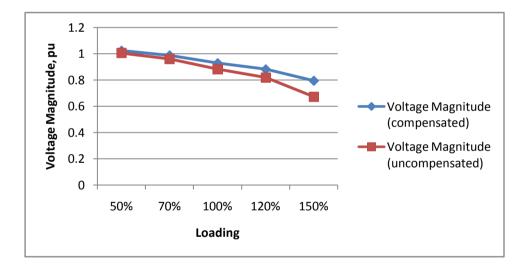


Figure 36: Graph of voltage magnitude at the load for a network with and without compensation installed with 185 mm² cable size

The network with 100 km long, 1 MVA loading and 11 kV voltage level is taken into consideration. But for this time around, the network configuration is set to be parallel which means there will be 2 cable of 100 km long cable.

By varying the loading, the voltage magnitude at the load is analyzed. At 100 % loading in parallel configuration network, the voltage magnitude configuration percentage difference is around 1.66 % while for the similar parameters in radial configuration the percentage difference is about 4.16 %.

Obviously, from the graph shows below the present of this series capacitor compensation will improve the voltage magnitude at the load.

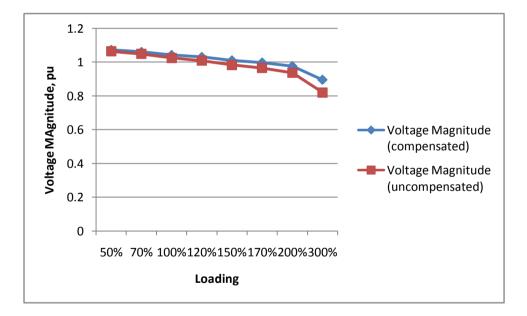


Figure 37: Graph of voltage magnitude at the load for a network with and without compensation installed with parallel configuration

4.4 Economic Analysis

Apart of analysis on losses reduction, the economic analysis is also taken into consideration in order to decide whether this series capacitor compensation is worth to be installed or not. But, to be able to analyze this application economically, certain elements or factors need to be determined such as the estimation cost involved to install this application and amount of losses can be reduced in term of money.

The estimation cost to install this series capacitor compensation involves the cost to buy the equipment such as the capacitor, circuit breaker protection system and some other equipment. The cost estimated is around RM 200,000.00 and extra RM 50,000.00 for the maintenance in 20 years time.

Next, to calculate the amount of money that the user can save taking into account the amount of power losses reduction, tariff rate and load factor. The information mentioned is;

Tariff rate (for C1, 11 kV)	:	28.8 cent/kWh
Load factor (assumption)	:	0.6

Table 20: Real power losses according to the compensation value in a network with 11 kV level, 1 MVA load, 100 km long and 0.9 lagging power factor

Compensation Value	Real Power Losses, MW
0%	0.152
50%	0.145
100%	0.140
300%	0.125
600%	0.114

Based on the data in **Table 20**, the real power losses in a network without any compensation is 152 kW but for a network with 100 % compensation value which is a recommended value of compensation give 140 kW real power losses. But, as mentioned earlier, at 600 % value of compensation the network still working properly and the user might considering to go up to this value.

As the result, a payback period can be calculated by setting the total cost to be RM 250,000.00.

Payback Period, Tyear

 $P_{loss} * R_{tariff} * T_{hour/day} * T_{day/year} * T_{year} * F_{load} = C_{total}$

Where,	P _{loss}	, in kW
	R _{tariff}	, 0.288 RM/kWh
	Thour/day	, $24_{hour/day}$
	T _{day/year}	, 365 _{day/year}
	C _{total}	, RM 250, 000.00
	Fload	, 0.6

Compensation	Real Power	Losses	Payback
Value	Losses, MW	Reduction, kW	Period, years
0%	0.152		
50%	0.145	7	24
100%	0.140	12	14
300%	0.125	27	7
600%	0.114	38	5

Table 21: Real power losses, losses reduction and payback period

according to the compensation value

After calculating the payback period, the user can decide whether to install this series capacitor compensation or not. Based on several assumptions been made, the best compensation value to be chosen is at 300 % where it takes 7 years for the user to cover back all the installation cost. Usually, this series capacitor compensation can be used up to 20 years and for the balance of 13 years the user can collect the profit.

To compare the result calculated in **Table 21**, the user can compare how much is the losses in term of money if this series capacitor compensation is not been installed. By using the same values and assumptions, the losses per day are about RM 111.97.

4.5 Loadability Analysis

Loadability analysis focuses on the current supplying the load. Therefore, this analysis is carried out by comparing a network with capacitor compensation with network without any compensation installed. From the data assembled in previous cases, the loadability analysis can be performed.

Basically, by knowing the power losses and resistance of the network, the line current can be calculated. The equation (5) is obtained from the equation (4) in the literature review part. Similarly, to calculate the line current, equation (6) can be used.

$$(I_L)^2 = \underline{P_{loss}}_{R_L}$$
(5)

$$I_L = \frac{V_S - V_R}{R_L \cos \varphi_R + (X_L - X_C) \sin \varphi_R}$$
(6)

Next, before start calculating the line current, there are several parameters that need to be clarified. The parameters are;

$$R = 0.161 \text{ ohm/km}; X = 0.0924 \text{ ohm/km}; B = 0.35 \text{ uF/km}$$
$$S_{base} = 1 \text{ MVA}; V_{base} = 11 \text{ kV}; Z_{base} = 121 \text{ ohm}; I_{base} = 90.91 \text{ A}$$
Power factor = 0.9 lagging

Compensation	Real Power	Voltage	Total Impedance,
Value	Losses, MW	Regulation, ΔV	R+jX
0%	0.152	0.163∟0.596	16.1 + j9.240
50%	0.145	0.143 -1.287	16.1 + j4.620
100%	0.140	0.124∟-3.098	16.1 + j0.000
300%	0.125	0.063∟-9.914	16.1 - j18.48
600%	0.114	0.022∟-19.791	16.1 - j46.20

 Table 22: Real power losses, voltage regulation and total impedance according to the compensation value

From the data collected in **Table 22**, the value of line current can be calculated. The line currents are as follow;

Table 23: Value of line current according to compensation value

Compensation Value	Line Current, A
0%	97.16
50%	94.90
100%	93.25
300%	88.11
600%	84.15

From the value of line current calculated in **Table 23**, the reduction of line current is almost 10 %. Therefore, the loadability is said to be improved by 10 % if the user use compensation value of 300 %.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.1 Conclusions

The main reason why capacitor compensations have been installed in the network is to improve the power transmission in distribution line. By having the series capacitor compensation, the voltage regulation and power losses can be controlled and limited. From the result obtained, it is proven that the application of series capacitor compensation can improve the power transmission in term of voltage improvement and power losses. The changes in power factor and loading can affect the network with series capacitor compensation where the voltage is improved and power losses reduced as well.

Voltage improvement is important in distribution network because service provider is required to supply quality power to the customer. The supply is said to be out of tolerance if the voltage regulation is not within the interval of ± 5 % at 11 kV. The service provider can easily step up the voltage at the sending end to improve the voltage regulation but it would involve a very high cost.

After considering all the cases, series capacitor compensation is capable to reduce the losses and improve loadability. Besides that, with series capacitor compensation installed the voltage at receiving end can be improved as well. As a conclusion, although the losses reduction is not very significant but by having this application the service provider can solve a few other problems such as loadability and voltage regulation.

5.2 Recommendations

After completing this study, there are advantages and disadvantages of installing the series capacitor compensation in distribution line. The advantages are losses are reduced along the network, voltage at the receiving end is improved and improve the loadability. In economic point of view, installing series capacitor compensation will need only 7-10 years of payback period over 20 years life span.

On the other hand, there are a few disadvantages of this application. The disadvantages are special protection system is required to avoid any damage to the system and the system might exposed to some side effect such as ferroresonance or overcurrent conditions.

To conclude, it is depending on the service provider whether to consider series capacitor compensation to be installed in distribution line or not. Economically, this application can reduce the losses that lead to saving the money. However, there are several disadvantages need to be considered such as ferroresonance and spending on new protection system or new cables.

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APPENDICES

APPENDIX I

Source code for compensation location at 100 km

and 100 % compensation value

%clear											
*	Name	1.1	Muhamma	d Azizi	. bir	n Mohd Wa	hidi				
*	Titl	e :	Analysia	s on Lo	sses	Reducti	on wi	ith Se	ries (Capac:	itor
*			Compense	ation i	n Di	stributi	on Ne	etwork			
*	sv		IR Mohd	Faris	bin	Abdullah					
*	Case	1.1	Compense	ation's	100	ation at	100	km			
*			Value o:	f compe	ensat	ion is 1	00%				
%Base po	wer	= 1 M	VA , Base	e volta	ige =	11 kV ,	Base	e impe	dance	= 12:	1 ohm
%Line re	sist	ance	= 0.161 (ohm/km,	Lir	ne reacta:	nce =	= i0.0	924 ol	am/ km	, Line
*Capacit	or c	ompen:	sation =	100% ,	Dis	stance =	100 km	n , PF	= 0.9) lag	ging
basemva	= 1;	acc	uracv = (.0001;	acc	el = 1.6	; ma	axiter	= 60.		
			-								
÷	Bus	Bus	Voltage	Angle		-Load		Gen	erato		-Injecte
*	No	code	Mag.	Degree	MU	J Mvar	MW	Mvar	Qmin	Qmax	Mvar
busdata=	[1	1	1.1	0.0	C) 0	0	0	0	0	0
	2	0	1	0.0	C) 0	0	0	0	0	0
	3	0	1	0.0	0.90	0.436	0	0	0	0	0];
•							Line	e code			
*		s bus	R	x		1/0 P					
*						1/2 B		for 1		1	1
		nr 2		p.u.		p.u. 0.00005		or <i t<="" td=""><td>r. taj</td><td>pacı</td><td>ous nl</td></i>	r. taj	pacı	ous nl
linedata	-						1				
	2	3	0.00000	-0.076	55	0.00000	1];				
lfybus				% Form	ns th	ne bus adı	mitte	ance m	atrix		
*lfgauss		÷ ₽	ower flo	w solut	ion	by Newto:	n-Rar	hson :	metho	ł	
lfnewtor						Vewton-					
%decoup1					-	v Newton	-				
busout	-					, solutio:					
lineflow	r s			·		he line :					
					-	lfnewton					

