การกำหนดตำแหน่งและขนาดที่เหมาะสมของระบบกักเก็บพลังงานในระบบจำหน่ายที่เชื่อมต่อกับระบบผลิตไฟฟ้าพลังงานแสงอาทิตย์โดยพิจารณาค่าพลังงานสูญเสียต่ำสุด

นายวัดทานาก ซก

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
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DETERMINATION OF OPTIMAL SITING AND SIZING OF ENERGY STORAGE SYSTEM IN PV-CONNECTED DISTRIBUTION SYSTEMS CONSIDERING MINIMUM ENERGY LOSSES

Mr. Vattanak Sok

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Engineering Program in Electrical Engineering
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By	Mr. Vattanak Sok
Field of Study	Electrical Engineering
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วัดทานาก ซก : การกำหนดตำแหน่งและขนาดที่เหมาะสมของระบบกักเก็บพลังงานในระบบจำหน่ายที่เชื่อมต่อกับระบบผลิตไฟฟ้าพลังงานแสงอาทิตย์โดยพิจารณาค่าพลังงานสูญเสียต่ำสุด (DETERMINATION OF OPTIMAL SITING AND SIZING OF ENERGY STORAGE SYSTEM IN PV-CONNECTED DISTRIBUTION SYSTEMS CONSIDERING MINIMUM ENERGY LOSSES) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. ดร.ธวัชชัย เตชัสอนันต์, 75 หน้า.

พลังงานแสงอาทิตย์เป็นพลังงานหมุนเวียนที่ใช้อย่างแพร่หลายในประเทศที่ซึ่งมีแสงอาทิตย์เพียงพอสำหรับการผลิตพลังงานสะอาด นอกจากประโยชน์ของพลังงานแสงอาทิตย์แล้ว พลังงานแสงอาทิตย์ยังก่อให้เกิดปัญหาด้านคุณภาพไฟฟ้าต่อระบบไฟฟ้าที่มีการติดตั้งพลังงานหมุนเวียนชนิดนี้ วิทยานิพนธ์ฉบับนี้เสนอการแก้ปัญหาแรงดันเกินและแรงดันตกในมุมมองของผู้ผลิตไฟฟ้าโดยการใช้ตัวกักเก็บพลังงาน เป็นการวิเคราะห์หาตำแหน่งและขนาดที่เหมาะสมของตัวกักเก็บพลังงาน เพื่อเป็นการเสนอแนวทางให้ผู้ผลิตไฟฟ้ามีการติดตั้งตัวกักเก็บพลังงาน โดยมีวัตถุประสงค์เพื่อลดพลังงานสูญเสียทั้งหมดของระบบไฟฟ้า กระบวนการที่นำเสนอสามารถช่วยลดผลกระทบจากแรงดันเกินและแรงดันตกได้

ภาควิชา	วิศวกรรมไฟฟ้า	ลายมือชื่อนิสิต	....
สาขาวิชา	วิศวกรรมไฟฟ้า	ลายมือชื่อ อ.ที่ปรึกษาหลัก	....
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VATTANAK SOK: DETERMINATION OF OPTIMAL SITING AND SIZING OF ENERGY STORAGE SYSTEM IN PV-CONNECTED DISTRIBUTION SYSTEMS CONSIDERING MINIMUM ENERGY LOSSES. ADVISOR: ASSOC. PROF. THAVATCHAI TAYJASANANT, Ph.D., 75 pp.

Photovoltaic (PV) is a renewable energy which is used widely by many countries which have enough sun light to utilize this clean energy. Along with its advantages, PV also brings along power quality problems to power systems which it is connected. In this thesis, mitigation of voltage rise and voltage drop by using energy storage (ES) is proposed. However, the mitigation will only focus on utility aspect. This method requests the utility to install proper size and location of ES. Thus, the proper siting and sizing of ES is analyzed. The objective is to minimize the total energy losses of the system. The proposed method can help to lower impacts of voltage rise and voltage drop.

Department:	Electrical Engineering	Student's Signature	....
Field of Study:	Electrical Engineering	Advisor's Signature	....
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Chapter 1
INTRODUCTION

1.1 Problem Statement

New projects of conventional electrical energy power plant have been abandoned or reconsidered to create because of limited resources, environmental factor, and renewable sources. In 2010, the amount of renewable energy is approximately 19.4% of the total energy produced by the world at that time[1]. Furthermore, the amount of this renewable energy has been increased yearly. This is a very good news for environment. Some of the renewable sources, for example: Power voltaic (PV) and Wind energy, however, will bring along with some power quality (PQ) problems such as voltage rise, voltage fluctuation, flicker and others [2]. In Thailand, PQ problem of PV is more interesting than that of wind, since Thailand has integrated their transmission system and distributed systems with PV.

Most of the PV problems causes by the variation of solar radiation (predictable), and the blocking of the cloud (unpredictable). This two fundamentals cause PV to generate power less than its Maximum Power Point (MPP). In this case, the power injected into grid is less than what utility expected, and voltage will drop during this period. There are many ways to mitigate this matter. The author in [3] has solved this problem by controlling the reactive power of PV by its inverter. Another way to solve this problem is proposed in [4] by controlling the voltage from utility source. To do that utility must have the known characteristics of PV cell and predicts it accordingly. It is also seen that in [5], the author proposes to use energy storage system, battery, in order to mitigate voltage fluctuation. In that paper, the authors focused on battery storage controlled by the customer side. In contrast, the utility would not agree to this method since it is opposite of grid code condition, and the customers themselves would not be interested much in it because they have to increase their initial cost.

In this thesis, the mitigation of voltage rise and voltage fluctuation by energy storage (ES) is still proposed, but it will focus on utility aspect. This method requests the utility to install the ES. Thus the optimization of size and location of battery is proposed in this document, while the energy losses are minimized. The main purpose is mitigation voltage fluctuation, so that the utility might be interested to use this proposal.

1.2 Objectives and Scope of Study

There are two main objectives for this study:

- To find the optimal siting of ES according to sensitivity losses analysis
- To find the optimal sizing of ES after optimal siting is selected

The proposed method used MATLAB/Simulink program to run load flow by modifying code in [6]. The test will be done by modifying IEEE 34-bus where the original test standard is given in figure 1, and PV cell data recorded on Chulalongkorn University building 4 rooftops (2013) will be used. The line will be one of constrains to consider whether it is able to stand for installing new power or not. A method of how to control charge and discharge of ES, unfortunately, will not be discussed in this paper. All the case scenarios can be divided into 3 main parts. The first part is base scenario and given by figure 2. There are several modification of the original one. First, bus 800 is considered to be slack bus. Second, all the voltage changers is neglected, while transformer between bus 832 and bus 888 will be replaced by line impedance calculated by its resistance and reactance. Figure 3 shows the second parts of all scenarios which include one 1.2 MW PV on bus 838. The other case is illustrated by figure 4, which has PV at bus 838 and bus 858. Both PV has 1.2 MW power each.

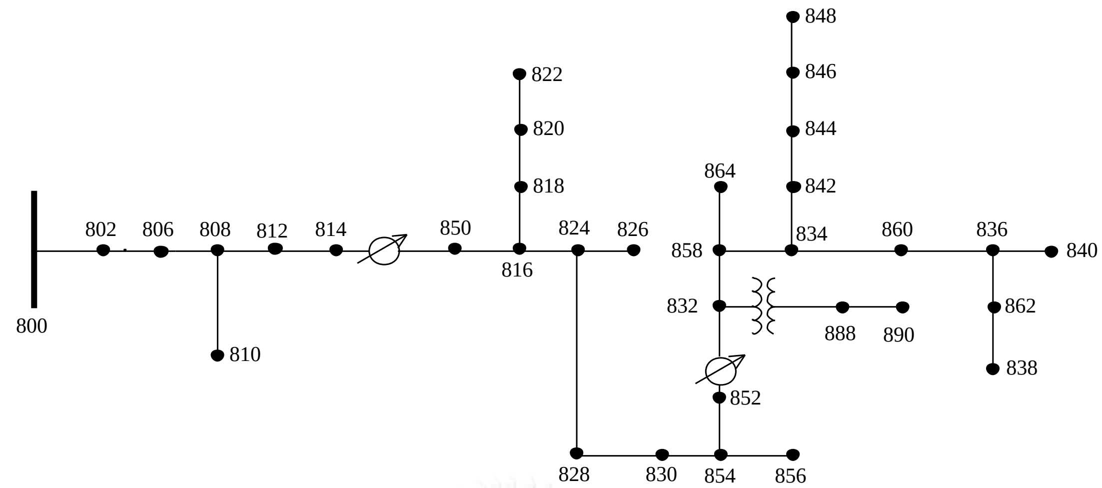

Figure 1 IEEE 34 Node Test Feeder

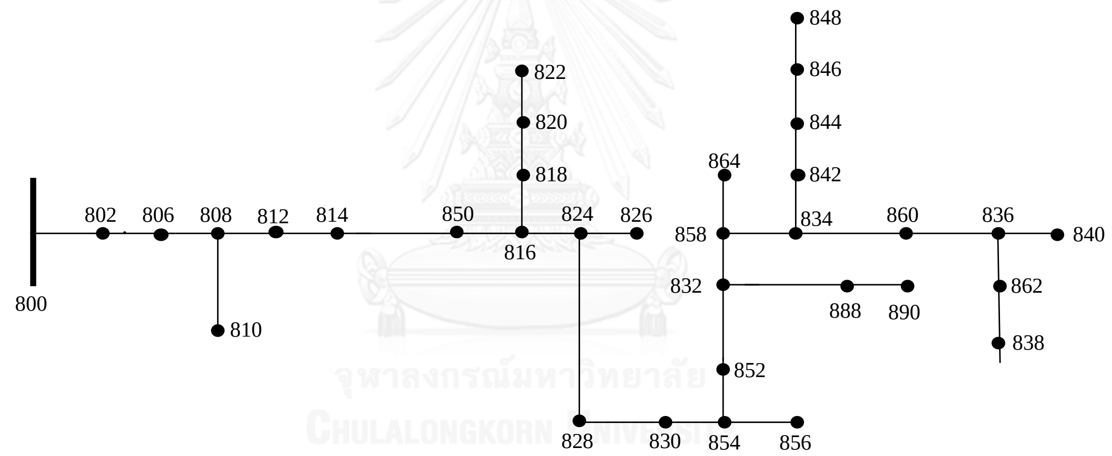

Figure 2 IEEE 34 Node Test Feeder modification

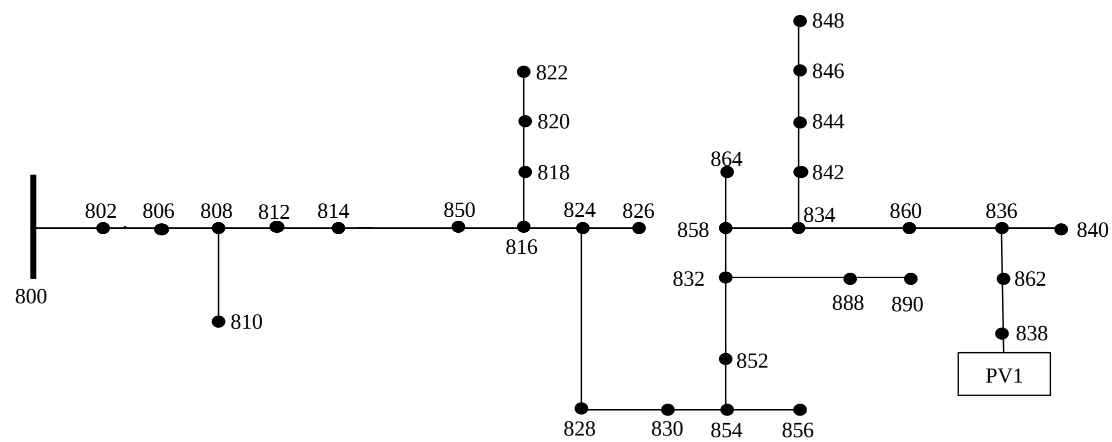

Figure 3 IEEE 34 Node Test Feeder modification with one PV

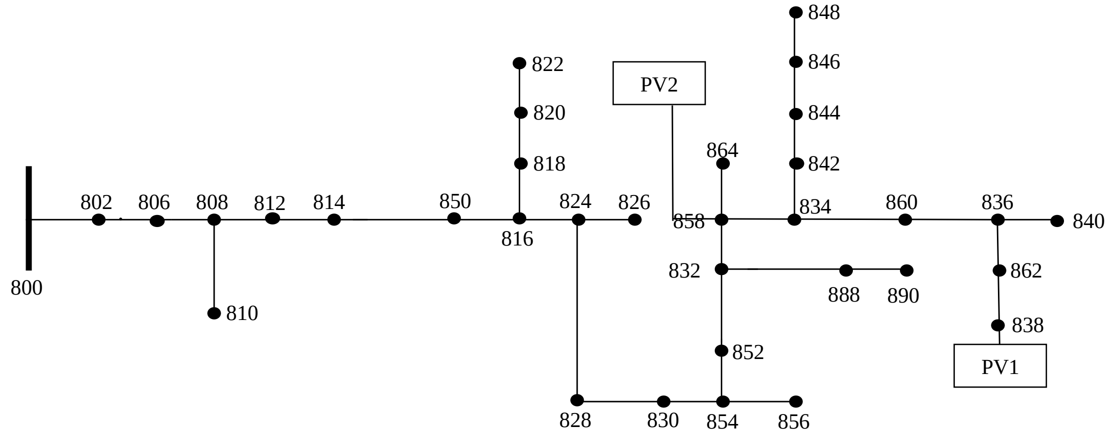

Figure 4 IEEE 34 Node Test Feeder modification with two PVs

The objective function is given by

$$Minimize\ E_L(ES_{size}) \quad (1)$$

where $E_L(ES_{size})$ is the system energy losses according to ES size and location after the ES is installed. It is subjected to the following constrains:

- Line ampacity
- Voltage range of Distributed Resource (DR) $0.95\ p.u. \leq V_i \leq 1.05\ p.u.$
- Voltage range of other buses $0.90\ p.u. \leq V_{each\ bus} \leq 1.1\ p.u.$
- Maximum capacity that ES can store from PV

Chapter 2

LITURATURE REVIEW

2.1 Power Losses Analysis

Complex power that flow from bus i to j and j to i are given by equation bellow:

$$S_{ij} = V_i I_{ij}^* \tag{2}$$

$$S_{ji} = V_j I_{ji}^* \tag{3}$$

where
$$I_{ij} = -I_{ji} = y_{ij}(V_i - V_j) + y_{io}V_i \tag{4}$$

Power loss of bus i and j given by summation of the above power and state as

$$S_{Lij} = S_{ij} + S_{ji} \tag{5}$$

Total Power losses is given by

$$S_{LT} = \sum S_{Lij} \tag{6}$$

Total Power Losses is also define by an author, Dopazo of [7], using bus powers, voltages and system parameters. In that document, he proposed that total power loss is the subtraction of power generated by each generators and load of each buses; and he states that total power losses given by:

$$P_L(ES_{size}) = \sum_{i=1}^{n}\sum_{j=1}^{n}\frac{R_{ij}}{|V_i||V_j|}\left[(P_iP_j + Q_iQ_j)\cos\delta_{ij} + (Q_iP_j - P_iQ_j)(sin\delta_{ij})\right] \tag{7}$$

The detailed of how to get this equation is describe in Appendix A.