% (b) Comment lfgauss and uncomment lfnewton
 % (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX II

Simulation for compensation location at 100 km and 100 % compensation value

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 4.51584e-008 No. of Iterations = 4

Bus	Voltage	Angle	Lo	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1	1.100	0.000	0.000	0.000	1.040	0.436	0.000
2	0.944	-1.180	0.000	0.000	0.000	0.000	0.000
3	0.976	3.098	0.900	0.436	0.000	0.000	0.000
Tota	1		0.900	0.436	1.040	0.436	0.000

	Lin	_		bus & line			loss	Transformer
	from	to	MW	Mvar	MVA	MW	Mvar	tap
	1		1.040	0.436	1.127			
		2	1.040	0.436	1.127	0.140	0.080	
	2		0.000	0.000	0.000			
		1	-0.900	-0.356	0.968	0.140	0.080	
		3	0.900	0.356	0.968	0.000	-0.080	
	3		-0.900	-0.436	1.000			
		2	-0.900	-0.436	1.000	0.000	-0.080	
. 1	ſotal	loss				0.140	-0.000	

APPENDIX III

Source code for compensation location at 50 km

and 50 % compensation value

%clear												
÷	Name		Muhamma	d Azizi	bin	Mohd Wah	idi					
4	Titl	e :	Analysi:	s on Los	ses	Reductio	n vi	th Se	ries C	apac	itor	
*			Compensa	ation in	Dis	stributio	n Ne	twork				
÷	sv		IR Mohd	Faris b	in J	bdullah						
÷	Case		Compense	ation's	loca	ation at	50 k	m				
2Bage no	Mer	= 1 MT	VA Bas	e volter		11 kV ,	Bage	imne	lance	= 12	1 ohm	
						e reactan						can
						ance = 10						oup
				, -				· · · ·				
basemva	= 1;	acci	uracy = (0.0001;	acce	el = 1.6;	me	xiter	= 60;			
	_	_						_				
*			Voltage	-		-Load					-	ed
÷			Mag.	Degree		Mvar			Qmin	-		
busdata=	-	1	1.1	0.0	0	0	0	0	0	0	0	
	2	0	1	0.0	0	0	-		0	0	0	
	3 4	0 0	1 1	0.0	0	0 0.436	-		0	0 0	0 01;	
	4	U	T	0.0 0	.90	0.430	0	U	U	U	0];	
*							Line	code				
*	Bu	s bus	R	X	1	L/2 B	= 1	for 1	ines			
*	nl	nr	p.u.	p.u.	1	9.u.	>1 c	r < 1 t	r. tap	at l	ous nl	
linedata	i=[1	2	0.06653	0.0381	8 (0.000023	1					
	2	3	0.00000	-0.0381	8 (0.000000	1					
	з	4	0.06653	0.0381	8 (0.000023	1]	;				
lfybus				> Forme	the	e bus adm	itte	nce m	atriv			
lfgauss		÷ Pi	ower flo			by Newton						
lfnewton						Newton-F						
%decoupl					-	7 Newton-	-					
busout						solution						
lineflow						he line f						
			auss and				.100	and 1	55565			
						nd uncomm	ent	decou	nle			
∞ (c) C0	manen	o iriði	auss anu	TTHEWCO	n ai	ia ancomm	CHC.	accou,	bre -			

APPENDIX IV

Simulation for compensation location at 50 km and 50 % compensation value

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 4.01889e-008 No. of Iterations = 4

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1	1.100	0.000	0.000	0.000	1.045	0.478	0.000
2	1.020	-0.415	0.000	0.000	0.000	0.000	0.000
3	1.037	1.596	0.000	0.000	0.000	0.000	0.000
4	0.957	1.287	0.900	0.436	0.000	0.000	0.000
Tota	1		0.900	0.436	1.045	0.478	0.000

Lin from	le to	Power at MW	bus & li Mvar	ne flow MVA	Line MW	loss Mvar	Transformer tap
1		1.045	0.478	1.149			
	2	1.045	0.478	1.149	0.073	0.042	
2		0.000	0.000	0.000			
	1	-0.973	-0.436	1.066	0.073	0.042	
	3	0.973	0.436	1.066	-0.000	-0.042	
3		0.000	0.000	0.000			
0	2	-0.973	-0.478	1.084	-0.000	-0.042	
	4	0.973	0.478	1.084	0.073	0.042	
4			0 407	1 000			
4	3	-0.900	-0.436	1.000	0 070	0 040	
	3	-0.900	-0.436	1.000	0.073	0.042	
Total	loss				0.145	0.042	

APPENDIX V

Source code for compensation location at 100 km

and 70 % compensation value

%clear : Muhammad Azizi bin Mohd Wahidi ÷ Name : Analysis on Losses Reduction with Series Capacitor ÷, Title Compensation in Distribution Network sv : IR Mohd Faris bin Abdullah ÷ : Compensation's location at 100 km Case Value of compensation is 70% Base power = 1 MVA, Base voltage = 11 kV, Base impedance = 121 ohm %Line resistance = 0.161 ohm/km, Line reactance = i0.0924 ohm/km , Line capacitance = 0.35 uF/km Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; ---Load---- ----Generator----Injected ÷ Bus Bus Voltage Angle No code Mag. Degree MU Mvar MU Mvar Omin Omax Mvar % No cont busdata=[1 1 1.1 2 0 1 0.0 0 0 0.0 0 0 0 0 0 0 0 0 0 Ο 3 0 1 0.0 0.90 0.436 0 0 0 0 0]; Line code ÷ X 1/2 B = 1 for lines ÷ Bus bus R nl nr p.u. >1 or<1 tr. tap at bus nl 4 p.u. p.u. linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.05346 0.00000 11; lfybus % Forms the bus admittance matrix % Power flow solution by Newton-Raphson method %lfgauss % Power flow solution by Newton-Raphson method lfnewton %decouple % Power flow solution by Newton-Raphson method % Prints the power flow solution on the screen busout lineflow % Computes and displays the line flow and losses $\$ (b) Comment lfgauss and uncomment lfnewton

% (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX VI

Simulation for compensation location at 100 km and 70 % compensation value

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 8.69795e-009 No. of Iterations = 4

Bus	Voltage	Angle	Lo	ad	Genera	ation	Injected
No.	Mag.	Degree	MU	Mvar	MU	Mvar	Mvar
1	1.100	0.000	0.000	0.000	1.043	0.460	0.000
2	0.942	-1.015	0.000	0.000	0.000	0.000	0.000
з	0.965	2.019	0.900	0.436	0.000	0.000	0.000
Tota	1		0.900	0.436	1.043	0.460	0.000

Lir	ne	Power at	bus & li	ne flow	Line	loss	Transformer
from	to	MU	Mvar	MVA	MW	Mvar	tap
1		1.043	0.460	1.140			
	2	1.043	0.460	1.140	0.143	0.082	
2		0.000	0.000	0.000			
	1	-0.900	-0.379	0.976	0.143	0.082	
	3	0.900	0.379	0.976	-0.000	-0.057	
3		-0.900	-0.436	1.000			
	2	-0.900	-0.436	1.000	-0.000	-0.057	
Total	loss				0.143	0.024	