2.2 Sensitivity Analysis of System Losses

There are two types of loss sensitivity analysis. First type is the type that system losses are compensated by the slack bus, and the second one is compensated by all the buses [8].

2.2.1 System Losses Slack Bus as Compensator

Slack bus is a compensator so the power of slack bus is given by

$$P_{ref} = P_{ref,load} + P_L$$
$$= \sum_{j=1}^{n} |V_a||V_j||Y_{aj}| \cos(\theta_{aj} - \delta_a + \delta_j) \quad (8)$$

where a is slack bus

For schedule load $P_{ref,load}$ is fix or constant thus the change of slack bus power is equal to the change of loss power which is given by

$$\Delta P_{ref} = \Delta P_L \quad (9)$$

Partial differentiation of Power with voltage magnitude and voltage angle are also equal

$$\frac{\partial P_{ref}}{\partial |V_m|} = \frac{\partial P_L}{\partial |V_m|} \quad (10)$$

$$\frac{\partial P_{ref}}{\partial \delta_m} = \frac{\partial P_L}{\partial \delta_m} \quad (11)$$

As it is already known that power loss depends on active and reactive power of all buses. At the same time, active and reactive powers of these buses depend on Voltage magnitudes and Voltage angles of all buses. By apply rule of differential chain we can get

$$\frac{\partial P_{ref}}{\partial |V_m|} = \frac{\partial P_L}{\partial |V_m|} = \sum_{i=1}^{N} \left[\frac{\partial P_L}{\partial P_i} \cdot \frac{\partial P_i}{\partial |V_m|} + \frac{\partial P_L}{\partial Q_i} \cdot \frac{\partial Q_i}{\partial |V_m|} \right] \quad (12)$$

$$\frac{\partial P_{ref}}{\partial \delta_m} = \frac{\partial P_L}{\partial \delta_m} = \sum_{i=1}^{N}\left[\frac{\partial P_L}{\partial P_i}\cdot\frac{\partial P_i}{\partial \delta_m} + \frac{\partial P_L}{\partial Q_i}\cdot\frac{\partial Q_i}{\partial \delta_m}\right] \tag{13}$$

Rewrite it into matrix form we get

$$\begin{bmatrix}\frac{\partial P_{ref}}{\partial \delta_m}\\ \frac{\partial P_{ref}}{\partial |V_m|}\end{bmatrix} = \begin{bmatrix}\frac{\partial P_i}{\partial \delta_m} & \frac{\partial Q_i}{\partial \delta_m}\\ \frac{\partial P_i}{\partial |V_m|} & \frac{\partial Q_i}{\partial |V_m|}\end{bmatrix}\begin{bmatrix}\frac{\partial P_L}{\partial P_i}\\ \frac{\partial P_L}{\partial Q_i}\end{bmatrix} \tag{14}$$

Or

$$\begin{bmatrix}\frac{\partial \mathrm{P_{ref}}}{\partial \delta_\mathrm{m}}\\ \frac{\partial \mathrm{P_{ref}}}{\partial |\mathrm{V_m}|}\end{bmatrix} = [\mathrm{J^T}]\begin{bmatrix}\frac{\partial \mathrm{P_L}}{\partial \mathrm{P_i}}\\ \frac{\partial \mathrm{P_L}}{\partial \mathrm{Q_i}}\end{bmatrix} \tag{15}$$

Thus

$$\begin{bmatrix}\frac{\partial \mathrm{P_L}}{\partial \mathrm{P_i}}\\ \frac{\partial \mathrm{P_L}}{\partial \mathrm{Q_i}}\end{bmatrix} = [\mathrm{J^T}]^{-1}\begin{bmatrix}\frac{\partial \mathrm{P_{ref}}}{\partial \delta_\mathrm{m}}\\ \frac{\partial \mathrm{P_{ref}}}{\partial |\mathrm{V_m}|}\end{bmatrix} \tag{16}$$

2.2.2 System Losses All Buses as Compensator

All buses are the compensators of power losses mean that the subtraction of power generated from each generators and consume power is power loss and give by power balance equation bellow

$$\left(P_1 - P_{1,load}\right) + \left(P_2 - P_{2,load}\right) + \cdots + \left(P_i - P_{i,load}\right) + \cdots$$
$$+ \left(P_N - P_{N,load}\right) = P_L \tag{17}$$

or

$$\sum_{ig}^{N_g} P_{ig} + \sum_{il}^{N_l} P_{il} = P_L$$

The power equation is

$$P_L = \sum_{i=1}^{n}\sum_{j=1}^{n} |V_i||V_j||Y_{ij}|\cos(\theta_{ij} - \delta_i + \delta_q) \tag{18}$$

Not quite different from the previous case, the power losses depend on active and reactive powers of all buses; and active and reactive of powers of all buses depend on voltage magnitude and voltage angle of all buses. According to chain rule of differential we get

$$\frac{\partial P_L}{\partial |V_m|} = \sum_{i=1}^{N}\left[\frac{\partial P_L}{\partial P_i}\cdot\frac{\partial P_i}{\partial |V_m|} + \frac{\partial P_L}{\partial Q_i}\cdot\frac{\partial Q_i}{\partial |V_m|}\right] \tag{19}$$

$$\frac{\partial P_L}{\partial \delta_m} = \sum_{i=1}^{N}\left[\frac{\partial P_L}{\partial P_i}\cdot\frac{\partial P_i}{\partial \delta_m} + \frac{\partial P_L}{\partial Q_i}\cdot\frac{\partial Q_i}{\partial \delta_m}\right] \tag{20}$$

Rewrite it into matrix form we get

$$\begin{bmatrix}\frac{\partial P_L}{\partial \delta_m}\\ \frac{\partial P_L}{\partial |V_m|}\end{bmatrix} = \begin{bmatrix}\frac{\partial P_i}{\partial \delta_m} & \frac{\partial Q_i}{\partial \delta_m}\\ \frac{\partial P_i}{\partial |V_m|} & \frac{\partial Q_i}{\partial |V_m|}\end{bmatrix}\begin{bmatrix}\frac{\partial P_L}{\partial P_i}\\ \frac{\partial P_L}{\partial Q_i}\end{bmatrix} \tag{21}$$

Or

$$\begin{bmatrix}\frac{\partial P_L}{\partial \delta_m}\\ \frac{\partial P_L}{\partial |V_m|}\end{bmatrix} = [J^T]\begin{bmatrix}\frac{\partial P_L}{\partial P_i}\\ \frac{\partial P_L}{\partial Q_i}\end{bmatrix} \tag{22}$$

Thus

$$\begin{bmatrix}\frac{\partial P_L}{\partial P_i}\\ \frac{\partial P_L}{\partial Q_i}\end{bmatrix} = [J^T]^{-1}\begin{bmatrix}\frac{\partial P_L}{\partial \delta_m}\\ \frac{\partial P_L}{\partial |V_m|}\end{bmatrix} \tag{23}$$

The parameter which is used for sensitivity analysis of system losses is $\partial P_L/\partial P_i$

2.3 Acceptable Voltage Range

To connect PV and ES into distribution system, the voltage of Point of Common Coupling (PCC) must not violate the acceptable range of voltage variation. IEEE std. 1547™ [9], states that it is applicable for three type of Distributed Resource (DR) such as statics power inverter/converter, induction machine and synchronous machine. The voltage of DR should work parallel with grid and voltage fluctuation must be less than $\pm 5\%$ of the nominal voltage, and the requirement of flicker is also included. DR should also de-energize to the grid with specific clearing time if the voltage is in the rage given in table 1.

Table 1: Voltage range and its clearing time

Voltage Range (%)	Clearing Time (s)
$V < 50$	0.16
$50 \leq V < 88$	2.00
$110 < V < 120$	1.00
$V \geq 120$	0.16

2.4 Power Profile of Photovoltaics

Power given by PV is different from normal generator because it depends on solar radiation and ambient temperatures. Normally, it gives the most power at peak sun. Many studies has predict the power generated by PV using historical data depend on time of the day and power generated by PV called power profile of PV. This data is very useful for other analysis such as power flow, fault location, and power management. The sample of the power profile of PV is given in figure 5 [10].

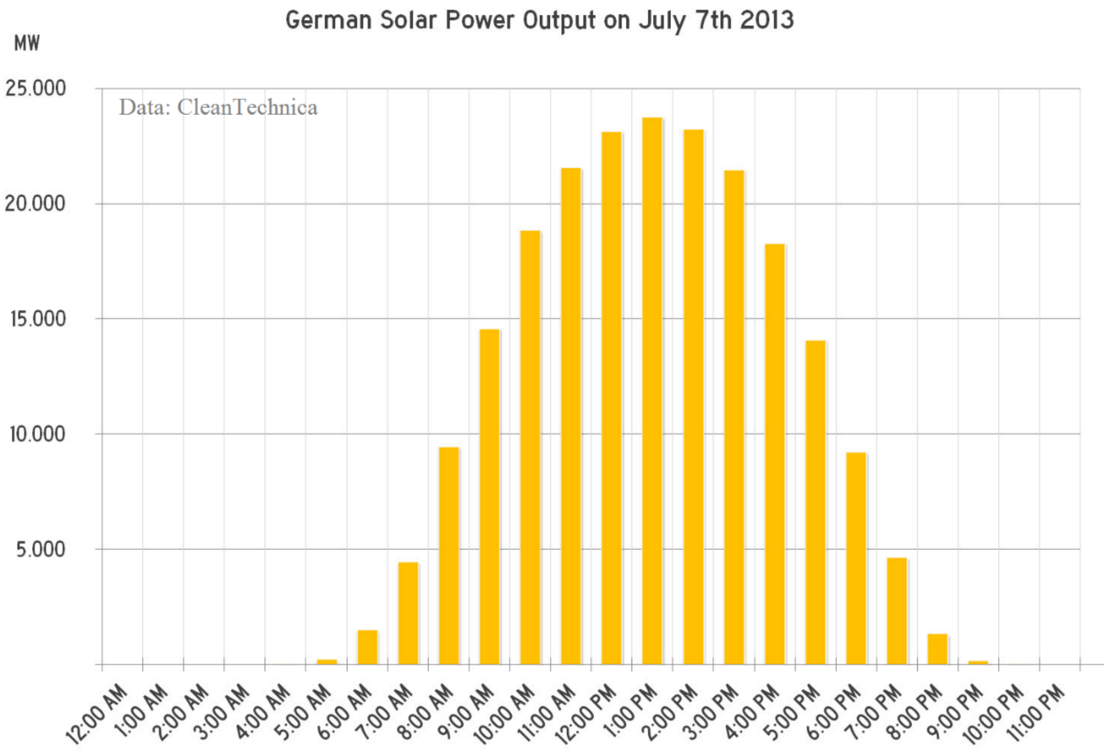

Figure 5 Solar power profile of German on July 7th 2013

Chapter 3
Proposed Technique

This document proposes a technique which optimizes siting and sizing of ES storage in PV-connected distribution system by minimize the energy of system power losses. 2 main algorithms is separated for system with and without ES. First, voltage of all buses is calculated when system without ES is connected, and not connected with PV. Then, these voltage data will be compared with the voltage data when the system is connected with ES. The system which connected to ES will be defined by flowchart below in figure 6.

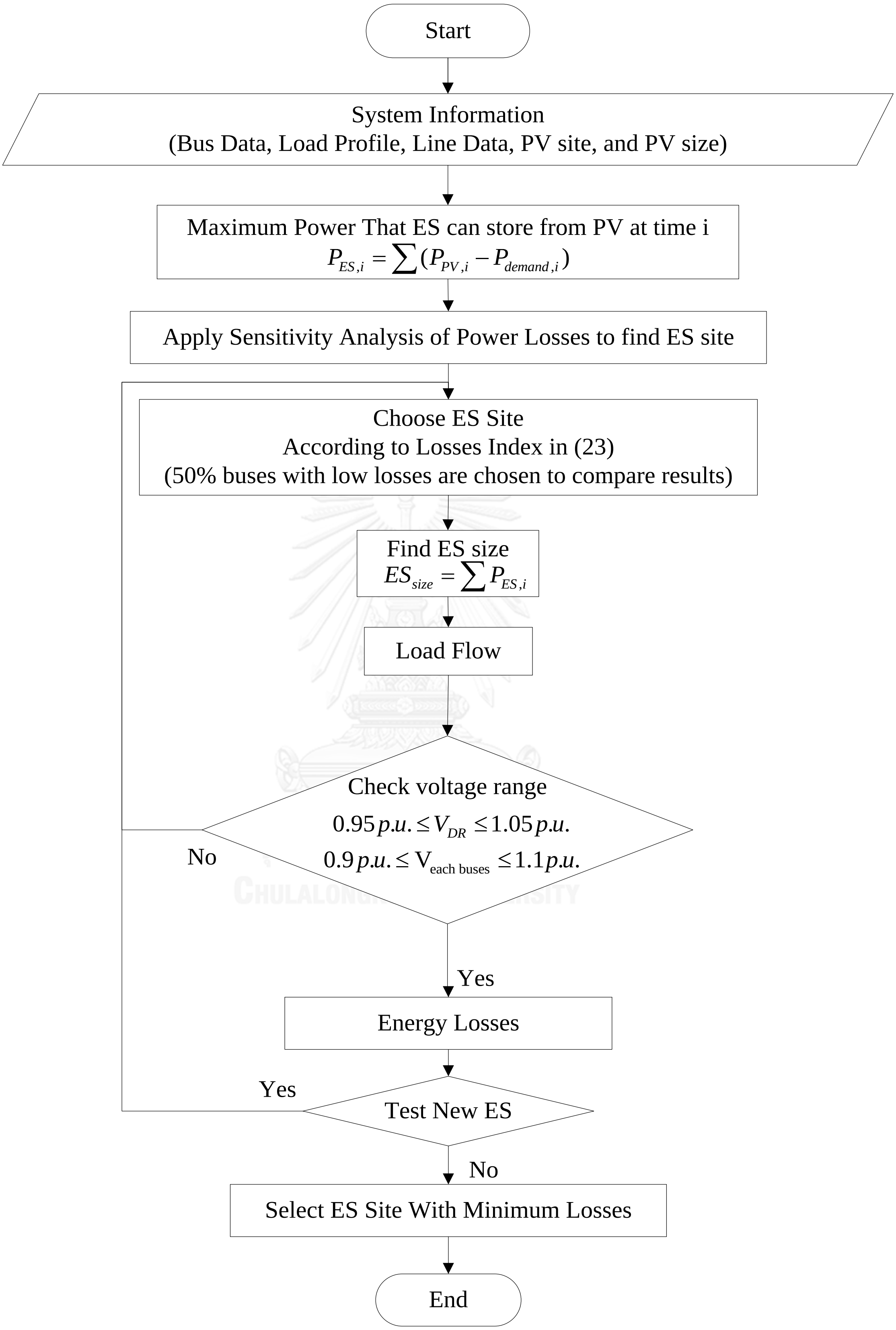

Figure 6 Flowchart of siting and sizing energy storage

Chapter 4

Scenarios

There are 3 main scenarios in the proposed method:

- Power losses and voltage profile of power system without PV and ES
- Power losses and voltage profile of power system with PV
- Power losses and voltage profile of power system with PV and ES

After define each power losses and voltage profile of each cases. The line graph will be plotted to show the comparison of the cases. Bar graph will also plotted so that power losses can be compared. To make it easy to understand Table 3 below shows the summary of all scenarios.