APPENDIX VII

Source code for the 150 % loading

and compensation location and value are 100%

<pre>Name : Muhammad Azizi bin Mohd Wahidi Title : Analysis on Losses Reduction with Series Capacitor Compensation in Distribution Network SV : IR Mohd Faris bin Abdullah Case : Compensation's location at 100 km Value of compensation is 100% Load : 150% (1 MVA) *Base power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm %Line resistance = 0.161 ohm/km, Line reactance = 10.0924 ohm/km , Line can %Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; %Bus Bus Voltage AngleLoadGeneratorInjected No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 2 0 1 0.0 1.35 0.654 0 0 0 0 0]; Line code %Bus bus R X 1/2 B = 1 for lines</pre>												
<pre>Title : Analysis on Losses Reduction with Series Capacitor Compensation in Distribution Network SV : IR Mohd Faris bin Abdullah Case : Compensation's location at 100 km Value of compensation is 100% Load : 150% (1 MVA) % Ease power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm % Load : 150% (1 MVA) % Ease power = 0.161 ohm/km, Line reactance = i0.0924 ohm/km , Line cat % Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; % Bus Bus Voltage AngleLoadGeneratorInjected % No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 0 2 0 1 0.0 1.35 0.654 0 0 0 0 0]; % Line code % Bus bus R X 1/2 B = 1 for lines % n1 nr p.u. p.u. p.u. >1 or<1 tr. tap at bus n1 linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00000 1]; % Forms the bus admittance matrix % lfgauss % Power flow solution by Newton-Raphson method % Here the solution by Newton-Raphson method % Power flow solution by Newton-Raphson method % String % Power flow solution by Newton-</pre>	%clear											
<pre>Compensation in Distribution Network SV : IR Mohd Faris bin Abdullah Case : Compensation's location at 100 km Value of compensation is 100% Load : 150% (1 MVA) Base power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm Load : 150% (1 MVA) Base power = 0.161 ohm/km, Line reactance = 10.0924 ohm/km , Line cat Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; Bus Bus Voltage AngleLoadGeneratorInjected No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; Line code Bus bus R X 1/2 B = 1 for lines Inl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00000 1]; Ifybus</pre>	*	Name	1	Muhamma	d Aziz:	i bin	n Mohd Wa	hidi				
<pre>SV : IR Mohd Faris bin Abdullah Case : Compensation's location at 100 km Value of compensation is 100% Load : 150% (1 MVA) %Base power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm %Line resistance = 0.161 ohm/km, Line reactance = i0.0924 ohm/km , Line case %Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; % Bus Bus Voltage AngleLoadGeneratorInjected % No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; % Line code % Bus bus R X 1/2 B = 1 for lines % nl nr p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00005 1]; lifybus % Forms the bus admittance matrix % lfgauss % Power flow solution by Newton-Raphson method % % % Power flow solution by Newton-Raphson method % % % % % % % % % % % % % % % % % % %</pre>	*	Titl	e :	Analysia	s on Lo	osses	s Reducti	on wi	th Se	ries (Capac	itor
Case : Compensation's location at 100 km Value of compensation is 100% Load : 150% (1 MVA) *Base power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm *Line resistance = 0.161 ohm/km, Line reactance = i0.0924 ohm/km , Line ca *Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; * Bus Bus Voltage AngleLoadGeneratorInjected * No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; * Line code * Bus bus R X 1/2 B = 1 for lines * nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00005 1]; lifybus * Forms the bus admittance matrix * lifgauss * Power flow solution by Newton-Raphson method * hower flow solution by Newton-Raphson method * power %	\$			Compense	ation :	in D:	istributi	on Ne	twork			
Value of compensation is 100% Load : 150% (1 MVA) % Load : 0.061 ohm/km, Line reactance = 10.0924 ohm/km, Line cata % Capacitor compensation = 100%, Distance = 100km, PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; % Bus Bus Voltage AngleLoadGeneratorInjected % No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; % Bus bus R X 1/2 B = 1 for lines % nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl	*	SV	1	IR Mohd	Faris	bin	Abdullah	1				
<pre>Load : 150% (1 MVA) % Load : 150% (1 MVA) % Base power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm % Line resistance = 0.161 ohm/km, Line reactance = 10.0924 ohm/km , Line cat % Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; % Bus Bus Voltage AngleLoadGeneratorInjected % No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; % Line code % Bus bus R X 1/2 B = 1 for lines % nl nr p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00000 1]; lfybus</pre>	*	Case		Compense	ation's	3 loo	cation at	100	km			
*Base power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm *Line resistance = 0.161 ohm/km, Line reactance = 10.0924 ohm/km , Line cay *Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; * Bus Bus Voltage AngleLoadGeneratorInjected * No code Mag. Degree MW Mvar NW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; * Line code * Bus bus R X 1/2 B = 1 for lines * In nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl	*			Value o:	f compe	ensat	tion is 1	.00%				
<pre>%Line resistance = 0.161 ohm/km, Line reactance = 10.0924 ohm/km, Line cay %Capacitor compensation = 100%, Distance = 100km, PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; % Bus Bus Voltage AngleLoadGeneratorInjected % No code Mag. Degree MW Mvar NW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; % Line code % Bus bus R X 1/2 B = 1 for lines % nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00000 1]; lfybus % Forms the bus admittance matrix %lfgauss % Power flow solution by Newton-Raphson method %decouple % Power flow solution by Newton-Raphson method %decouple % Power flow solution by Newton-Raphson method busout % Prints the power flow solution on the screen</pre>	*			Load : 3	150% (:	1 MVJ	A.)					
<pre>%Capacitor compensation = 100%, Distance = 100km , PF = 0.9 lagging basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; % Bus Bus Voltage AngleLoadGeneratorInjected % No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; % Line code % Bus bus R X 1/2 B = 1 for lines % nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00005 1]; lfybus % Forms the bus admittance matrix %lfgauss % Power flow solution by Newton-Raphson method lfnewton % Power flow solution by Newton-Raphson method %decouple % Power flow solution by Newton-Raphson method busout % Prints the power flow solution on the screen</pre>	%Base po	wer :	= 1 M	VA , Base	e volta	age =	= 11 kV ,	Base	e impe	dance	= 12	1 ohm
<pre>basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60; Bus Bus Voltage AngleLoadGeneratorInjected No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0 0]; Line code Bus bus R X 1/2 B = 1 for lines nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00000 1]; Ifybus</pre>	%Line re	sist	ance	= 0.161 (ohm/km,	, Lii	ne reacta	ince =	i0.0	924 ol	um/ km	, Line ca
* Bus Bus Voltage Angle Load GeneratorInjected * No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0]; * Line code * Bus bus R X 1/2 B = 1 for lines * * nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl	%Capacit	or c	ompen:	sation =	100% ,	, Dis	stance =	100 km	n, PF	= 0.9) lag	ging
* Bus Bus Voltage Angle Load GeneratorInjected * No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0]; * Line code * Bus bus R X 1/2 B = 1 for lines * * nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl * linedata=[1 2 0.13306 0.07636 0.00005 1 * * * lfybus * Forms the bus admittance matrix * * * * * lfybus * Forms the bus admittance matrix * * * * * * Power flow solution by Newton-R												
* Bus Bus Voltage Angle Load GeneratorInjected * No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0]; * Line code * Bus bus R X 1/2 B = 1 for lines * * nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl * linedata=[1 2 0.13306 0.07636 0.00005 1 * * * lfybus * Forms the bus admittance matrix * * * * * lfybus * Forms the bus admittance matrix * * * * * * Power flow solution by Newton-R												
* Bus Bus Voltage Angle Load GeneratorInjected * No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 2 0 1 0.0 0 0 0 0 0 0 3 0 1 0.0 1.35 0.654 0 0 0 0]; * Line code * Bus bus R X 1/2 B = 1 for lines * * nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl	basemva	= 1;	acci	uracv = (0.0001;	aco	cel = 1.6	; ma	xiter	= 60;		
No code Mag. Degree NW Mvar NW Mvar Qmin Qmax Mvar busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <td></td> <td></td> <td></td> <td>-</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>				-								
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2 0 1 0.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	*	No	code	Mag.	Degree	e MU	J Mvar	MW	Mvar	Qmin	Qmax	Mvar
3 0 1 0.0 1.35 0.654 0 0 0 0]; * Line code * Bus bus R X 1/2 B = 1 for lines * nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl	busdata=	[1	1	1.1	0.0	() 0	0	0	0	0	0
Line code Line code		-	-	-		() 0	-	-	-	-	0
Bus bus R X 1/2 B = 1 for lines nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00000 1]; Ifybus & Forms the bus admittance matrix %Ifgauss & Power flow solution by Newton-Raphson method lfnewton & Power flow solution by Newton-Raphson method %decouple & Power flow solution by Newton-Raphson method busout & Prints the power flow solution on the screen		3	0	1	0.0	1.35	5 0.654	0	0	0	0	0];
Bus bus R X 1/2 B = 1 for lines nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00000 1]; Ifybus & Forms the bus admittance matrix %Ifgauss & Power flow solution by Newton-Raphson method lfnewton & Power flow solution by Newton-Raphson method %decouple & Power flow solution by Newton-Raphson method busout & Prints the power flow solution on the screen												
<pre>nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl linedata=[1 2 0.13306 0.07636 0.00005 1 2 3 0.00000 -0.07636 0.00000 1]; lfybus</pre>	*							Line	code			
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2 3 0.00000 -0.07636 0.00000 1]; lfybus & Forms the bus admittance matrix %lfgauss & Power flow solution by Newton-Raphson method lfnewton & Power flow solution by Newton-Raphson method %decouple & Power flow solution by Newton-Raphson method busout & Prints the power flow solution on the screen	÷	nl	\mathbf{nr}	p.u.	p.u.		p.u.	>1 o	or<1 t	r. tap) at 3	bus nl
Ifybus % Forms the bus admittance matrix % Ifgauss % Power flow solution by Newton-Raphson method Ifnewton % Power flow solution by Newton-Raphson method % decouple % Power flow solution by Newton-Raphson method busout % Prints the power flow solution on the screen	linedata	a=[1	2	0.13306	0.070	536	0.00005	1				
*Ifgauss & Power flow solution by Newton-Raphson method Ifnewton & Power flow solution by Newton-Raphson method *decouple & Power flow solution by Newton-Raphson method busout & Prints the power flow solution on the screen		2	3	0.00000	-0.070	536	0.00000	1];				
*Ifgauss & Power flow solution by Newton-Raphson method Ifnewton & Power flow solution by Newton-Raphson method *decouple & Power flow solution by Newton-Raphson method busout & Prints the power flow solution on the screen												
*Ifgauss & Power flow solution by Newton-Raphson method Ifnewton & Power flow solution by Newton-Raphson method *decouple & Power flow solution by Newton-Raphson method busout & Prints the power flow solution on the screen	l fiele u e				*			land to the sec				
Ifnewton & Power flow solution by Newton-Raphson method &decouple & Power flow solution by Newton-Raphson method busout & Prints the power flow solution on the screen	-		». П.								a	
<pre>%decouple % Power flow solution by Newton-Raphson method busout % Prints the power flow solution on the screen</pre>							-				1	
busout % Prints the power flow solution on the screen												
	-	Le l										
ineriow 👒 computes and displays the line flow and losses					- C							
And Comments Ideasans and an annual Ideasates					-			I10M	and 1	osses		

% (b) Comment lfgauss and uncomment lfnewton
 % (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX VIII

Simulation for the 150 % loading and compensation location and value are 100%

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 8.4903e-006 No. of Iterations = 4