Table 2: All scenarios of the case study

Scenarios	Number of PV	Number of ES	Power Losses	Voltage Profile
1	No	No	NR[1] for a day	NR for a day
2	1 (1.2MW)	No	NR for a day	NR for a day
3	2 (1.2MW each)	No	NR for a day	NR for a day
4	1 (1.2MW)	1 bus	Flowchart figure 6	Flowchart figure 6
5	1 (1.2MW)	2 buses	Flowchart figure 6	Flowchart figure 6
6	1 (1.2MW)	3 buses	Flowchart figure 6	Flowchart figure 6
7	2 (1.2MW each)	1 bus	Flowchart figure 6	Flowchart figure 6
8	2 (1.2MW each)	2 buses	Flowchart figure 6	Flowchart figure 6
9	2 (1.2MW each)	3 buses	Flowchart figure 6	Flowchart figure 6
10	2 (1.2MW each)	1 bus	Flowchart figure 6	Flowchart figure 6
11	2 (1.2MW each)	2 buses	Flowchart figure 6	Flowchart figure 6

In scenario 10 and 11, PV_1 has move from bus 838 to bus 808 which is near the substation.

[1] NR is Newton Raphson method

Chapter 5

Simulation Results

5.1 System without PV and ES

System without PV and ES is a base case system and its detail is in figure 2. Voltage profile of bus 838, 888 and 890 during 17:15AM and 24:00 PM is shown in line chart figure 7 below. Bus 838 is the bus which PV is connected, while bus 888 and 890 are buses which show the worst case of voltage drop during heavy load. The other voltages are show in a table in Appendix G.

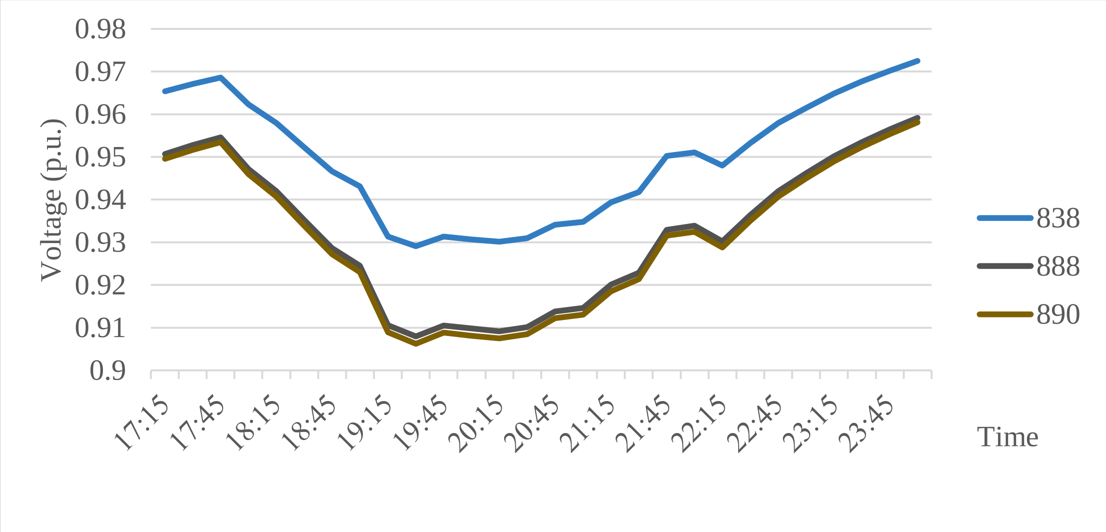

Figure 7 Voltages of each bus for one day period (Base Case)

According to the graph, it can be seen that during the evening from 17:30 to 22:45 voltages of bus 888 and 890 show a dramatic voltage drop, and their minimum voltage is below 0.91. Thus it will have a better performance if there are some sources at the end of the line to improve voltage at that point. The average power losses a day is 59.807 kW. Meanwhile, the energy loss for one day period is 1.4353 MWh from line losses only. For household which uses energy less than 150 kWh a month, 1.4353 MWh is a very huge energy which can supply their house nearly a year.

5.2 System with PV_1

Figure 8 below shows the voltage of every bus of the system rise increadilby between 10 AM and 14:30 PM. During the night voltage will drop similarly to the base case after lossing power from PV. The details of voltage is attached in appendix H.

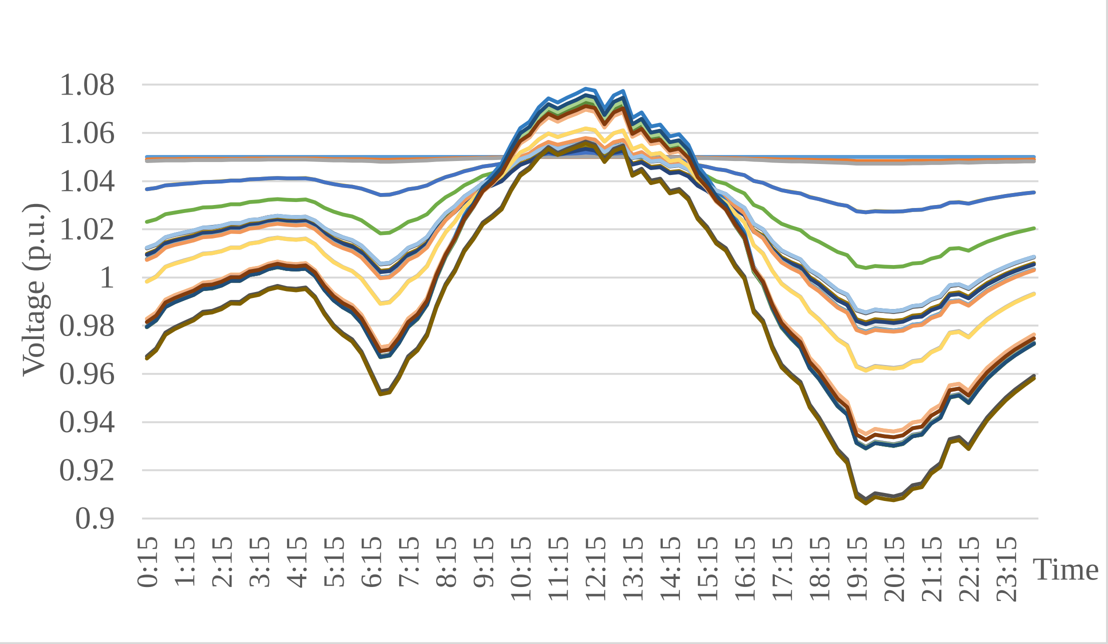

Figure 8 Voltages of each bus for one day period (a PV connected to bus 838)

In figure 9 (a) the straight line represents the voltage at the slack bus. The other voltages which show not much significant increase are voltage near the slack bus (bus 812) and voltage near the end of the line (bus 888 and 890). In contrast to the others, voltages near PV source (840,842) and the source (838) has increase significantly in figure 9 (b).

(a)

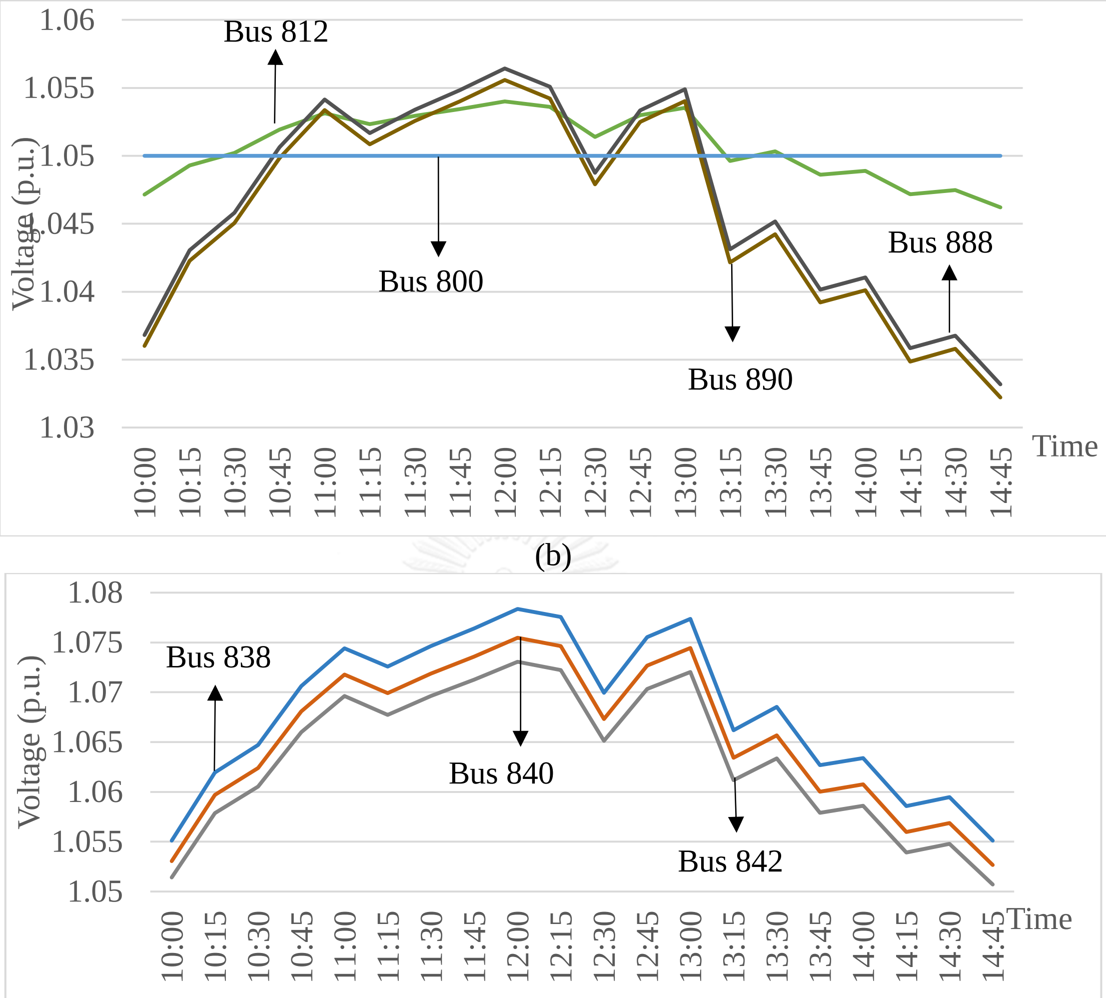

Figure 9 Details of line graph of voltages rise (a PV connected to bus 838)

The total power losses is 1.2255 MWh/day from line losses only.

5.3 System with PV_1 and PV_2

To get the full view of this system, figure 4 is given. The line graph below show voltages of all bus during one day period. The voltage drops here is not different from the previous case, because high consumption is happened during the night time while there is no power from any PV. The fundamental spot is voltage rise which is given by figure 11 for a better point out. From 8:45 to 16:30, the bus which is not influence by voltage rise are the bus near the slack bus and the slack bus itself (bus 800, 802), meanwhile other bus are rising dramatically. The bus near both of the PV, especially buses number 836, 842,844,846 and 862 show voltage rise nearly as high as that of the PV sources.

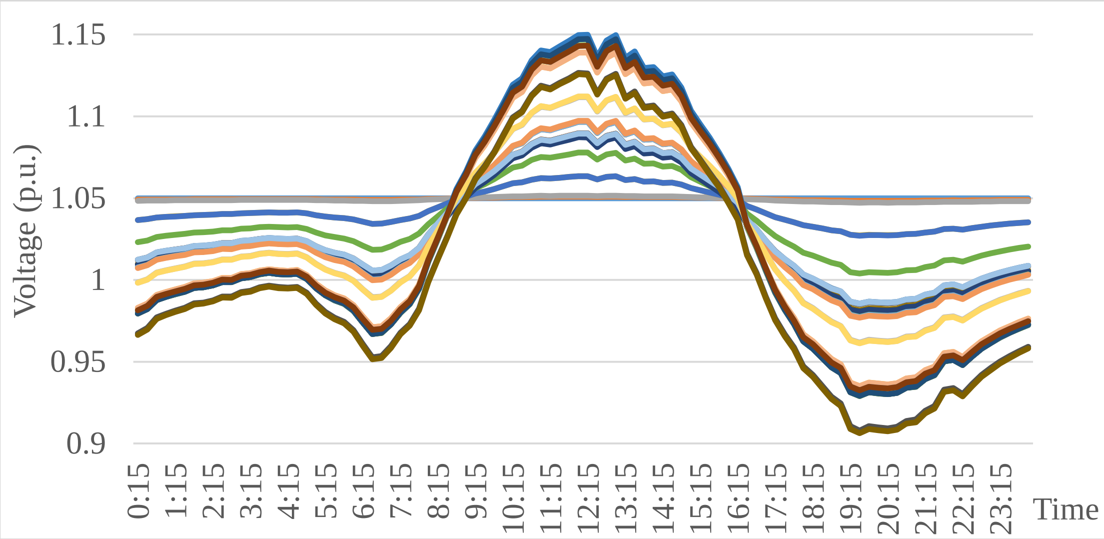

Figure 10 Voltages of each bus for one day period (PV connected to bus 838 and 858)

The total power losses is 1.8677 MWh/day.

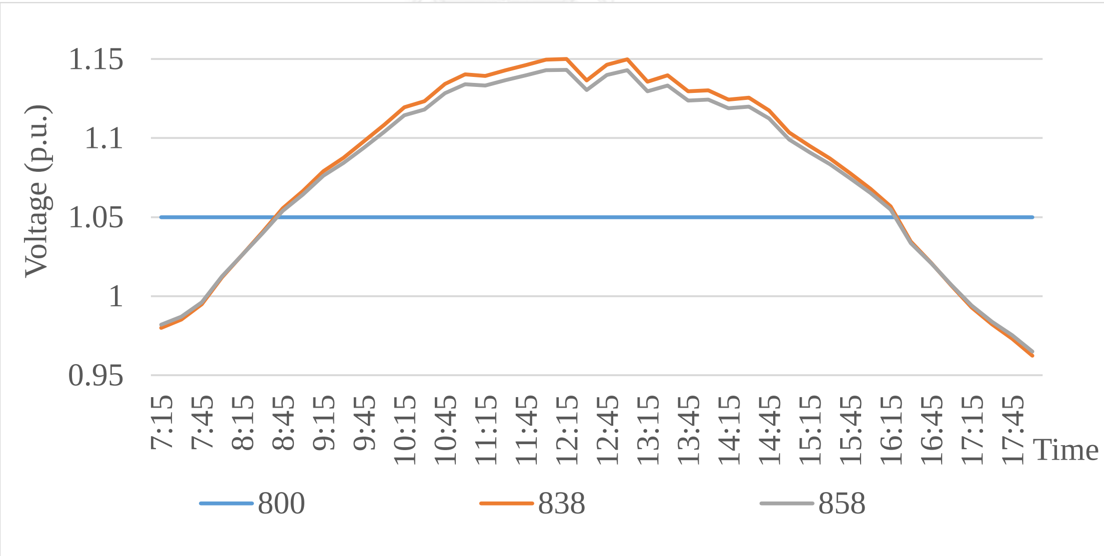

Figure 11 Details of voltages rise at bus 838 and 858

5.4 System with PV_1 and one ES

To choose the bus to which ES is connected, sensitivity of power losses is calculated. The battery will be connected to the bus which can reduce losses the most. By considered that ES is a pure active power, the sensitivities of power losses only effected by the active power, given by the table in Appendix P.

To make it easy for us to understand a picture of the sensitive part of the system will be shown with its top 10 bus which gives less losses sensitivities.

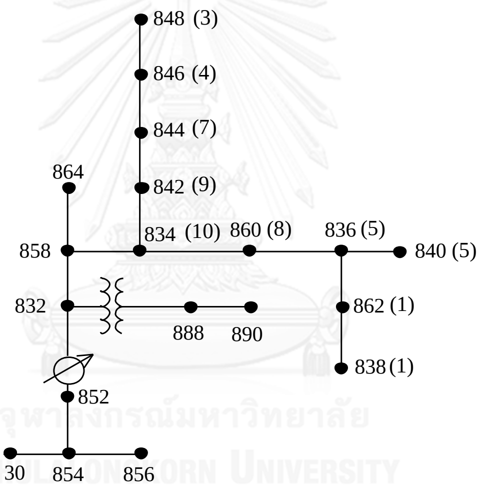

Figure 12 Rank of sensitivity of system losses in modified system

Table 3: Top 10 best rank of sensitivity of system losses

Rank	Bus	dP_L/dP_i
1	838	-0.333665723
1	862	-0.333665723
3	848	-0.333629854
4	846	-0.333627839
5	836	-0.333622004
5	840	-0.333622004
7	844	-0.333510388
8	860	-0.333184372
9	842	-0.33231432
10	834	-0.332065698

From this illustration, it demonstrates that the farther the bus that we connected to, the power losses will drop.

The energy that we can save from PV given by

$$E_{ES} = \sum P_{ES,i} = \sum (P_{PV,i} - P_{demand,i}) \tag{24}$$

where i is the ith time between 6:30 AM to 5:00 PM.

The energy that is store in the energy storage system is the energy that PV produce more than the total consumption of load. The total power that ES can charge is 1.8025 MWh/day. The ES will discharge back to the system during the night when the bus which PV, or ES has voltage lower than the limited range. With the energy storage, the system losses by a day is 0.8874 MWh/day. While comparing its losses with the basic system without PV and ES, the system losses is 1.4353 MWh/day and to that of PV_1 system is 1.2255 MWh/day. It has shown the potential to bypass both systems in scenario 1 and scenario 2. More than that, the voltage of three worst buses also improve (figure 12). The most noticeable point is that there is no bus with the voltage over 1.05 p.u. value. Furthermore, only two buses (888 and 890) drop lower than 0.95 p.u. with a short period of time. At bus 838 where PV is connected, voltage shows a good improvement where the minimum point is higher than the lower boundary (0.95 p.u.), unlike the base case and scenario number 4 where voltage drop below the limited value for DR bus.

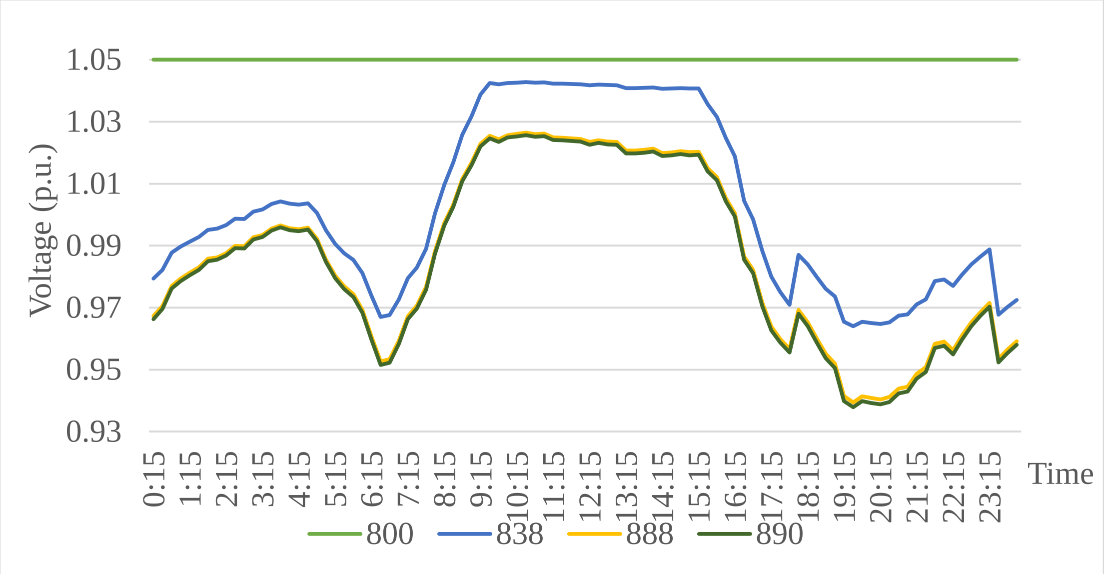

Figure 13 Voltages improvement after using ES at bus 838

5.5 System with PV_1 and ES in 2 Different Buses

The two difference buses which are chosen for installing the ES are on bus 838 and 862 acording to its lowest losses characteristic. From the simulation result it is seen that the energy loss for one day period will be lower if the energy stored at bus 838 is higher than that of bus 862. Figure 14 and Figure 15. show energy losses for 24 hours by the percentage of energy stored in bus 838 and 862. By these results, it can be interpreted that the energy losses will be better if the energy only store in only one bus (838). On the other hand voltages after installing ES in two different buses, figure 16, does not show significant improvement, compared with voltages after using one ES (scenario 4). The details of each voltages can be found in Appendix K.

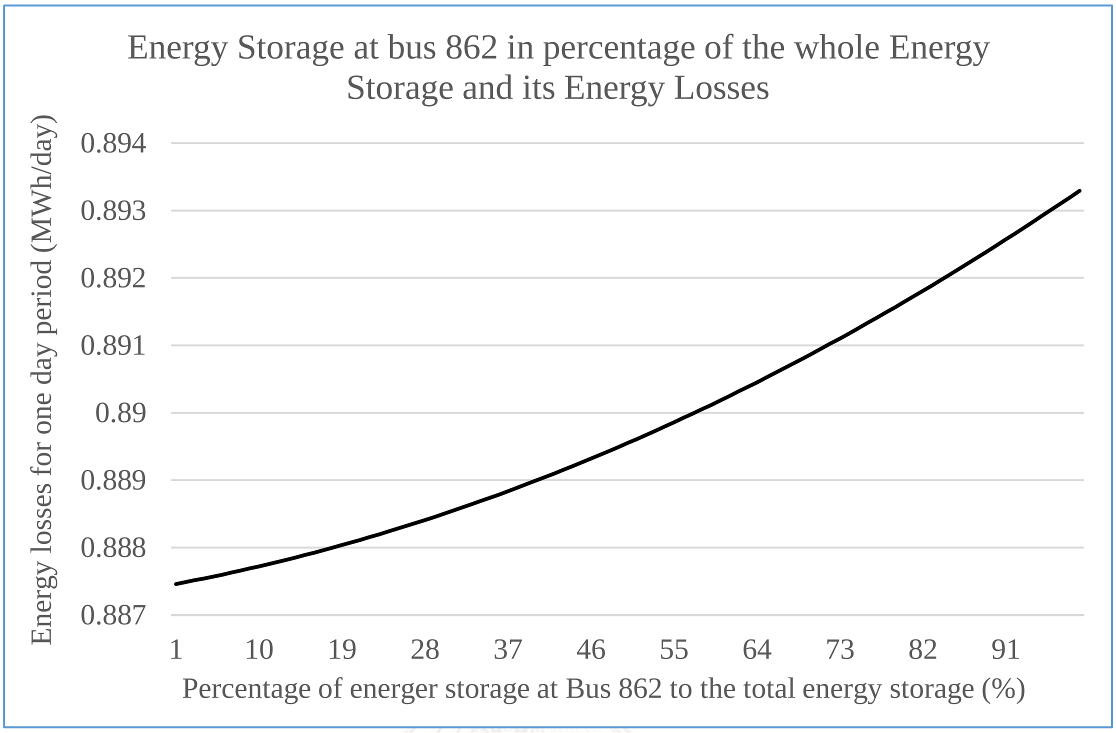

Figure 14 Energy storage at bus 862 in percentage of the whole energy storage and its energy losses

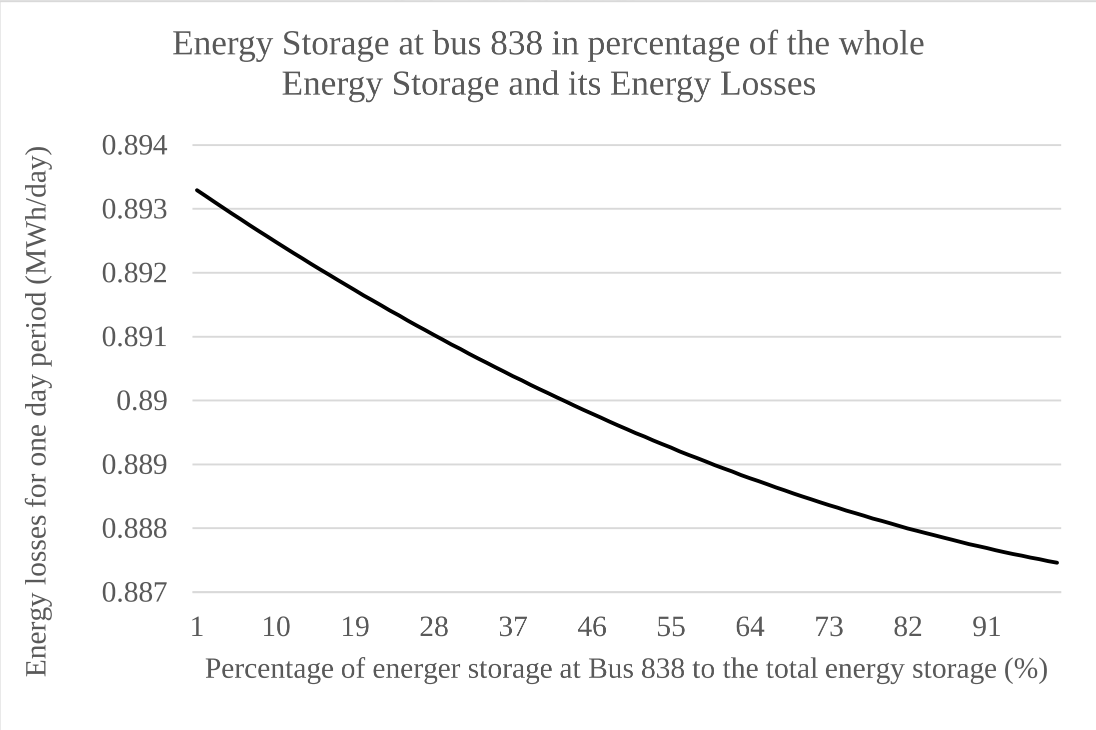

Figure 15 Energy storage at bus 838 in percentage of the whole energy storage and its energy losses

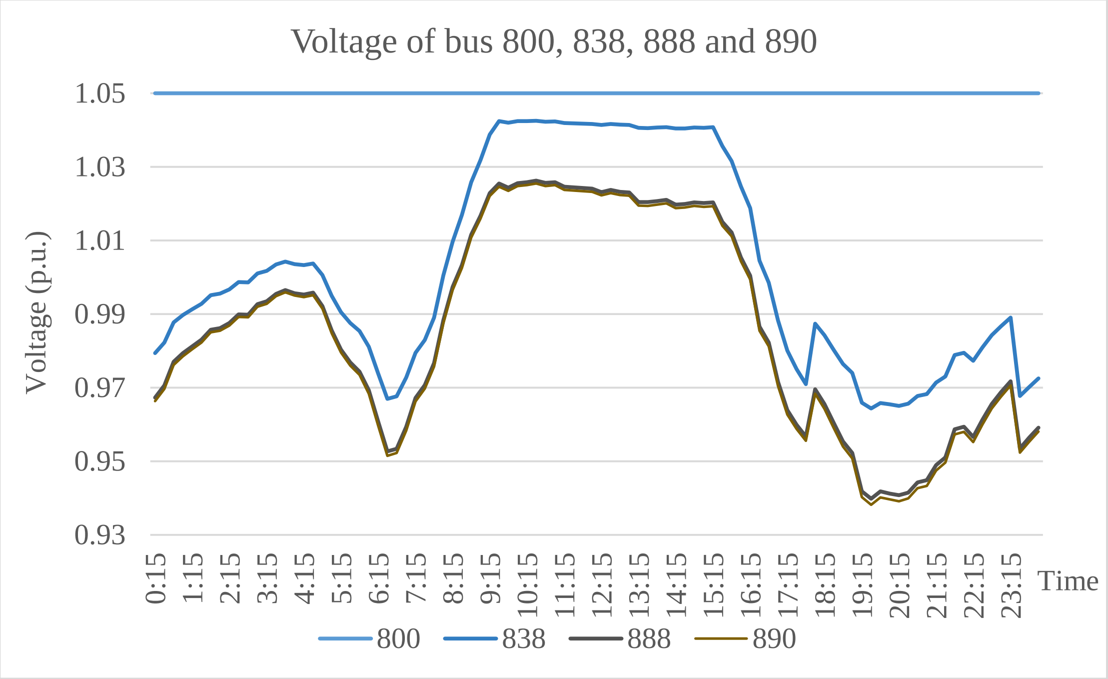

Figure 16 Voltages of bus 800, 838, 888 and 890 for 24 hours after using 2 ESs

5.6 System with 1 PV and ES in 3 Different Buses

Not much different from using 2 energy storage in different buses, the 3 energy storage for 3 buses are applied by the same method. The qualify 3 buses are bus 838, 862 and 842. Supposing that the sum of energy storage of three buses equal to the energy storage during the daytime, every possible combination of a 100 percent by using increment percentage of 1 percent to 98 percent in bus 838, we have 4851 combination of the three buses. The results show that the more energy stored in bus 862 and 842 the more energy losses. The more the energy stored in bus 838, the less the energy losses. The lowest energy loss for 24 hours is 0.8875MWh/day where energy is stored in bus 838 98%, bus 862 1% and bus 842 1%. The voltages of each buses are not different from using ES in two buses (scenario 4), and the details of the voltages are given in appendix L.