Voltage	Angle	Loa	ad	Genera	ation	Injected
Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1.100	0.000	0.000	0.000	1.724	0.654	0.000
0.847	-2.744	0.000	0.000	0.000	0.000	0.000
0.895	5.071	1.350	0.654	0.000	0.000	0.000
1		1.350	0.654	1.724	0.654	0.000
	Mag. 1.100 0.847 0.895	Mag. Degree 1.100 0.000 0.847 -2.744 0.895 5.071	Mag. Degree NW 1.100 0.000 0.000 0.847 -2.744 0.000 0.895 5.071 1.350	Mag. Degree MW Mvar 1.100 0.000 0.000 0.000 0.847 -2.744 0.000 0.000 0.895 5.071 1.350 0.654	Mag. Degree MW Mvar MW 1.100 0.000 0.000 0.000 1.724 0.847 -2.744 0.000 0.000 0.000 0.895 5.071 1.350 0.654 0.000	Mag. Degree NW Mvar MW Mvar 1.100 0.000 0.000 0.000 1.724 0.654 0.847 -2.744 0.000 0.000 0.000 0.000 0.895 5.071 1.350 0.654 0.000 0.000

Lir	ne	Power at	bus & li	ne flow	Line	loss	Transformer
from	to	MU	Mvar	MVA	MW	Mvar	tap
1		1.724	0.654	1.844			
	2	1.724	0.654	1.844	0.374	0.214	
2		0.000	0.000	0.000			
	1	-1.350	-0.439	1.420	0.374	0.214	
	3	1.350	0.439	1.420	0.000	-0.215	
3		-1.350	-0.654	1.500			
	2	-1.350	-0.654	1.500	0.000	-0.215	
Total	loss				0.374	-0.000	

APPENDIX IX

Source code for the 150 % loading

and compensation location and value are 100% and 0 % respectively

%clear

.orcor												
*	Name	1.1	Muhamma	d Azizi	i bin	Mohd W	ahidi					
*	Titl	e :	Analysi:	s on Lo	osses	Reduct	ion w	ith Se	ries C	apac	itor	
÷			Compens	ation i	in Di	stribut	ion N	etwork	:			
÷	sv	1.1	IR Mohd	Faris	bin	Abdulla	h					
÷	Case	1.1	Compensa	ation's	s loc	ation a	t 100	km				
*			Value of	f compe	ensat	ion is	0%					
*			Load :	150% (1	L MVA	.)						
Base po	wer	= 1 M	VA , Bas	e volta	are =	11 kV	. Bas	e impe	dance	= 12:	1 ohm	
			= 0.161		-							e ca
%Capacit	or c	ompen	sation =	100%	Dis	tance =	100k	m , PF	= 0.9	lag	aina	
asemva	= 1:	acc	uracy =	0.0001:	aco	el = 1.	6: m	axiter	= 60:			
			4				,					
*	Bus	Bus	Voltage	Angle		-Load		Gen	erator		-Injec	ted
*	No	code	Mag.	Degree	e MW	Mva	r MW	Mvar	Qmin	Qmax	Mvar	
busdata=	[1	1	1.1	0.0	0	0	0	0	0	0	0	
	2	0	1	0.0	1.35	0.654	0	0	0	0	0];	
4							Lin	e code				
* *	Bu	s bus	R	x		1/2 B		for 1				
*		s Dus nr		л р.u.		1/2 Б р.u.			r. tap	at 1	oue pl	
` linedata		2	p.u. 0.13306			0.00005			r. cap	ati	Jub III	
rineuate	ι-[I	4	0.13300	0.076		0.00005	±].					
lfybus				* Form	ns th	e bus a	dmitte	ance m	atrix			
<pre>%lfgauss</pre>	;	% ₽	ower flo	w solut	ion	by Newt	on-Raj	phson	method	L		
lfnewtor	1 -	8 Pow	er flow :	solutio	on by	Newton	-Raph:	son me	thod			
%decoup1	.e	% Po	wer flow	soluti	ion b	y Newto:	n-Rapi	hson m	ethod			
busout			ints the									
lineflow	л ÷		utes and	-								
		-	aves and	-	-							

(b) Comment lfgauss and uncomment lfnewton
 (c) Comment lfgauss and lfnewton and uncomment decouple

71

APPENDIX X

Simulation for the 150 % loading

and compensation location and value are 100% and 0 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 2.73751e-005 No. of Iterations = 4

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1	1.100	0.000	0.000	0.000	1.795	0.910	0.000
2	0.820	-1.021	1.350	0.654	0.000	0.000	0.000
Tota	1		1.350	0.654	1.795	0.910	0.000

							Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
1		1.795	0.910	2.013			
	2	1.796	0.910	2.013	0.446	0.256	
2		-1.350	-0.654	1.500			
	1	-1.350	-0.654	1.500	0.446	0.256	
Total	loss				0.446	0.256	

APPENDIX XI

Source code for the 0.8 lagging power factor load and compensation location and value are 100%

%clear											
	Name					Mohd Wal					
8	Titl	e :	Analysi:	s on Lo:	sses	Reductio	on wi	th Se	ries (apac:	itor
*			Compense	ation in	n Di	stributio	on Ne	twork			
*	sv		IR Mohd	Faris B	oin	Abdullah					
*	Case		Compense	ation's	loc	ation at	100	km			
*						ion is 10	00%				
*			Power Fa	actor :	0.8	lagging					
%Base po	wer	= 1 M	VA , Base	e volta	ge =	11 kV ,	Base	impe	dance	= 123	1 ohm
%Line re	sist	ance :	= 0.161 (ohm/km,	Lin	e reactai	nce =	i0.0	924 oł	ım/ km	, Line
%Capacit	or c	ompen	sation =	100% ,	Dis	tance = 3	100 km	n , PF	= 0.9) lag	ging
basemva	= 1;	acci	uracy = (0.0001;	acc	el = 1.6.	; ma	xiter	= 60;		
	Deer	D				T1		<i>a</i>		_	Turinan
*			-	-		-Load					-
·		code 1	Mag. 1.1	Degree 0.0	nw O		nw O	nvar 0	Qmin O	Qmax	nvar O
busdata=	2		1.1		-	-	-	0	-	-	0
	3	0 0	1	0.0	0	0.600	-	0	0	-	-
	3	U	T	0.0 (J.80	0.600	U	U	U	U	0];
÷							Line	code			
*	Bu	s bus	R	Х		1/2 B	= 1	for 1	ines		
*	nl	nr	p.u.	p.u.		p.u.	>1 0	or<1 t	r. tap	at B	ous nl
linedata	=[1	2	0.13306	0.0763	36	0.00005	1				
	2	3	0.00000	-0.0763	36	0.00000	1];				
lfybus						e bus adı					
					ion '	by Newton	n-Rap	hson	method	ł	
%lfgauss			ower flo								
lfnewton		% Pow	er flow :	solution	n by	Newton-1	-				
-		% Pow	er flow :	solution	n by		-				
lfnewton		% Pow % Po™	er flow : wer flow	solution solution	n by on b	Newton-1	-Raph	nson m	ethod		
lfnewton %decoupl	e	* Pow * Po * Po * Pr	er flow : wer flow ints the	solution solution power :	n by on b flow	Newton-1 y Newton-	-Raph n on	nson m the s	ethod creen		
lfnewton %decoupl busout	e *	<pre>% Pow % Poi % Poi % Pr Compi </pre>	er flow : wer flow ints the utes and	solution solution power : display	n by on b flow ys t	Newton-J y Newton- solution he line :	-Raph n on flow	nson m the s	ethod creen		

APPENDIX XII

Simulation for the 0.8 lagging power factor load and compensation location and value are 100%

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 2.93958e-008 No. of Iterations = 4

Bus	Voltage	Angle	Los	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1	1.100	0.000	0.000	0.000	0.936	0.600	0.000
2	0.945	0.461	0.000	0.000	0.000	0.000	0.000
з	0.989	4.206	0.800	0.600	0.000	0.000	0.000
Tota	1		0.800	0.600	0.936	0.600	0.000

Lir	ne	Power at	bus & li	ine flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
1		0.936	0.600	1.112			
	2	0.936	0.600	1.112	0.136	0.078	
2		0.000	0.000	0.000			
	1	-0.800	-0.522	0.955	0.136	0.078	
	3	0.800	0.522	0.955	0.000	-0.078	
3		-0.800	-0.600	1.000			
	2	-0.800	-0.600	1.000	0.000	-0.078	
Total	loss				0.136	-0.000	

APPENDIX XIII

Source code for the 0.8 lagging power factor load and compensation location and value are 100% and 0 % respectively

%clear															
*	Name		Muhammac	a Azizi bi	in Mohd Wa	hidi									
4	Title				es Reducti		th Se	ries (Capaci	tor					
*)istributi										
*	sv				n Abdullah										
*	Case				cation at		km								
*					ation is O										
\$				-	8 lagging										
2 Baga 1	nower = 1	- M32	/) Bage	a voltare	= 11 kV ,	Bage	imne	dance	= 121	ohm					
	-			-	ine reacta						ne ca	nacit	ance =	0.35	uF/km
					istance =					· · · ·		pacro	anoc	0.00	ur / 140
.capac.	reor comp		acton	100. , 01	boance	100/46	,	0	/ Iugg	ing					
basemv	a = 1: a	accu	urac⊽ = C	1.0001: ac	cel = 1.6	: ma	xiter	= 60							
Dabenit	, .		itaoy c	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		, 100			,						
÷	Bus Bu	18	Voltage	Angle -	Load		Gen	erato		Injed	ted				
÷	No co			Degree M					Qmax	_					
busdata	a=[1 1		1.1	0.0	o 0	Ο	Ο	ο	0	0					
	2 0		1	0.0 0.8	30 0.600	Ο	ο	ο	ο	01 2					
										-					
÷						Line	code								
÷	Bus b	ous	R	X	1/2 B	= 1	for 1	ines							
÷	nl r	nr	p.u.	p.u.	p.u.	>1 o	r<1 t	r. taj) at b	us ni	L				
linedat	ta=[1 2	2	0.13306	0.07636	0.00005	1];									
	-					-									
lfybus				% Forms t	he bus ad	mitta	nce m	atrix							
*lfgau	55 ¥	; Po	wer flou	, solutior	n by Newto	n-Rap	hson	metho	1						
lfnewto	on % F	owe	r flow s	solution k	y Newton-	Raphs	on me	thod							
*decou					by Newton										
busout	-				w solutio										
				•	the line										

busout % Prints the power flow solution on the solution lineflow % Computes and displays the line flow and losses % (b) Comment lfgauss and uncomment lfnewton