5.7 System with 2 PVs and 1 ES

8.7176 MWh is the energy that PV generate over the necessary load during day time by using 2 PVs. With the energy storage, the minimum energy losses by a day is 0.6424

MWh/day while the storage is at bus 834 which is between PV1 and PV2. It has given the lowest energy losses, compared to previous scenarios (1, 2, 3, 4, 5, and 6). More than that, the voltage of every bus also improve (figure 17). Furthermore, buses 888 and 890 drop lower than 0.95 p.u. and higher than 0.94 p.u. with a short period of time. At bus 838 and bus 858, the voltages are in good condition and within the limited range. It also can be seen that, it solves all the problems which occur in scenarios 3 where most of voltages violent the voltage boundary and has a very high energy losses. Appendix M show the details of each voltages.

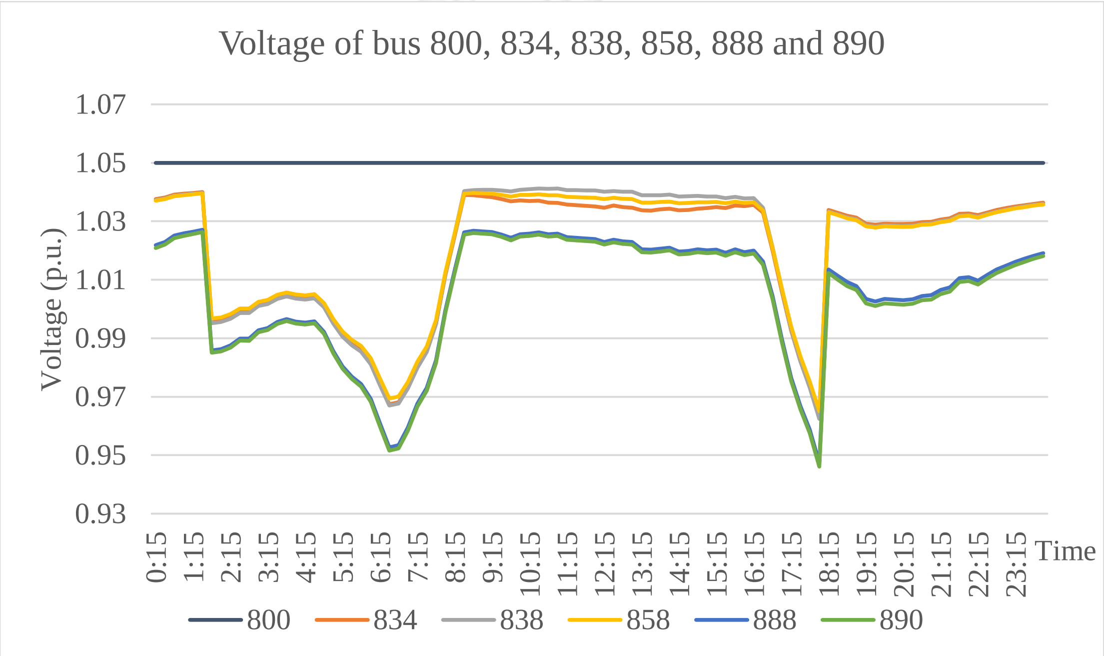

Figure 17 Voltages of buses 800, 834, 838, 858, 888, and 890 after using one ES with 2 PVs installing

5.8 System with 2 PVs and 2 ESs

The two different buses which are chosen for installing the ES are on bus 838 and 858 acording to its lowest losses characteristic. From the simulation result it is seen that the energy loss for one day period will be the lowest (0.6088MWh/day) if the energy stored at bus 858 (51%) is alittle bit bigger than that of bus 838 (49%). Figure 18 and Figure

19. show energy losses for a day by the percentage of energy stored in bus 858 and 838. By these results, it can be interpreted that the energy losses will be better if the energy is stored at the same bus as PV source.

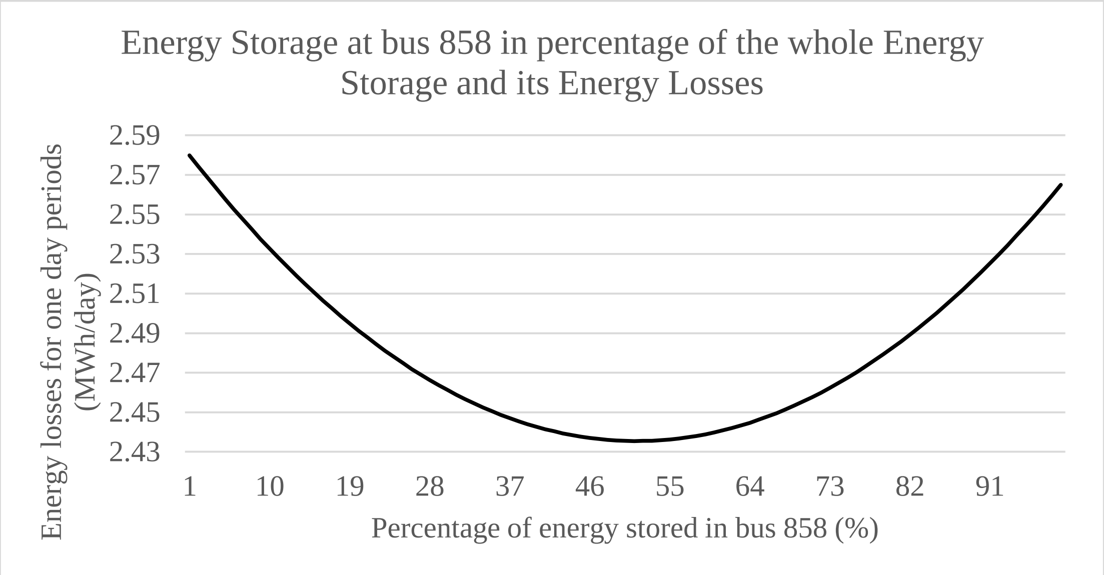

Figure 18 Energy storage at bus 858 in percentage of the whole energy storage and its energy losses

Voltae of bus 800, 834,838,858, 888, and 890 are shown in figure 20. The linegraph does not show an important different from scenarios 7. The details of each voltages of each buses are given in appendix N.

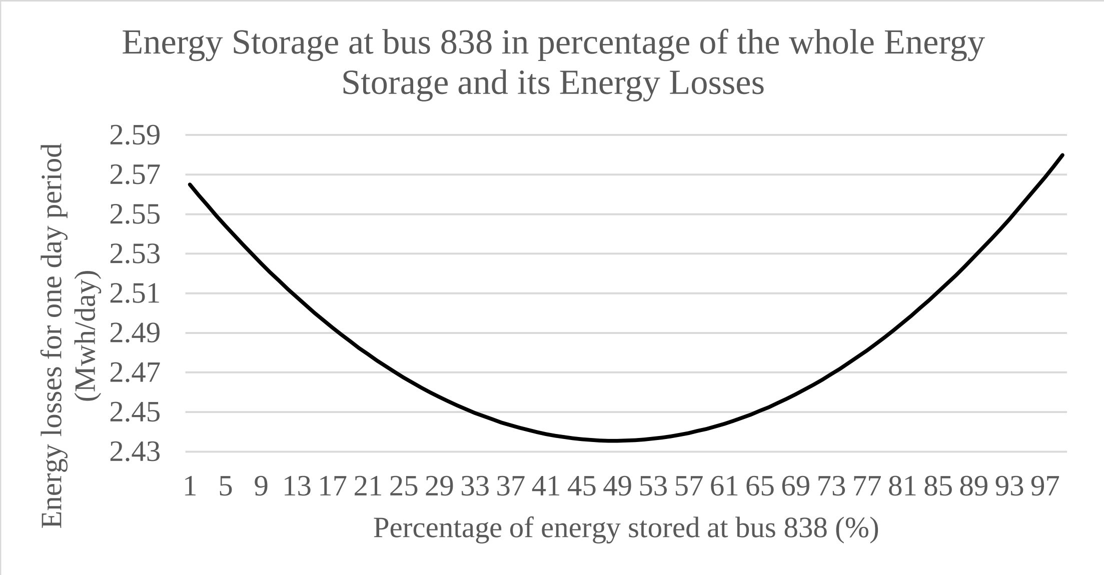

Figure 19 Energy storage at bus 838 in percentage of the whole energy storage and its energy losses

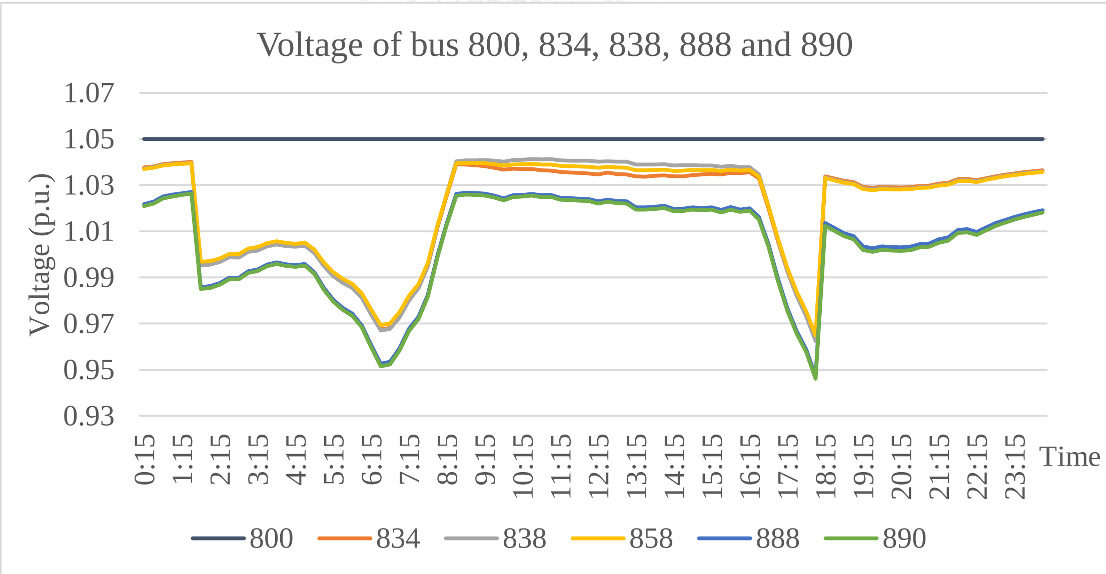

Figure 20 Voltages of buses 800, 834, 838, 858, 888, and 890 after using 2 ES with 2 PVs installing

5.9 System with 2 PV and 3 ES

Bus 338 (34%), bus 358 (64%), and bus 334 (2%) give the lowest energy loss of 0.9203MWh/day when we choose to use three energy storages in different buses. It shows that using energy storage more than PV sites doesn't improve energy losses at all . Moreover, the energy losses are worse than that of using only one ES.

5.10 System of scenarios 10 and 11

The PV_1 is moved to bus 808 which is the middle of loads (bus 806 and bus 810) near the slack bus to see the differences. The simulation show that the best location for installing one ES with lowest energy losses is bus 858 which is the bus of PV_2 and near the heavy load consumption. In addition, the energy losses will be the lowest at 0.7284 MWh/day if we install two ESs at both buses of PV (47% at bus 808 and 53% at bus 858).

5.11 Result Interpretation

From Simulation results Table 4 and 5 summarize all the scenarios

Table 4: Summary of all case scenarios of one PV and base case

Scenario	PV Bus	ES Bus	V_{PV} $0.95\ p.u. \le V_{PV} \le 1.05\ p.u.$	$V_{\text{each Buses}}$ $0.9\ p.u. \le V_{PV} \le 1.1\ p.u.$	Energy losses (MWh/day)	
					Energy Losses	Improvement (%)
1	No	No	-	✓	1.4353	Base Case
2	838	No	✖	✖	1.2255	14.61 %
4	838	838	✓	✓	0.8874	38.17 %
5	838	838 and 862	✓	✓	0.8875	38.17 %
6	838	838, 862, and 842	✓	✓	0.8875	38.17 %

- means the data is not improved or base case value
✓ means it is in the acceptable range
✖ means it is out of limited range

Table 5: Summary of all case scenarios of two PVs and base case

Scenario	PV Bus	ES Bus	V_{PV} $0.95\ p.u. \leq V_{PV} \leq 1.05\ p.u.$	$V_{each\ Buses}$ $0.9\ p.u. \leq V_{PV} \leq 1.1\ p.u.$	Energy losses (MWh/day)	
					Energy Losses	Improvement (%)
1	No	No	-	✓	1.4353	Base Case
3	838, 858	No	✖	✖	1.8677	-
7	838,858	834	✓	✓	0.6424	55.24%
8	838.858	838 and 858	✓	✓	0.6088	57.58%
9	838,858	838, 858, and 834	✓	✓	0.9203	35.88%
10	808, 858	858	✓	✓	1.008	29.27%
11	808, 858	808, 858	✓	✓	0.7284	49.25%

- means the data is not improved or base case value
✓ means it is in the acceptable range
✖ means it is out of limited range

Main points can be summarized as follows:

1. Scenario 1: It is the base case where voltages of every buses are simulated and the energy losses are calculated. It gives the second highest energy losses in the system (1.4353 MWh/day).
2. Scenario 2: PV_1 is connected to bus 838 which is the farthest bus of the system. Voltages of all buses include voltage of PV bus are out of acceptable range, but the energy of line losses of the system has decrease 14.61%.
3. Scenario 3: PV_1 and PV_2 are connected to buses 838 and 858 respectively. PV_2 is located near the heavy load. Voltages of all buses are violence the boundary voltages. The energy losses is the worst of all case scenario, 1.8677 MWh/day.
4. Scenario 4: System with PV_1 and one ES is connected to the same bus (838). Voltages of all buses have been improved and in acceptable range. It provides the best result of energy losses (0.8874MWh/day) for system with one PV.
5. Scenario 5: PV_1 is still attached to bus 838, but there are two ESs sites at bus 838 and 862. Voltages of all buses are in range, but the energy losses is a little bit higher than that of scenario 4 (0.8875 MWh/day).
6. Scenario 6: The system has one PV at bus 838, and three ESs at bus 838, 862, and 842. Voltages of all buses and energy losses are quite similar to those of scenario 5
7. Scenario 7: PV_1 and PV_2 are connected to buses 838 and 858 respectively and one ES is at bus 834. Voltages of all buses are in the limited range. The energy losses is the second best result after scenario 8 for the system using two PV.

8. Scenario 8: Two PVs are connected to buses 838 and 858 with its own ES. It provides the best result for scenarios with two PVs for both voltages and energy losses (0.6088MWh/day or 57.58% improvement) results.
9. Scenario 9: There are 3 ESs at bus 838, 858, and 834 while PV_1 and PV_2 are at buses 838 and 858. Even all the voltages are in range, the energy losses of scenario 9 has increased slightly (0.9203 MWh/day) which could imply that using more sites does not mean decreasing energy losses.
10. Scenario 10 and 11: The results of simulation show that, using one ES or two ESs for system with two PVs has mitigated voltages problems. However, for better result using two ESs provides better energy losses.
11. Sensitivity of losses can be used to find the proper site and size of ES to mitigate voltage rise and voltage drop of the system with simple simulation
12. After applying the method, the system with a PV require only one ES at the PV location to get the smallest amount of energy losses, and voltages problem of the system have been mitigated. Using more energy storage locations will lead to more energy loses.
13. The system with two PVs requires 2 ES at the same location as PVs to get the lowest energy losses. Furthermore, the ES of PV near heavy load tends to have slightly bigger capacity to that of PV far away from load. IF one ES is used, the ES location will be connected to one of buses between the two PVs, and settled near the heavy load.
14. The simulation results of all case studied above show that using proper site and size of ES can solve problems of voltages rise and voltages drop of the system which is the main proposed problem.

Chapter 6

Conclusion

This thesis proposed mitigation of voltage rise and voltage drop by utilizing energy storage. Proper site and size of energy storage is simulated by using sensitivity of losses and Newton Raphson method. Results of the proposed method show that energy storage should be connected to PVs' location to get low energy losses and better voltages profile. In the case of using one PV, scenario 4 gives the best result by connecting one ES at the same bus as the PV. All of the 11 scenarios, the best results is provided by scenarios 8 where there are two PVs and two ESs connected to the same buses (838, and 858) near load and at the farthest buses of the system. In the case that there are two PVs and only one energy storage is used, the energy storage provides a good results by connecting to bus between the two PVs and near the heavy loads, but it cannot win again using 2 ESs. The pros of using this method is that the simulation method is easy to understand with some basic knowledge of sensitivity of system losses, and power flow.

Chapter 7
Future Work

The applied method is easy to understand. However it also has drawbacks because it might not give the most accurate results. Moreover, it can only be applied with balanced three phase system. In the future the unbalance system with voltage regulators, capacitors, and transformer should be studied. In the case that accurate result is needed, the complex optimization techniques such as Genetic Algorithm or Bee Algorithm should be used. Lastly, rather than using simulation results of one day, using whole year data will increase the accuracy of simulation.

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APPENDIX

Appendix A: Power Losses Calculation

According to [7], if the injected power at bus i is S_i, thus S_i equal to the subtraction of power generated at bus i with load at bus i. The total power loss can get by summing up all the power losses at each buses

$$P_L + jQ_L = \sum_{i=1}^{n} S_i = \sum_{i=1}^{n} V_i I_i^* = V_{bus}^T I_{bus}^* \quad (25)$$

but
$$V_{bus} = Z_{bus} I_{bus} \quad (26)$$

thus
$$P_L + jQ_L = I_{bus}^T Z_{bus}^T I_{bus}^* = I_{bus}^T Z_{bus} I_{bus}^* \quad (27)$$

Because Z_{bus} is symmetrical matrix

By consider each elements composed by real and reactive

$$I_{bus} = I_{real} + jI_{reactive} \quad (28)$$

$$Z_{bus} = R + jX \quad (29)$$

Therefore

$$P_L + jQ_L = (I_{real} + jI_{reactive})^T (R + jX)(I_{real} - jI_{reactive}) \quad (30)$$

From the above equation we can separate the real active power losses by

$$P_L = I_{real}^T R I_{real} + I_{real}^T X I_{ractive} + I_{reactive}^T X I_{reactive} - I_{reactive}^T X I_{real} \quad (31)$$

$$P_L = I_{real}^T R I_{real} + I_{reactive}^T X I_{reactive} \quad (32)$$

In term of summation we can rewrite the above equation by

$$P_L = \sum_{i=1}^{n} \sum_{j=1}^{n} R_{ij} (I_{real,i} I_{real,j} + I_{reactive,i} I_{reactive,j}) \quad (33)$$

from
$$P_i + jQ_i = V_i I_i^* = |V|(cos\delta_i + jsin\delta_i)(I_{real,i} - jI_{reactive,i}) \quad (34)$$

we get
$$P_i = |V_i| cos\delta_i I_{real,i} + |V_i| sin\delta_i I_{reactive,i} \quad (35)$$

and $$Q_i = |V_i| sin\delta_i I_{real,i} + |V_i| cos\delta_i I_{reactive,i}$$

Solve this equation we get

$$I_{real,i} = \frac{1}{|V_i|}(P_i cos\delta_i + Q_i\, sin\,\delta_i) \quad (36)$$

$$I_{reactive,i} = \frac{1}{|V_i|}(P_i\, sin\,\delta_i - Q_i\, cos\,\delta_i) \quad (37)$$

From equation 33, 36and 37 we can get

$$P_L = \sum_{i=1}^{n}\sum_{j=1}^{n}\frac{R_{ij}}{|V_i||V_j|}[(P_i cos\delta_i + Q_i\, sin\,\delta_i)(P_j cos\delta_j + Q_j\, sin\,\delta_j) + (P_i\, sin\,\delta_i - Q_i\, cos\,\delta_i)(P_j\, sin\,\delta_j - Q_j\, cos\,\delta_j)] \quad (38)$$

or

$$P_L = \sum_{i=1}^{n}\sum_{j=1}^{n}\frac{R_{ij}}{|V_i||V_j|}[P_iP_j\left(cos\,\delta_i\, cos\,\delta_j + sin\,\delta_i\, sin\,\delta_j\right) + Q_iQ_j(cos\,\delta_i\, cos\,\delta_j + sin\,\delta_i\, sin\,\delta_j) + P_iQ_j(cos\,\delta_i\, sin\,\delta_j - sin\,\delta_i\, cos\,\delta_j) + Q_iP_j(sin\,\delta_i\, cos\,\delta_j - cos\,\delta_i\, sin\,\delta_j)] \quad (39)$$

or

$$P_L = \sum_{i=1}^{n}\sum_{j=1}^{n}\frac{R_{ij}}{|V_i||V_j|}[(P_iP_j + Q_iQ_j)(cos\left(\delta_i - \delta_j\right)) + (Q_iP_j - P_iQ_j)(sin\left(\delta_i - \delta_j\right))] \quad (40)$$

thus

$$P_L = \sum_{i=1}^{n}\sum_{j=1}^{n}\frac{R_{ij}}{|V_i||V_j|}\left[(P_iP_j + Q_iQ_j\right)cos\,\delta_{ij} + (Q_iP_j - P_iQ_j)(sin\delta_{ij})] \quad (41)$$