% (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XIV

Simulation for the 0.8 lagging power factor load and compensation location and value are 100% and 0 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 3.68961e-009 No. of Iterations = 4

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1	1.100	0.000	0.000	0.000	0.951	0.687	0.000
2	0.937	1.041	0.800	0.600	0.000	0.000	0.000
Tota	1		0.800	0.600	0.951	0.687	0.000

Lir	ne	Power at	bus & lin	ne flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MU	Mvar	tap
1		0.951	0.687	1.173			
	2	0.951	0.687	1.173	0.151	0.087	
2		-0.800	-0.600	1.000			
	1	-0.800	-0.600	1.000	0.151	0.087	
Total	loss				0.151	0.087	

APPENDIX XV

Source code for the overcompensation condition and compensation location and value are 100% and 300 % respectively

%clear											
\$	Name	:	Muhamma	d Aziz	i bin	n Mohd Wa	hidi				
*	Titl	e :	Analysi	s on L	osses	Reducti	on wi	th Sei	ries (Capaci	itor
*			Compense	ation :	in Di	stributi	on Ne	twork			
*	sv		IR Mohd	Faris	bin	Abdullah	L .				
*	Case		Compense	ation':	s loc	ation at	100	km			
*			Value o:	E comp	ensat	ion is 3	00%				
⊹Base po	wer	= 1 MV	VA , Base	e volta	age =	11 kV ,	Base	e impe	dance	= 121	Lohm
∘ %Line re	sist	ance :	= 0.161 (ohm/km	, Lin	ne reacta	ince =	i0.09	924 oł	um/ km	, Line
%Capacit	or c	ompen	sation =	100%	, Dis	stance =	100 km	a, PF	= 0.9) lago	ging
basemva	= 1;	acci	uracv = (.0001	: acc	el = 1.6	; ma	xiter	= 60;		
			-								
\$	Bus	Bus	Voltage	Angle		-Load		Gene	erator		Injecte
*	No	code	Mag.	Degree	e Mu	J Mvar	MU	Mvar	Qmin	Qmax	Mvar
busdata=	[1	1	1.1	0.0	0) 0	0	0	0	0	0
	2	0	1	0.0	0) 0	0	ο	ο	0	0
	3	0	1	0.0	0.90	0.436	0	0	0	0	0];
4							Line	code			
*	Bu	s bus	R	х		1/2 B	= 1	for 1:	ines		
*	nl	nr	p.u.	p.u.		p.u.				atk	ous nl
linedata			-			0.00005					
	2	3				0.00000	1];				
	-	-					-17				
lf⊽bus				* For	wa th	ne bus ad	mitto		striv		
-										,	
<pre>%lfgauss</pre>						by Newto	-			ı	
lfnewton						7 Newton-					
%decoup1	e					y Newton					
busout				-		J SOlutio					
lineflow					-	he line		and lo	osses		
k (b) Co:	mmen	t lfq:	auss and	uncom	ment	lfnewton	1				

(b) Comment lfgauss and uncomment lfnewton
 (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XVI

Simulation for the overcompensation condition and compensation location and value are 100% and 300 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 1.82588e-006 No. of Iterations = 4

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected		
No.	Mag.	Degree	MW Mvar		MW	Mvar	Mvar		
1	1.100	0.000	0.000	0.000	1.025	0.292	0.000		
2	0.956	-2.143	0.000	0.000	0.000	0.000	0.000		
3	1.032	9.914	0.900	0.436	0.000	0.000	0.000		
Tota	1		0.900	0.436	1.025	0.292	0.000		

Lin	ie	Power at	bus & li	ne flow	Line	loss	Transformer
from	to	MU	Mvar	MVA	MW	Mvar	tap
1		1.025	0.292	1.066			
	2	1.025	0.292	1.066	0.125	0.072	
2		0.000	0.000	0.000			
	1	-0.900	-0.221	0.927	0.125	0.072	
	3	0.900	0.221	0.927	0.000	-0.215	
3		-0.900	-0.436	1.000			
	2	-0.900	-0.436	1.000	0.000	-0.215	
Total	loss				0.125	-0.144	

APPENDIX XVII

Source code for the network with 33 kV voltage level and compensation location and value are 0% and 100 % respectively

*	· · · · · · · · · · · · · · · · · · ·															
÷	Title	e :	Analysi	s on Los	ses Re	ductio	n wi	th Sei	ries C	apaci	tor					
*			Compens	ation in	n Distr	ibutio	n Ne	twork								
*	sv		IR Mohd	Faris k	in Abd	ullah										
*	Case		Compens	ation's	locati	on at	0 km									
÷			Value o	f comper	sation	is 10	10%									
*Base po	ower :	= 1 M	VA , Bas	e voltag	je = 33	kV ,	Base	impe	dance	= 108	9 ohm					
%Line re	esista	ance	= 0.161	ohm/km,	Line r	eactan	ice =	i0.10	05 ohm	/km ,	Line	capa	citance	e = 0.23	2 uF/k	m
%Capacit	cor co	ompen	sation =	100% ,	Distan	ce = 1	.00 km	, PF	= 0.9	lage	ring					
basemva	= 1;	acc	uracy =	0.0001;	accel	= 1.6;	ma	xiter	= 60;							
\$	Bus	Bus	Voltage	Angle	Lo	ad		Gen	erator		Inject	ted				
4			Mag.	Degree					Omin		-					
busdata-		1	1	0.0	0	0	0	0	0	0	0					
	2	0	1	0.0	0	0	0	0	o	0	0					
	3	0	1	0.0 0	.90 O	.436	0	0	0	0	0];					
*							Line	code								
4	Bus	s bus	R	x	1/2			for 1:	ines							
*			p.u.	p.u.	p.u				r. tap	at b	us nl					
linedata			-	-0.0096												
	2	3		0.0096				1;								
	-	-					-									
lfybus				% Forms												
%lfgaus:			ower flo		-		-									
lfnewton			er flow													
%decoup:	ie.		wer flow													
busout			ints the	- C.												
lineflo			utes and					ana 1	Jases							

% (b) Comment lfgauss and uncomment lfnewton

%clear

 $\ensuremath{\mathfrak{s}}$ (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XVIII

Simulation for the network with 33 kV voltage level and compensation location and value are 0% and 100 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 2.4564e-006 No. of Iterations = 3

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1	1.000	0.000	0.000	0.000	0.915	0.436	0.000
2	1.004	0.503	0.000	0.000	0.000	0.000	0.000
3	0.986	0.374	0.900	0.436	0.000	0.000	0.000
Total		0.900	0.436	0.915	0.436	0.000	

Lir	ie	Power at	bus & li	ne flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
1		0.915	0.436	1.014			
	2	0.915	0.436	1.014	0.000	-0.010	
2		0.000	0.000	0.000			
	1	-0.915	-0.446	1.018	0.000	-0.010	
	3	0.915	0.446	1.018	0.015	0.010	
3		-0.900	-0.436	1.000			
	2	-0.900	-0.436	1.000	0.015	0.010	
Total	loss				0.015	-0.000	

APPENDIX XIX

Source code for the network with 33 kV voltage level and compensation location and value are 100% and 80 % respectively

%clear												
	Name		Muhamma									
*	Titl	e :	Analysi							apac:	itor	
*						stributi		twork				
*	sv		IR Mohd	Faris	bin <i>i</i>	Abdullah						
*	Case		Compens	ation'	s loca	ation at	100	km				
*			Value o	f comp	ensat:	ion is 8	0%					
%Base po	wer	= 1 M	VA , Bas	e volt	age =	33 kV ,	Base	impe	dance	= 108	39 ohm	
%Line re	sist	ance	= 0.161	ohm/km	, Line	e reacta:	nce =	i0.1	05 ohm	/ km ,	, Line	capa
%Capacit	or c	ompen:	sation =	100%	, Dist	ance =	100 km	, PF	= 0.9	lag	ging	
basemva	= 1;	acc	uracy =	0.0001	; acce	el = 1.6	; ma	xiter	= 60;			
*	Bus	Bus	Voltage	Angle		-Load		Gen	erator		-Injec	ted
*	No	code	Mag.	Degre	e MW	Mvar	MW	Mvar	Qmin	Qmax	Mvar	
busdata=	[1	1	1	0.0	0	0	0	0	0	0	0	
	2	0	1	0.0	0	0	0	0	0	0	0	
	3	0	1	0.0	0.90	0.436	0	0	0	0	0];	
*								code				
* *	Pu	s bus	R	x		L/2 B		for 1	inea			
2 4		nr		p.u.		0.u.				at 1	ous nl	
` linedata			0.01478						. cap	acs	Jus III	
IIneuata	2		0.00000					1;				
	4	5	0.00000	-0.00	//I (U 1	1.				
lf⊽bus				<pre>% For</pre>	ms the	e bus adı	mitta	nce m	atrix			
%lfgauss		% Pi	ower flo									
lfnewton			er flow			-						
%decoup1			wer flow									
busout	-		ints the									
lineflow	<u>×</u>		utes and									
TIMETION		Comp	uces and	urspr	ays ti	ie iine .	1100	and 1	Jabes			

(b) Comment lfgauss and uncomment lfnewton

 $\ensuremath{\overset{}_{\scriptscriptstyle -}}$ (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XX

Simulation for the network with 33 kV voltage level and compensation location and value are 100% and 80 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 1.33387e-005 No. of Iterations = 3

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected		
No.	Mag.	Degree	MW	MW Mvar		Mvar	Mvar		
1	1.000	0.000	0.000	0.000	0.915	0.438	0.000		
2	0.982	-0.137	0.000	0.000	0.000	0.000	0.000		
3	0.986	0.274	0.900	0.436	0.000	0.000	0.000		
Tota	1		0.900	0.436	0.915	0.438	0.000		

Lir	1e	Power at	bus & li	ne flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
1		0.915	0.438	1.015			
	2	0.915	0.438	1.015	0.015	0.010	
2		0.000	0.000	0.000			
	1	-0.900	-0.428	0.997	0.015	0.010	
	3	0.900	0.428	0.997	0.000	-0.008	
3		-0.900	-0.436	1.000			
	2	-0.900	-0.436	1.000	0.000	-0.008	
Total	loss				0.015	0.002	

APPENDIX XXI

Source code for the network with 33 kV voltage level and 500 % loading and compensation location and value are 100%

%clear												
\$	Name					Mohd Wah						
*	Titl	e :	Analysi:	s on Lo:	sses	Reductio	n wi	th Se	ries C	apac:	itor	
*			Compense	ation i:	n Dis	tributio	n Ne	twork				
*	sv		IR Mohd	Faris 1	oin A	bdullah						
*	Case		Compense	ation's	loca	tion at	100	km				
*			Value o:	f compe:	nsati	on is 10	0%					
*Base po	wer	= 1 M	VA , Base	e volta	ge =	33 kV ,	Base	impe	dance	= 108	39 ohm	
%Line re	sist	ance	= 0.161 (ohm/km,	Line	reactan	ce =	i0.1	05 ohm	/ km ,	, Line	capa
%Capacit	or c	ompen:	sation =	100% ,	Dist	ance = 1	00 km	n , PF	= 0.9	lage	ging	
basemva	= 1;	acci	uracy = (0.0001;	acce	1 = 1.6;	mε	xiter	= 60;			
			-									
÷	Bus	Bus	Voltage	Angle		Load		Gen	erator		-Inject	ted
*	No	code	Mag.	Degree	MW	Mvar	MW	Mvar	Qmin	Qmax	Mvar	
busdata=	[1	1	1	0.0	0	0	0	0	0	0	0	
	2	0	1	0.0	0	0	0	0	0	0	0	
	3	0	1	0.0	4.50	2.180	0	0	0	0	0];	
4							Line	code				
*	p	s bus	R	x				for 1				
*		s bus nr								at 1	ous nl	
⊸ linedata		2		p.u.		.u. .0000000			r. cap	aur	Jus III	
rineuata	2	3				.00000032		.1;				
	4	3	0.014/0	0.009	u-r U		1	·1 /				
lfybus				* Form	s the	bus adm	itta	nce m	atrix			
*lfgauss		* P	ower flo	w solut	ion b	y Newton	-Rap	hson i	method			
lfnewton						Newton-R						
%decoup1						Newton-	-					
busout						solution						
lineflow				•		e line f						
			auss and				200	Carlos I.				
• (b) CO	manell	o irigi	aabb anu	ancontin	Luc I	Line wooll						

 $\ensuremath{\hat{\ast}}$ (b) Comment lfgauss and uncomment lfnewton $\ensuremath{\hat{\ast}}$ (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XXII

Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and value are 100%

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 8.60752e-008 No. of Iterations = 4

Bus	Voltage	Angle	Lo	ad	Genera	ation	Injected		
No.	Mag.	Degree	MW Mvar		MU	Mvar	Mvar		
1	1.000	0.000	0.000	0.000	4.929	2.180	0.000		
2	1.022	2.665	0.000	0.000	0.000	0.000	0.000		
з	0.928	1.990	4.500	2.180	0.000	0.000	0.000		
Tota	1		4.500	2.180	4.929	2.180	0.000		

Lir	ne	Power at	bus & li	ne flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
		4 000	0 100	F 200			
1		4.929	2.180	5.390			
	2	4.929	2.180	5.390	0.000	-0.280	
2		0.000	0.000	0.000			
	1	-4.929	-2.460	5.509	0.000	-0.280	
	3	4.929	2.460	5.509	0.429	0.280	
3		-4.500	-2.180	5.000			
	2	-4.500	-2.180	5.000	0.429	0.280	
Total	loss				0.429	-0.000	

APPENDIX XXIII

Source code for the network with 33 kV voltage level and 500 % loading and compensation location and value are 100% and 0 % respectively

%clear		· West-summed beder Wested Wested							
*	Name	: Muhammad Azizi bin Mohd Wahidi							
*	Title								
*	* Compensation in Distribution Network								
	SV	: IR Mohd Faris bin Abdullah							
*	Case	: Compensation's location at 100 km							
*		Value of compensation is 0%							
4 Pogo	nover = ·	MVA , Base voltage = 33 kV , Base impedance = 1089 ohm							
	-	<pre>mvk , Base voltage = 33 kV , Base impedance = 1009 0nm e = 0.161 ohm/km, Line reactance = i0.105 ohm/km , Line capacitance = 0.22 uF/k</pre>							
		ensation = 100% , Distance = 100km , PF = 0.9 lagging	10						
scapac	ICOL COM	ensation - 100% , Distance - 100Am , Fr - 0.9 Tagging							
hasemu	a = 1• s	ccuracy = 0.0001; accel = 1.6; maxiter = 60;							
Dabeniy	u 1, (coaraby c.cocr, about 1.0, Maxice 00,							
*	Bus Bi	s Voltage AngleLoadGeneratorInjected							
*		de Mag. Degree NW Mvar NW Mvar Qmin Qmax Mvar							
	a=[1 1								
Dabaao	2 0								
*		Line code							
*	Bus B	us R X 1/2 B = 1 for lines							
*	nlı	r p.u. p.u. p.u. >1 or<1 tr. tap at bus nl							
lineda	ta=[1 2	0.01478 0.00964 0.0000032 1];							
	-	-							
lfybus		% Forms the bus admittance matrix							
%lfgau	ss :	Power flow solution by Newton-Raphson method							
lfnewt	on 👘	ower flow solution by Newton-Raphson method							
*decou	ple 🐐	Power flow solution by Newton-Raphson method							
busout	÷	Prints the power flow solution on the screen							
linefl	ow % Co	mputes and displays the line flow and losses							
% (b)	Comment :	fgauss and uncomment lfnewton							
* (C)	Comment :	- fgauss and lfnewton and uncomment decouple							

APPENDIX XXIV

Simulation for the network with 33 kV voltage level and 500 % loading and compensation location and value are 100% and 0 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 6.21229e-007 No. of Iterations = 4

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected
No.	Mag.	Degree	MU	Mvar	MW	Mvar	Mvar
1	1.000	0.000	0.000	0.000	4.953	2.476	0.000
2	0.903	-0.708	4.500	2.180	0.000	0.000	0.000
Tota	1		4.500	2.180	4.953	2.476	0.000

Lir from		Power at MW	bus & lin Mvar	ne flow MVA	Line MW	loss Mvar	Transformer tap
11 Olu		110	nvar	MVA	1100	nvar	cap
1		4.953	2.476	5.537			
	2	4.953	2.476	5.537	0.453	0.296	
2		-4.500	-2.180	5.000			
	1	-4.500	-2.180	5.000	0.453	0.296	
Total	loss				0.453	0.296	

APPENDIX XXV

Source code for the network with 185 mm² cable size and 150 % loading and compensation location and value are 100%

%clear											
	Vame	-				Mohd Wa					
	Titl	e :				Reducti				apac:	itor
*			· ·			stributi		twork			
	3V					Abdullah					
	Case		-			ation at		km			
*			Value of	t comp	ensat	ion is 1	00%				
Base por	wer :	= 1 MV	/A , Base	e volt	age =	11 kV ,	Base	impe	dance	= 12	1 ohm
Line rea	sist:	ance =	= 0.211 d	hm/km	, Lir	e reacta	nce =	i0.0	962 of	im/ km	, Line c
<pre>%Capacit</pre>	or c	ompens	sation =	100%	, Dis	tance =	100km	, PF	= 0.9	lag	ging
asemva :	= 1;	acci	uracy = (0.0001	; acc	el = 1.6	; ma	xiter	= 60;		
k.	B110	B119	Voltere	ingle		beol		Cen	arator		-Injected
• •	No	code	-	Deare				Mvar			-
busdata=		1	1.1	0.0	C		0	0	0	0	0
bubuucu	2	0	1	0.0		-	0	ō	o	ō	0
	3	0	1	0.0		0.654		ō	ō	o	0];
	Ŭ	0	-	0.0	1.00	0.001		Ŭ	Ŭ	0	01,
÷							Line	code			
*	Bu	s bus	R	x		1/2 B	= 1	for 1	ines		
*	nl	\mathbf{nr}	p.u.	p.u.		p.u.	>1 o	r < 1 t	r. tap	at l	bus nl
linedata	=[1	2	0.17438	0.07	950	0.000040	1				
	2	3	0.00000	-0.07	950	0.000000	1];				
lfybus						e bus ad					
%lfgauss						by Newto				1	
lfnewton						Newton-	-				
%decoupl(2					y Newton					
busout						solutio					
lineflow	÷	Comp	utes and	displ	ays t	he line	tlow	and l	osses		

% (b) Comment lfgauss and uncomment lfnewton

Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XXVI

Simulation for the network with 185 mm² cable size and 150 % loading and compensation location and value are 100%

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 6.81791e-008 No. of Iterations = 5

Bus	Voltage	Angle	Lo	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1	1.100	0.000	0.000	0.000	1.972	0.654	0.000
2	0.741	-3.006	0.000	0.000	0.000	0.000	0.000
3	0.794	7.501	1.350	0.654	0.000	0.000	0.000
Tota	al		1.350	0.654	1.972	0.654	0.000

Lin	ie	Power at	bus & lin	ne flow	Line	loss	Transformer
from	to	MU	Mvar	MVA	MW	Mvar	tap
1		1.972	0.654	2.078			
	2	1.972	0.654	2.078	0.622	0.284	
2		0.000	0.000	0.000			
	1	-1.350	-0.370	1.400	0.622	0.284	
	3	1.350	0.370	1.400	0.000	-0.284	
3		-1.350	-0.654	1.500			
	2	-1.350	-0.654	1.500	0.000	-0.284	
Total	loss				0.622	-0.000	

APPENDIX XXVII

Source code for the network with 185 mm² cable size and 150 % loading and compensation location and value are 100% and 0 % respectively

%clear
sciear % Name : Muhammad Azizi bin Mohd Wahidi
 Name . Autammuda X2121 Diff Mond Wantul Title : Analysis on Losses Reduction with Series Capacitor
Compensation in Distribution Network
* SV : IR Wohd Faris bin Abdullah
 System in the second sec
Value of compensation is 0%
Base power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm
%Line resistance = 0.211 ohm/km, Line reactance = 10.0962 ohm/km , Line capacitance = 0.31 uF/km
<pre>%Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging</pre>
basemva = 1; accuracy = 0.0001 ; accel = 1.6 ; maxiter = 60 ;
8 Bus Bus Voltage AngleLoadGeneratorInjected
% No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar
busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0
2 0 1 0.0 1.35 0.654 0 0 0 0 0];
% Line code
8 Bus bus R X 1/2 B = 1 for lines
% nl nr p.u. p.u. >1 or<1 tr. tap at bus nl
linedata=[1 2 0.17438 0.07950 0.000040 1];
lfybus % Forms the bus admittance matrix
<pre>% Higauss % Power flow solution by Newton-Raphson method</pre>
lfnewton & Power flow solution by Newton-Raphson method
%decouple % Power flow solution by Newton-Raphson method
busout % Prints the power flow solution on the screen

lineflow % Computes and displays the line flow and losses
% (b) Comment lfgauss and uncomment lfnewton
% (c) Comment lfgauss and lfnewton and uncomment decouple

89

APPENDIX XXVIII

Simulation for the network with 185 mm² cable size and 150 % loading and compensation location and value are 100% and 0 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 3.666e-005 No. of Iterations = 5

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected
No.	Mag.	Degree	MU	Mvar	MW	Mvar	Mvar
1	1.100	0.000	0.000	0.000	2.217	1.049	0.000
2	0.673	0.520	1.350	0.654	0.000	0.000	0.000
Tota	1		1.350	0.654	2.217	1.049	0.000

Lir	1e	Power at	bus & lin	ne flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
1		2.217	1.049	2.453			
	2	2.217	1.049	2.453	0.867	0.395	
2		-1.350	-0.654	1.500			
	1	-1.350	-0.654	1.500	0.867	0.395	
Total	loss				0.867	0.395	

APPENDIX XXIX

Source code for the network with 185 mm² cable size and compensation location and value are 100% and 400 % respectively

%clear												
*	Name		Muhamma	d Azizi	bin	Mohd Wah	nidi					
*	Titl	e :	Analysi:	s on Lo	sses	Reductio	on wi	th Se	ries (Capaci	itor	
*			Compense	ation i	n Dis	tributic	on Ne	twork				
*	sv		IR Mohd	Faris	bin A	bdullah						
*	Case		Compense	ation's	loca	tion at	100	km				
*			Value o:	f compe	nsati	on is 40)0%					
&Base po	wer	= 1 M	VA , Bas	e volta	ge =	11 kV ,	Base	impe	dance	= 121	lohm	
%Line re	sist	ance	= 0.211 (ohm/km,	Line	reactar	nce =	i0.0	962 oł	ım/ km	, Line	cap
%Capacit	or c	ompen	sation =	100% ,	Dist	ance = 1	.00km	n , PF	= 0.9) lago	ging	
basemva	= 1;	acc	uracy = (0.0001;	acce	1 = 1.6;	ma	axiter	= 60;			
	Deem	D				1					T 4	1
*			Voltage	-							-	ea
*			Mag.	Degree	nw	Mvar O		Mvar O	Qmin	Qmax D	nvar 0	
busdata=	-	1	1.1 1	0.0	-	-	0	-	-	-	-	
	2 3	0 0	1	0.0 0.0	0	0 0.436	0	0	0	0	0	
	3	U	T	0.0	0.90	0.436	U	U	U	U	0];	
*							Line	code				
÷	Bu	s bus	R	x	1	/2 B	= 1	for 1	ines			
÷	nl	nr	p.u.	p.u.	р	.u.	>1 o	or<1 t	r. tap	at b	ous nl	
linedata	a=[1	2	0.17438	0.079	50 O	.000040	1					
	2	3	0.00000	-0.318	02 0	.000000	1];					
lfybus				<pre>% Form</pre>	s the	bus adm	nitta	ance m	atrix			
%lfgauss	3	% ₽	ower flo	ø solut	ion b	y Newtor	n-Rap	hson i	method	1		
lfnewtor	1	% Pow	er flow :	solutio	n by l	Newton-F	Raphs	son me	thod			
%decoup1	.e	% Po	wer flow	soluti	on by	Newton-	Raph	nson m	ethod			
busout		% Pr	ints the	power	flow	solutior	n on	the s	creen			
lineflow	J 🗧	Comp	utes and	displa	ys th	e line f	low	and 1	osses			

lineflow % Computes and displays the line flow and losses
% (b) Comment lfgauss and uncomment lfnewton
% (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XXX

Simulation for the network with 185 mm² cable size and and compensation location and value are 100% and 400 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 1.97344e-005 No. of Iterations = 4

var
000
000
000
000
1

Lir	ie	Power at	bus & lin	e flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
1		1.071	0.202	1.090			
	2	1.071	0.202	1.090	0.171	0.078	
2		0.000	0.000	0.000			
	1	-0.900	-0.124	0.908	0.171	0.078	
	3	0.900	0.124	0.908	0.000	-0.312	
3		-0.900	-0.436	1.000			
	2	-0.900	-0.436	1.000	0.000	-0.312	
Total	loss				0.171	-0.234	

APPENDIX XXXI

Source code for the network with parallel configuration and 300 % loading and compensation location and value are 100% and 100 % respectively

%clear												
	Name	:	Muhamma	d Azizi	bin 1	Mohd Wah	idi					
	Titl	e :	Analysi	s on Lo	sses l	Reductio	n wi	ith Se	ries (Capac	itor	
			Compens	ation i	n Dist	tributic	n Ne	etwork				
	sv		IR Mohd	Faris	bin AB	odullah						
	Case		Compens	ation's	locat	tion at	100	km				
:			Value o	f compe	nsati	on is 10	0%					
Base p	ower	= 1 M	VA , Bas	e volta	ge = :	11 kV ,	Base	e impe	dance	= 12	1 ohm	
Line r	esist	ance	= 0.161	ohm/km,	Line	reactar	ice =	i0.0	924 ol	um/ km	, Line	cap
Capaci	tor c	ompen	sation =	100% ,	Dista	ance = 1	.00km	n , PF	= 0.9) lag	ging	
asemva	= 1;	acc	uracy =	0.0001;	acce.	1 = 1.6;	ms	axiter	= 60;			
	Pug	Pug	Voltage	ingle		l ood		Con	oroto		Trioct	od
	No		Mag.	Degree		Mvar			Omin			eu
usdata		1	nag. 1.1	0.0	0	nvar	10	O	O U	O	nvar O	
usuata	2	0	1		-	1.308	-	-	0	0	0	
	3	0	1	0.0	2.,0 0	1.000	0	0	0	0	0	
	4	0	1	0.0	0	0	0	0	0	0	0];	
	-	0	-	0.0		0		0	0		0],	
5							Line	e code				
;	Bu	s bus	R	х	1,	/2 B	= 1	for 1	ines			
	nl	nr	p.u.	p.u.	р	.u.	>1 o	or<1 t	r. tap	at	bus nl	
inedat	a=[1	3	0.13306	0.076	36 O	.000045	1					
	3	2	0.00000	-0.076	36 O	.000000	1					
	1	4	0.13306	0.076	36 O	.000045	1					
	4	2	0.00000	-0.076	36 O	.000000	1];					
fybus				% Form	s the	bus adm	nitta	ance m	atrix			
lfgaus	3	% ₽	ower flo	w solut	ion by	y Newton	-Rap	hson :	method	1		
fnewto	n	* Pow	er flow :	solutio	n by I	Newton-F	aphs	son me	thod			
decoup	le	% Po	wer flow	soluti	on by	Newton-	Raph	nson m	ethod			
ousout		% Pr	ints the	power	flow :	solution	on	the s	creen			
lineflo	w %	Comp	utes and	displa	ys the	e line f	low	and 1	osses			
(b) C	ommen	t lfg	auss and	uncomm	ent l:	fnewton						
» (m) C	ommen	t lfor	auge and	lfnewt	on en	d uncom	ent	decou	nle			

 $\ensuremath{\mathfrak{s}}$ (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XXXII

Simulation for the network with parallel configuration and 300 % loading and compensation location and value are 100% and 100 % respectively

	Maximum Power Mismatch = 8.58733e-006 No. of Iterations = 4													
			NO. OI	Iteration	3 = 4									
Bus	Voltage	Angle	Los	ad	Genera	Generation								
No.	Mag.	Degree	MU	Mvar	MW	Mvar	Mvar							
1	1.100	0.000	0.000	0.000	3.448	1.308	0.000							
2	0.895	5.071	2.700	1.308	0.000	0.000	0.000							
3	0.847	-2.744	0.000	0.000	0.000	0.000	0.000							
4	0.847	-2.744	0.000	0.000	0.000	0.000	0.000							
Tota	1		2.700	1.308	3.448	1.308	0.000							

Mavimum Dowar Migmatch = $8.58733a_006$

Lin	ie	Power at	bus & lin	ne flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
1		3.448	1.308	3.687			
	3	1.724	0.654	1.844	0.374	0.214	
	4	1.724	0.654	1.844	0.374	0.214	
2		-2.700	-1.308	3.000			
	3	-1.350	-0.654	1.500	0.000	-0.215	
	4	-1.350	-0.654	1.500	0.000	-0.215	
3		0.000	0.000	0.000			
	1	-1.350	-0.439	1.420	0.374	0.214	
	2	1.350	0.439	1.420	0.000	-0.215	
4		0.000	0.000	0.000			
	1	-1.350	-0.439	1.420	0.374	0.214	
	2	1.350	0.439	1.420	0.000	-0.215	
Total	loss				0.748	-0.000	

APPENDIX XXXIII

Source code for the network with parallel configuration and 300 % loading and compensation location and value are 100% and 0 % respectively

SCIEAL										
*	Name	: Muhamma	ad Azizi bi	in Mohd Wal	hidi					
*	Title	: Analysi	s on Losse	es Reductio	on wi	th Ser	cies Ca	apaci	tor	
*		Compens	ation in I)istributio	on Ne	twork				
÷	sv	: IR Moho	l Faris bir	h Abdullah						
*	Case	: Compens	ation's lo	cation at	100	km				
÷		Value o	of compense	ation is Of	\$					
-		1 MVA , Bas	-							
		ce = 0.161								capa
*Capaci	tor com	pensation =	• 100% , Di	istance = :	100 km), PF	= 0.9	lagg	ing	
basemva	a = 1; a	accuracy =	0.0001; ad	cel = 1.6	; ma	xiter	= 60;			
	D			T = = -1		<i>a</i>			T	
*		us Voltage	-						-	eα
*		ode Mag.	Degree M			Mvar	-	-		
busdata	-			0 0	0	0	0	0	0	
	2 0	1	0.0 2.7	70 1.308	0	0	0	0	0];	
÷					Line	code				
4	Bus k	ous R	X	1/2 B		for 1:	inaa			
4	nl i		р.u.	1/2 Б р.u.		r<1 tr		at b	ug nl	
linedat		-	p.u. 5 0.07636	-		ullu UI	. cap	at D	uə ni	
TTHEdat	-									
	1 2	s 0.1330t	0.07636	0.000045	1];					
lfybus			<pre>% Forms t</pre>	he bus adı	mitte	ince ma	atrix			
%lfgaus		Power flo								
				-						
lfnewto		Power flow		-						
*decoup		Power flow								
busout		Prints the	-							
lineflo		omputes and			flow	and lo	osses			
a 11-1 C	· · · · · · · · · · · · · · · · · · ·	1	1	1. 1. Contractor and a second						

*clear

(b) Comment lfgauss and uncomment lfnewton
 (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XXXIV

Simulation for the network with parallel configuration and 300 % loading and compensation location and value are 100% and 0 % respectively

Power Flow Solution by Newton-Raphson Method Maximum Power Mismatch = 5.47511e-005 No. of Iterations = 4

Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
1	1.100	0.000	0.000	0.000	3.591	1.819	0.000
2	0.820	-1.021	2.700	1.308	0.000	0.000	0.000
Tota	1		2.700	1.308	3.591	1.819	0.000

Liı	ne	Power at	bus & li	ne flow	Line	loss	Transformer
from	to	MW	Mvar	MVA	MW	Mvar	tap
1		3.591	1.819	4.025			
	2	1.796	0.910	2.013	0.446	0.256	
	2	1.796	0.910	2.013	0.446	0.256	
2		-2.700	-1.308	3.000			
	1	-1.350	-0.654	1.500	0.446	0.256	
	1	-1.350	-0.654	1.500	0.446	0.256	
Total	loss				0.891	0.511	

APPENDIX XXXV

Source code for the network with parallel configuration and compensation location and value are 100% and 1000 % respectively

<pre>%clear % Name : Muhammad Azizi bin Mohd Wahidi % Title : Analysis on Losses Reduction with Series Capacitor % Compensation in Distribution Network % SV : IR Mohd Faris bin Abdullah % Case : Compensation's location at 100 km % Value of compensation is 100%</pre>
 Title : Analysis on Losses Reduction with Series Capacitor Compensation in Distribution Network SV : IR Mohd Faris bin Abdullah Case : Compensation's location at 100 km
 Compensation in Distribution Network SV : IR Mohd Faris bin Abdullah Case : Compensation's location at 100 km
% SV : IR Mohd Faris bin Abdullah % Case : Compensation's location at 100 km
% Case : Compensation's location at 100 km
· · · · · · · · · · · · · · · · · · ·
· Varae of compensation is 100.
%Base power = 1 MVA , Base voltage = 11 kV , Base impedance = 121 ohm
%Line resistance = 0.161 ohm/km, Line reactance = i0.0924 ohm/km , Line cap
Capacitor compensation = 100% , Distance = 100km , PF = 0.9 lagging
basemva = 1; accuracy = 0.0001; accel = 1.6; maxiter = 60;
% Bus Bus Voltage AngleLoad GeneratorInjected
% No code Mag. Degree MW Mvar MW Mvar Qmin Qmax Mvar
busdata=[1 1 1.1 0.0 0 0 0 0 0 0 0
2 0 1 0.0 0.90 0.436 0 0 0 0 0
301 0.0 0 0 0 0 0 0
4 0 1 0.0 0 0 0 0 0 0];
% Line code
8 Bus bus R X 1/2 B = 1 for lines
% nl nr p.u. p.u. p.u. >1 or<1 tr. tap at bus nl
linedata=[1 3 0.13306 0.07636 0.000045 1
3 2 0.00000 -0.76360 0.000000 1
1 4 0.13306 0.07636 0.000045 1
4 2 0.00000 -0.76360 0.000000 1];
-
lfybus % Forms the bus admittance matrix
<pre>%lfgauss % Power flow solution by Newton-Raphson method</pre>
lfnewton % Power flow solution by Newton-Raphson method
<pre>%decouple % Power flow solution by Newton-Raphson method</pre>
busout % Prints the power flow solution on the screen
lineflow % Computes and displays the line flow and losses
% (b) Comment lfgauss and uncomment lfnewton
% (c) Comment lfgauss and lfnewton and uncomment decouple

APPENDIX XXXVI

Simulation for the network with parallel configuration and compensation location and value are 100% and 1000 % respectively

		naxi	imum Power	HISMACCH ·	- J.03001E-	-005	
			No. of	Iteration	s = 4		
Bus	Voltage	Angle	Loa	ad	Genera	ation	Injected
No.	Mag.	Degree	MW	Mvar	MW	Mvar	Mvar
	-	-					
1	1.100	0.000	0.000	0.000	0.951	0.171	0.000
2	1.138	15.676	0.900	0.436	0.000	0.000	0.000
3	1.037	-1.255	0.000	0.000	0.000	0.000	0.000
4	1.037	-1.255	0.000	0.000	0.000	0.000	0.000
Tota	1		0.900	0.436	0.951	0.171	0.000

Maximum Power Mismatch = 3.63061e-005

	Lin	.e	Power at	bus & line	e flow	Line	loss	Transformer
	from	to	MU	Mvar	MVA	MW	Mvar	tap
	1		0.951	0.171	0.967			
		3	0.476	0.085	0.483	0.026	0.015	
		4	0.476	0.085	0.483	0.026	0.015	
	2		-0.900	-0.436	1.000			
		3	-0.450	-0.218	0.500	0.000	-0.147	
		4	-0.450	-0.218	0.500	0.000	-0.147	
	3		0.000	0.000	0.000			
		1	-0.450	-0.071	0.456	0.026	0.015	
		2	0.450	0.071	0.456	0.000	-0.147	
	4		0.000	0.000	0.000			
		1	-0.450	-0.071	0.456	0.026	0.015	
		2	0.450	0.071	0.456	0.000	-0.147	
1	ſotal	loss				0.051	-0.266	

APPENDIX XXXVII

Gantt chart of the project (Final Year Project 1)

SECTION	DESCRIPTION		WEEK NUMBER												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
STUDY	Literature review on the title														
DOCUMENTATION	Preliminary report														
SOFTWARE	Identify the software														
HARDWARE	Identify the lab modeling														
DOCUMENTATION	Progress Report														
SOFTWARE	Run some examples and design a circuit														
SOFTWARE	Find the result (simulation)														
PRESENTATION	Prepare for seminar														
DOCUMENTATION	Prepare a draft report														
DOCUMENTATION	Compile all works (final report)														

APPENDIX XXXVIII

Gantt chart of the project (Final Year Project 2)

SECTION	DESCRIPTION		WEEK NUMBER												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
STUDY	Literature review on the title														
SOFTWARE	New result on previous cases														
DOCUMENTATION	Prepare the progress report 1														
SOFTWARE	Add more cases for testing														
DOCUMENTATION	Prepare the progress report 2														
SOFTWARE	Identify the solution														
STUDY	Problem in the application														
DOCUMENTATION	Prepare a poster for ElectEx														
DOCUMENTATION	Prepare a draft report														
DOCUMENTATION	Prepare a technical report														
PRESENTATION	Oral presentation														
DOCUMENTATION	Prepare the final report														