Appendix B: Load Profile

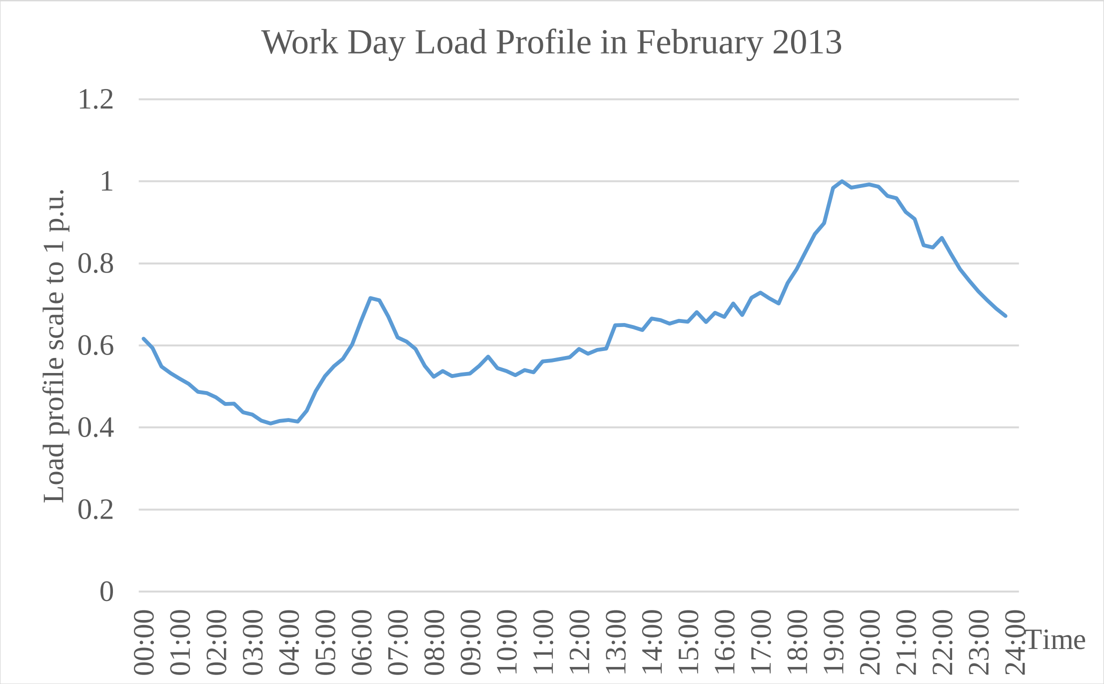

Figure 21 Work day load profile in February 2013

Appendix C: Power Profile at Each Points of PV

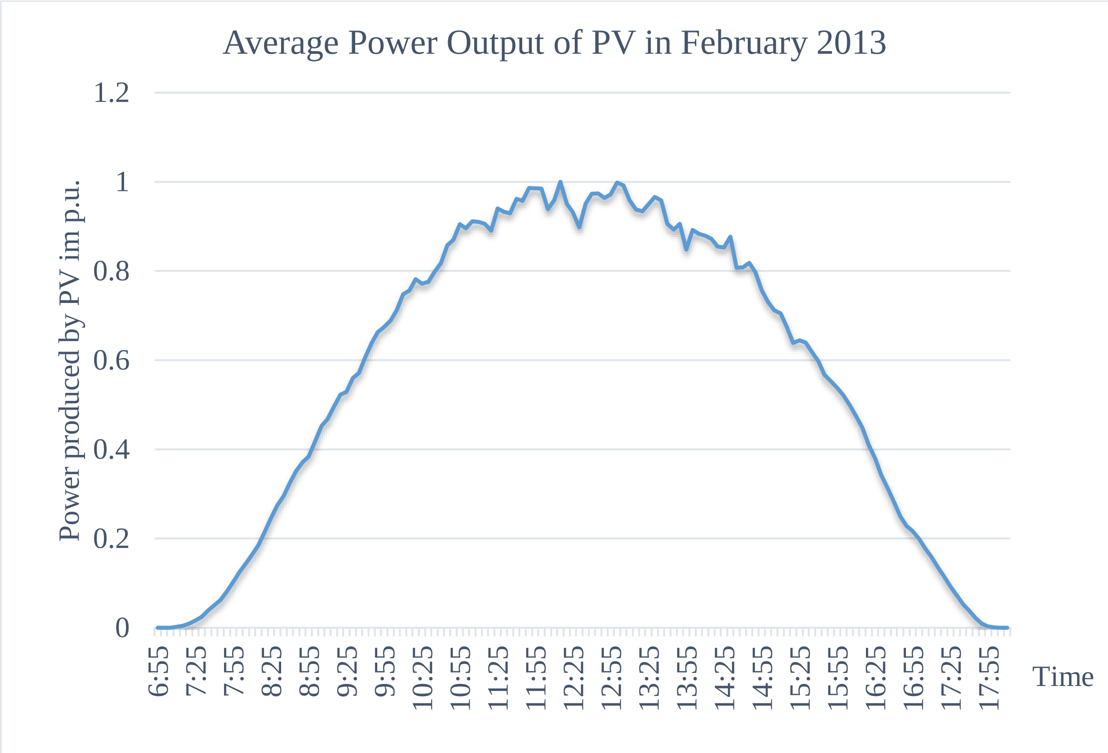

Figure 22 Average power output of PV in February 2013

Appendix D: Power Profile at Each Points of ES with one PV

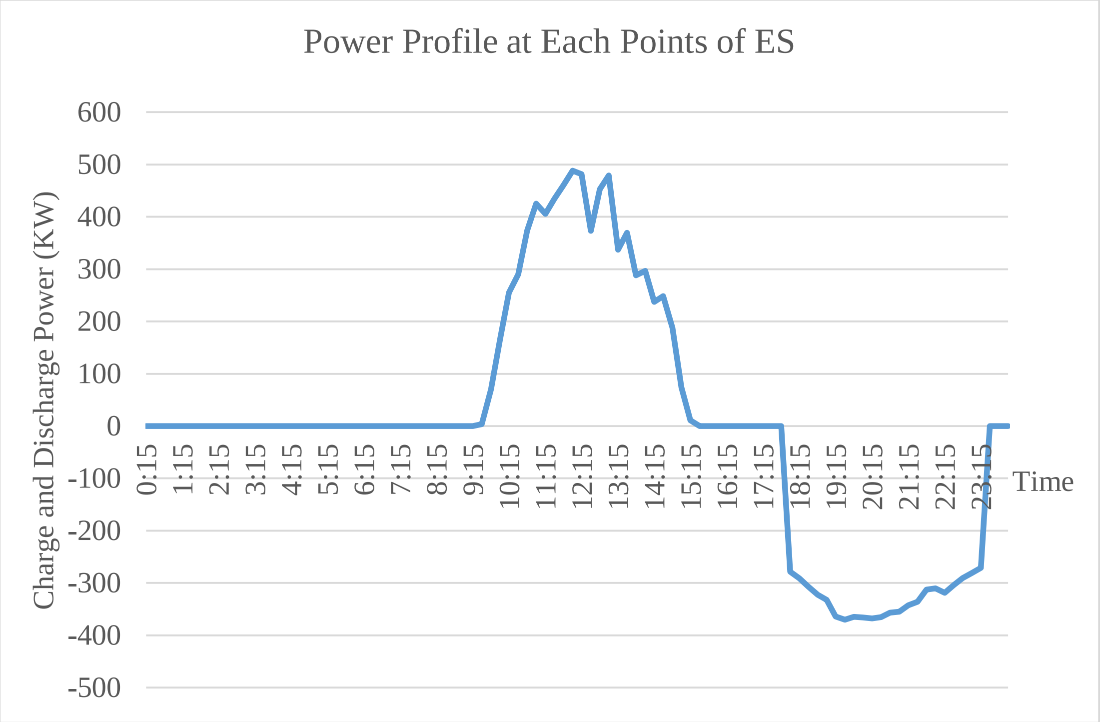

Figure 23 Power profile at each points of ES with one PV

Appendix E: Power Profile at Each Points of ES with two PVs

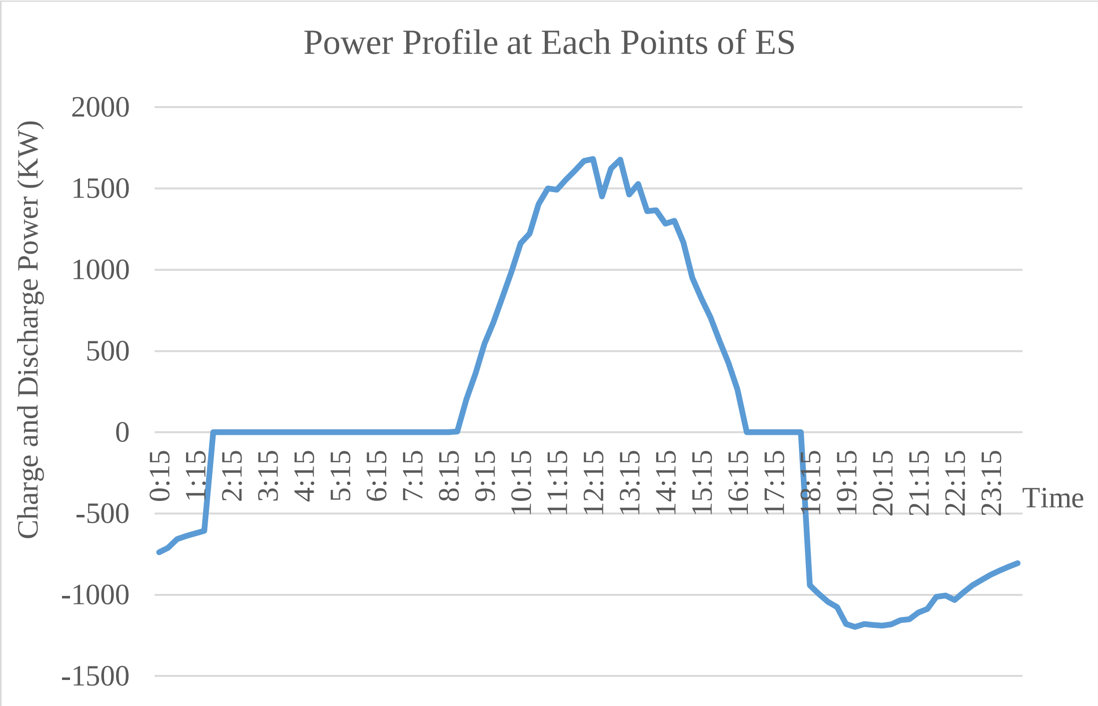

Figure 24 Power profile at each points of ES with two PVs

Appendix F: Newton-Raphson Power Flow Analysis [6]

Because of its quadratic convergence, Newton's method is mathematically superior to the Gauss-Seidel method and is less prone to divergence with ill-conditioned problems. For large power systems, the Newton-Raphson method is found to be more efficient and practical. The number of iteration required to obtain a solution is independent of the system size, but more functional evaluations are required at each iteration. Since in the power flow problem real power and voltage magnitude are specified for the voltage control bus, the power flow equation is formulated in polar form. For the typical bus of the power system, the current entering bus i is given by 10.21. This equation can be written in term of bus admittance matrix as

$$I_i = \sum_{j=1}^{n} Y_{ij} V_j \tag{42}$$

In the above equation, j includes bus i. Expressing this equation in polar form, we have

$$I_i = \sum_{j=1}^{n} |Y_{ij}||V_j| \angle \theta_{ij} + \delta_j \tag{43}$$

The complex number at bus i is

$$P_i - jQ_i = V_i^* I_i \tag{44}$$

Substituting from 43 for I_i in 44,

$$P_i - jQ_i = |V_i| \angle(-\delta_i) \sum_{j=1}^{n} |Y_{ij}||V_j| \angle \theta_{ij} + \delta_j \tag{45}$$

Separating the real and imaginary part,

$$P_i = \sum_{j=1}^{n} |V_i||V_j||Y_{ij}| \cos(\theta_{ij} - \delta_i + \delta_j) \tag{46}$$

$$Q_i = \sum_{j=1}^{n} |V_i||V_j||Y_{ij}| \sin(\theta_{ij} - \delta_i + \delta_j) \tag{47}$$

Equation 46 and 47 constitute a set of nonlinear algebraic equations in terms of the independent variables, voltage magnitude in per unit, and phase angle in radians. We have two equations for each load bus, given by 46 and 47, and one equation for each voltage controlled bus, given by 46. Expanding 46 and 47 in Taylor's series about the initial estimate and neglecting all higher order terms results in the following set of linear equations.

$$\begin{bmatrix} \Delta P_2^{(k)} \\ \vdots \\ \Delta P_n^{(k)} \\ \Delta Q_2^{(k)} \\ \vdots \\ \Delta Q_n^{(k)} \end{bmatrix} = \begin{bmatrix} \frac{\partial P_2}{\partial \delta_2}^{(k)} & \cdots & \frac{\partial P_2}{\partial \delta_n}^{(k)} & \frac{\partial P_2}{\partial |V_2|}^{(k)} & \cdots & \frac{\partial P_2}{\partial |V_n|}^{(k)} \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ \frac{\partial P_n}{\partial \delta_2}^{(k)} & \cdots & \frac{\partial P_n}{\partial \delta_n}^{(k)} & \frac{\partial P_n}{\partial |V_2|}^{(k)} & \cdots & \frac{\partial P_n}{\partial |V_n|}^{(k)} \\ \frac{\partial Q_2}{\partial \delta_2}^{(k)} & \cdots & \frac{\partial Q_2}{\partial \delta_n}^{(k)} & \frac{\partial Q_2}{\partial |V_2|}^{(k)} & \cdots & \frac{\partial Q_2}{\partial |V_n|}^{(k)} \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ \frac{\partial Q_n}{\partial \delta_2}^{(k)} & \cdots & \frac{\partial Q_n}{\partial \delta_n}^{(k)} & \frac{\partial Q_n}{\partial |V_2|}^{(k)} & \cdots & \frac{\partial Q_n}{\partial |V_n|}^{(k)} \end{bmatrix} \begin{bmatrix} \Delta \delta_2^{(k)} \\ \vdots \\ \Delta \delta_n^{(k)} \\ \Delta \left|V_2^{(k)}\right| \\ \vdots \\ \Delta \left|V_n^{(k)}\right| \end{bmatrix}$$

In the above equation, bus 1 is assumed to be the slack bus. The Jacobian matrix given the linearized relationship between small changes in voltage angle $\Delta\delta_i^{(k)}$ and voltage magnitude $\Delta\left|V_i^{(k)}\right|$ with the small changes in real and reactive power $\Delta P_i^{(k)}$ and $\Delta Q_i^{(k)}$. Element of Jacobian matrix are the partial derivatives of 46 and 47, evaluated at $\Delta\delta_i^{(k)}$ and $\Delta\left|V_i^{(k)}\right|$. In short term, it can be written as

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} J_1 & J_2 \\ J_3 & J_4 \end{bmatrix} \begin{bmatrix} \Delta \delta \\ \Delta |V| \end{bmatrix} \quad (48)$$

For voltage-controlled buses, the voltages magnitudes are known. Therefore, if m buses of the system are volage-controlled buses, m equations involving ΔQ and ΔV and the corresponding columns of the Jacobian matrix are eliminated. Accordingly, there are $n-1$ real power constrains and $n-1-m$ reactive constraints, and the Jacobian matrix is of order $(2n-2-m) \times (2n-2-m)$. J_1 is of the order $(n-1) \times (n-1)$, J_2 is of the order $(n-1) \times (n-1-m)$, J_3 is of the order $(n-1-m) \times (n-1)$, and J_4 is of the order $(n-1-m) \times (n-1-m)$.

The diagonal and the off-diagonal elements of J_1 are

$$\frac{\partial P_i}{\partial \delta_i} = \sum_{j \neq j} |V_i||V_j||Y_{ij}| \sin(\theta_{ij} - \delta_i + \delta_j) \quad (49)$$

$$\frac{\partial P_i}{\partial \delta_j} = -|V_i||V_j||Y_{ij}| \sin(\theta_{ij} - \delta_i + \delta_j) \qquad j \neq i \quad (50)$$

The diagonal and the off diagonal element of J_2 are

$$\frac{\partial P_i}{\partial |V_i|} = 2|V_i||Y_{ij}|\cos\theta_{ij} + \sum_{j \neq i} |V_j||Y_{ij}| \cos(\theta_{ij} - \delta_i + \delta_j) \quad (51)$$

$$\frac{\partial P_i}{\partial |V_j|} = |V_i||Y_{ij}| \cos(\theta_{ij} - \delta_i + \delta_j) \qquad j \neq i \quad (52)$$

The diagonal and the off-diagonal elements of J_3 are

$$\frac{\partial Q_i}{\partial \delta_i} = \sum_{j \neq i} |V_i||V_j||Y_{ij}| \cos(\theta_{ij} - \delta_i + \delta_j) \quad (53)$$

$$\frac{\partial Q_i}{\partial \delta_j} = -|V_i||V_j||Y_{ij}| \cos(\theta_{ij} - \delta_i + \delta_j) \qquad j \neq i \quad (54)$$

The diagonal and the off-diagonal element J_4 are

$$\frac{\partial Q_i}{\partial |V_i|} = -2|V_i||Y_{ij}|\sin\theta_{ii} - \sum_{j\neq i} |V_j||Y_{ij}| \sin(\theta_{ij} - \delta_i + \delta_j) \tag{55}$$

$$\frac{\partial Q_i}{\partial |V_j|} = -|V_i||Y_{ij}| \sin(\theta_{ij} - \delta_i + \delta_j) \qquad j \neq i \tag{56}$$

The terms $\Delta P_i^{(k)}$ and $\Delta Q_i^{(k)}$are the difference between the schedule and calculated values, known as the *power residuals*, given by

$$\Delta P_i^{(k)} = P_i^{sch} - P_i^{(k)} \tag{57}$$

$$\Delta Q_i^{(k)} = Q_i^{sch} - Q_i^{(k)} \tag{58}$$

The new estimates for bus voltages are

$$\delta_i^{(k+1)} = \delta_i^{(k)} + \Delta\delta_i^{(k)} \tag{59}$$

$$\left|V_i^{(k+1)}\right| = \left|V_i^{(k)}\right| + \Delta\left|V_i^{(k)}\right| \tag{60}$$

The procedure for power flow solution by the Newton-Raphson method is as follow:

1. For load buses, where P_i^{sch} and Q_i^{sch} are specified, voltage magnitudes and phase angle are set equal to the slack bus valtue, or 1.0 or 0.0, i.e.,$\left|V_i^{(0)}\right| = 1.0$ and $\delta_i^{(0)} = 0.0$. For voltage-regulated buses, where $|V_i|$ and P_i^{sch} are specified, phase angles are set equal to the slack bus angle, or 0, i.e., $\delta_i^{(0)} = 0$.

2. For load buses, $P_i^{(k)}$ and $Q_i^{(k)}$ are calculated from 46 and 47 and $\Delta P_i^{(k)}$ and $\Delta Q_i^{(k)}$ are calculated from 57 and 58.

3. For the voltage-controlled buses, $P_i^{(k)}$and $\Delta P_i^{(k)}$ are calculated from 46 and 47, respectively.

4. The elements of Jacobian matrix (J_1, J_2, J_3 and J_4) are calculated from (49)-(56).
5. The linear simultaneous equation 48 is solved directly by optimally ordered triangular factorization and Gaussian elimination.
6. The new voltage magnitudes and phase angles are computed from 59 and 60.
7. The process is continued until the residuals $\Delta P_i^{(k)}$ and $\Delta Q_i^{(k)}$ are less than the specified accuracy, i.e.,

$$\left|\Delta P_i^{(k)}\right| \leq \varepsilon$$
$$\left|\Delta Q_i^{(k)}\right| \leq \varepsilon \quad (61)$$

Appendix G: Voltages of bus 800-834 (Base case)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
0:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
0:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
1:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
8:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
8:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	0.99	0.99
8:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
9:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
9:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
9:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
9:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
10:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
10:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	0.99	0.99
10:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
10:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	0.99	0.99
11:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
11:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
11:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
11:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
12:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
12:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
12:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
12:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
13:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
13:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	1	0.98	0.98
13:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	1	0.98	0.98
13:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
14:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
14:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
14:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
14:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	1	0.98	0.98
15:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
15:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
15:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1	1	1	1	0.99	0.98	0.97
15:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
16:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1	1	1	1	0.99	0.98	0.97
16:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
16:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
16:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
17:00	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
17:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
17:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
17:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
18:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
18:15	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	1	0.99	0.99	0.99	0.98	0.96	0.96
18:30	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95
18:45	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.95	0.95
19:00	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.95	0.94
19:15	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
19:30	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
19:45	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93

20:00	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
20:15	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
20:30	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
20:45	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.97	0.94	0.93
21:00	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.97	0.94	0.94
21:15	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.94	0.94
21:30	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.97	0.95	0.94
21:45	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95
22:00	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95
22:15	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.95	0.95
22:30	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	0.99	0.99	0.99	0.99	0.98	0.96	0.95
22:45	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	1	0.99	0.99	0.99	0.98	0.96	0.96
23:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
23:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
23:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
23:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
0:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97

Appendix G: Voltages of bus 836-890 (Base case)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
1:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
3:45	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:00	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	1
4:15	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
4:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
5:00	0.99	0.99	0.99	1	1	0.99	0.99	1.02	1	1.01	1.01	1	1	0.99	1	0.99	0.98
5:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
5:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
5:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
6:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
6:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
6:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
6:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
7:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
7:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
8:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
8:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
8:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
8:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
9:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
9:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
9:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
9:45	0.98	0.98	0.98	0.99	0.98	0.98	0.98	1.02	0.99	1	1	0.99	0.98	0.98	0.99	0.97	0.97
10:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
10:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
10:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
10:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
11:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
11:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.97
11:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
11:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
12:00	0.99	0.98	0.98	0.99	0.99	0.98	0.98	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
12:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
12:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.99	0.98	0.98	0.99	0.97	0.97
12:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
13:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
13:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
13:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
13:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
14:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
14:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
14:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
14:45	0.97	0.97	0.97	0.98	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.98	0.97	0.98	0.96	0.96
15:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
15:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
15:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
15:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96

16:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
16:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
16:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
16:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
17:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
17:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
17:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
17:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
18:00	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.96	0.96	0.96	0.96	0.95	0.95
18:15	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.96	0.98	0.98	0.96	0.96	0.96	0.96	0.94	0.94
18:30	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.96	0.98	0.98	0.96	0.95	0.95	0.96	0.94	0.93
18:45	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.99	0.95	0.97	0.97	0.95	0.95	0.95	0.95	0.93	0.93
19:00	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.99	0.95	0.97	0.97	0.95	0.94	0.94	0.95	0.92	0.92
19:15	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
19:30	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
19:45	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
20:00	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
20:15	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
20:30	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
20:45	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.97	0.96	0.94	0.93	0.93	0.94	0.91	0.91
21:00	0.93	0.93	0.93	0.94	0.94	0.93	0.93	0.99	0.94	0.97	0.97	0.94	0.94	0.93	0.94	0.91	0.91
21:15	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.99	0.94	0.97	0.97	0.94	0.94	0.94	0.94	0.92	0.92
21:30	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.99	0.95	0.97	0.97	0.94	0.94	0.94	0.94	0.92	0.92
21:45	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.96	0.98	0.98	0.95	0.95	0.95	0.95	0.93	0.93
22:00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.96	0.98	0.98	0.95	0.95	0.95	0.95	0.93	0.93
22:15	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.95	0.98	0.98	0.95	0.95	0.95	0.95	0.93	0.93
22:30	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.96	0.98	0.98	0.96	0.95	0.95	0.96	0.94	0.94
22:45	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.96	0.98	0.98	0.96	0.96	0.96	0.96	0.94	0.94
23:00	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.96	0.96	0.96	0.96	0.95	0.94
23:15	0.96	0.96	0.96	0.97	0.97	0.96	0.96	1	0.97	0.99	0.99	0.97	0.97	0.96	0.97	0.95	0.95
23:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
23:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
0:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96

Appendix H: Voltages of bus 800-834 (PV1 connected to bus 838)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.02
0:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.02
0:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.03
1:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
1:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
1:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.03
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.03
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.02
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.02
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1.05	1.05	1.05	1.03	1.03	1.02
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1.05	1.05	1.05	1.03	1.03	1.02
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.02
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.02
7:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.02
7:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.03
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.03
8:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.03
8:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.01	1.05	1.05	1.05	1.04	1.04	1.04
8:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.04	1.04	1.04
9:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.05	1.05	1.04
9:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.05	1.05	1.04
9:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.04
9:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.04
10:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
10:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.01	1.05	1.05	1.05	1.05	1.05	1.05
10:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.05	1.05	1.05
10:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.01	1.05	1.05	1.05	1.05	1.05	1.05
11:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.05	1.05	1.05	1.05	1.05	1.05
11:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
11:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
11:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
12:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
12:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
12:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
12:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
13:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
13:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
13:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
13:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
14:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
14:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
14:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
14:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.05
15:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.04
15:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.05	1.05	1.04
15:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1	1.05	1.05	1.05	1.04	1.04	1.04
15:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.04
16:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1	1.05	1.05	1.05	1.04	1.04	1.04
16:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.03
16:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1.05	1.05	1.05	1.04	1.04	1.03
16:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.03
17:00	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1.05	1.05	1.05	1.04	1.04	1.02
17:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1.05	1.05	1.05	1.04	1.04	1.02
17:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1.05	1.05	1.05	1.04	1.04	1.02
17:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1.05	1.05	1.05	1.03	1.03	1.02
18:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1.05	1.05	1.05	1.03	1.03	1.02
18:15	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	1	1.05	1.05	1.05	1.03	1.03	1.01
18:30	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	1.05	1.05	1.05	1.03	1.03	1.01
18:45	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	1.05	1.05	1.05	1.03	1.03	1.01
19:00	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	1.05	1.05	1.05	1.03	1.03	1.01
19:15	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	1.05	1.05	1.05	1.03	1.03	1
19:30	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	1.05	1.05	1.05	1.03	1.03	1
19:45	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	1.05	1.05	1.05	1.03	1.03	1

20:00	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	1.05	1.05	1.05	1.03	1.03	1
20:15	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	1.05	1.05	1.05	1.03	1.03	1
20:30	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	1.05	1.05	1.05	1.03	1.03	1
20:45	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.98	0.98	1.05	1.05	1.05	1.03	1.03	1.01
21:00	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.98	0.98	1.05	1.05	1.05	1.03	1.03	1.01
21:15	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	1.05	1.05	1.05	1.03	1.03	1.01
21:30	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	1.05	1.05	1.05	1.03	1.03	1.01
21:45	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	1.05	1.05	1.05	1.03	1.03	1.01
22:00	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	1.05	1.05	1.05	1.03	1.03	1.01
22:15	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	1.05	1.05	1.05	1.03	1.03	1.01
22:30	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	0.99	1.05	1.05	1.05	1.03	1.03	1.01
22:45	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	1	1.05	1.05	1.05	1.03	1.03	1.01
23:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1.05	1.05	1.05	1.03	1.03	1.02
23:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1.05	1.05	1.05	1.03	1.03	1.02
23:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1.05	1.05	1.05	1.03	1.03	1.02
23:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1.05	1.05	1.05	1.03	1.03	1.02
0:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.05	1.05	1.05	1.04	1.04	1.02

Appendix H: Voltages of bus 838-890 (PV1 connected to bus 838)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
0:30	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98
0:45	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
1:00	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
1:15	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
1:30	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99	0.99	0.99	0.99	0.99	0.99	0.99
1:45	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
2:00	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
2:15	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
2:30	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
2:45	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
3:00	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
3:15	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
3:30	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1
3:45	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1
4:00	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1
4:15	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1
4:30	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1
4:45	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
5:00	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	0.99	0.99	0.99	1	1	0.99
5:15	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
5:30	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
5:45	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
6:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
6:15	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97
6:30	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
6:45	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
7:00	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97
7:15	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
7:30	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98
7:45	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
8:00	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
8:15	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
8:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
8:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.03	1.02	1.02	1.02	1.02
9:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
9:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.04	1.04	1.04
10:00	1.05	1.05	1.05	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.05	1.05	1.05	1.05
10:15	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
10:30	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
10:45	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.07
11:00	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
11:15	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.07
11:30	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
11:45	1.05	1.06	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.08	1.07	1.07	1.07	1.07
12:00	1.06	1.06	1.06	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07	1.08	1.08	1.08	1.07	1.07	1.07
12:15	1.06	1.06	1.06	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.08	1.07	1.07	1.07	1.07
12:30	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.06	1.06
12:45	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.08	1.07	1.07	1.07	1.07
13:00	1.06	1.06	1.06	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.08	1.07	1.07	1.07	1.07
13:15	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.07	1.06	1.06	1.06	1.06
13:30	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.07	1.07	1.07	1.06	1.06	1.06
13:45	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
14:00	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
14:15	1.05	1.05	1.05	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.05	1.05	1.05
14:30	1.05	1.05	1.05	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.05	1.05	1.05
14:45	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.05	1.05	1.05	1.05
15:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.05	1.04	1.04	1.04	1.04
15:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04

15:30	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03
15:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
16:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
16:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
16:30	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
16:45	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1	1	1	1	1	1	1
17:00	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
17:15	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
17:30	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.98	0.97	0.98	0.97	0.98	0.97	0.97
17:45	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
18:00	1	1	1	1	1	1	1	1	0.99	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96
18:15	1	1	1	1	1	0.99	0.99	0.99	0.98	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
18:30	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95
18:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
19:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94
19:15	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93
19:30	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93
19:45	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93
20:00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93
20:15	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93
20:30	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93
20:45	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.97	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93
21:00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.97	0.94	0.94	0.93	0.93	0.93	0.94	0.94	0.93
21:15	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
21:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.97	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94
21:45	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95
22:00	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95
22:15	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
22:30	1	1	1	1	0.99	0.99	0.99	0.99	0.98	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95
22:45	1	1	1	1	1	0.99	0.99	0.99	0.98	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
23:00	1	1	1	1	1	1	1	1	0.99	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96
23:15	1	1	1	1	1	1	1	1	0.99	0.97	0.97	0.96	0.96	0.96	0.97	0.97	0.96
23:30	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
23:45	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
0:00	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97

Appendix I: Voltages of bus 800-834 (PV connected to bus 838 and 858)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
0:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
0:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
1:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
7:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.01	1.01
8:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
8:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
8:45	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
9:00	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06
9:15	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.07	1.07	1.08
9:30	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.07	1.07	1.08	1.08
9:45	1.05	1.05	1.05	1.06	1.06	1.06	1.07	1.07	1.07	1.06	1.06	1.07	1.07	1.07	1.08	1.09	1.09
10:00	1.05	1.05	1.05	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.1	1.1
10:15	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.07	1.07	1.08	1.08	1.08	1.09	1.11	1.12
10:30	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.09	1.11	1.12
10:45	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.1	1.12	1.13
11:00	1.05	1.05	1.05	1.06	1.06	1.08	1.09	1.09	1.09	1.08	1.08	1.09	1.09	1.09	1.11	1.13	1.14
11:15	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.08	1.08	1.09	1.09	1.09	1.1	1.13	1.13
11:30	1.05	1.05	1.05	1.06	1.06	1.08	1.09	1.09	1.09	1.08	1.08	1.09	1.09	1.09	1.11	1.13	1.14
11:45	1.05	1.05	1.05	1.06	1.06	1.08	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.1	1.11	1.14	1.14
12:00	1.05	1.05	1.05	1.06	1.06	1.08	1.09	1.09	1.09	1.09	1.09	1.1	1.1	1.1	1.11	1.14	1.14
12:15	1.05	1.05	1.05	1.06	1.06	1.08	1.09	1.09	1.09	1.09	1.09	1.1	1.1	1.1	1.11	1.14	1.14
12:30	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.1	1.13	1.13
12:45	1.05	1.05	1.05	1.06	1.06	1.08	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.1	1.11	1.14	1.14
13:00	1.05	1.05	1.05	1.06	1.06	1.08	1.09	1.09	1.09	1.09	1.09	1.1	1.1	1.1	1.11	1.14	1.14
13:15	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.1	1.13	1.13
13:30	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.1	1.13	1.13
13:45	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.1	1.12	1.13
14:00	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.1	1.12	1.13
14:15	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.07	1.08	1.08	1.08	1.09	1.12	1.12
14:30	1.05	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.1	1.12	1.12
14:45	1.05	1.05	1.05	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.08	1.08	1.08	1.09	1.11	1.11
15:00	1.05	1.05	1.05	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.08	1.1	1.1
15:15	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.08	1.09	1.09
15:30	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.07	1.08	1.08
15:45	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07
16:00	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.07
16:15	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05
16:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
16:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
17:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
17:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	0.99	0.99
17:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
17:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
18:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
18:15	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	1	0.99	0.99	0.99	0.98	0.96	0.96
18:30	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95
18:45	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.95	0.95
19:00	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.95	0.94
19:15	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
19:30	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
19:45	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93

20:00	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
20:15	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
20:30	1.05	1.05	1.05	1.03	1.03	1	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.94	0.93
20:45	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.97	0.94	0.93
21:00	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.97	0.94	0.94
21:15	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.94	0.94
21:30	1.05	1.05	1.05	1.03	1.03	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.97	0.95	0.94
21:45	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95
22:00	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.95
22:15	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	0.99	0.99	0.99	0.99	0.99	0.98	0.95	0.95
22:30	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	0.99	0.99	0.99	0.99	0.98	0.96	0.95
22:45	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	1	0.99	0.99	0.99	0.98	0.96	0.96
23:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
23:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
23:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
23:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
0:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97

Appendix I: Voltages of bus 838-890 (PVs connected to bus 838 and 858)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
1:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
3:45	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:00	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	1
4:15	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
4:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
5:00	0.99	0.99	0.99	1	1	0.99	0.99	1.02	1	1.01	1.01	1	1	0.99	1	0.99	0.98
5:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
5:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
5:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
6:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
6:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
6:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
6:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
7:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
7:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
7:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	1	0.99	0.99	1	0.98	0.98
8:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.03	1.01	1.02	1.02	1.01	1.01	1.01	1.01	1	1
8:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
8:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
8:45	1.05	1.06	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.04	1.04
9:00	1.07	1.07	1.07	1.06	1.06	1.06	1.06	1.05	1.06	1.06	1.06	1.06	1.06	1.07	1.06	1.05	1.05
9:15	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.06	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.06	1.06
9:30	1.09	1.09	1.09	1.08	1.08	1.08	1.08	1.06	1.08	1.07	1.07	1.08	1.09	1.09	1.08	1.07	1.07
9:45	1.1	1.1	1.1	1.09	1.09	1.09	1.09	1.07	1.09	1.08	1.08	1.09	1.1	1.1	1.09	1.08	1.08
10:00	1.11	1.11	1.11	1.1	1.1	1.1	1.1	1.07	1.1	1.09	1.09	1.1	1.11	1.11	1.1	1.09	1.09
10:15	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.08	1.11	1.09	1.09	1.11	1.12	1.12	1.11	1.1	1.1
10:30	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.08	1.11	1.1	1.1	1.12	1.12	1.12	1.12	1.1	1.1
10:45	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.08	1.12	1.1	1.1	1.13	1.13	1.13	1.13	1.11	1.11
11:00	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.09	1.13	1.11	1.11	1.13	1.14	1.14	1.13	1.12	1.12
11:15	1.14	1.14	1.14	1.13	1.13	1.13	1.13	1.09	1.13	1.11	1.11	1.13	1.14	1.14	1.13	1.12	1.12
11:30	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.09	1.13	1.11	1.11	1.14	1.14	1.14	1.14	1.12	1.12
11:45	1.14	1.15	1.14	1.14	1.14	1.14	1.14	1.09	1.14	1.11	1.11	1.14	1.14	1.14	1.14	1.12	1.12
12:00	1.15	1.15	1.15	1.14	1.14	1.14	1.14	1.09	1.14	1.11	1.11	1.14	1.15	1.15	1.14	1.13	1.13
12:15	1.15	1.15	1.15	1.14	1.14	1.14	1.14	1.09	1.14	1.11	1.11	1.14	1.15	1.15	1.14	1.13	1.13
12:30	1.13	1.14	1.13	1.13	1.13	1.13	1.13	1.08	1.13	1.1	1.1	1.13	1.13	1.13	1.13	1.11	1.11
12:45	1.14	1.15	1.14	1.14	1.14	1.14	1.14	1.09	1.14	1.11	1.11	1.14	1.14	1.14	1.14	1.12	1.12
13:00	1.15	1.15	1.15	1.14	1.14	1.14	1.14	1.09	1.14	1.11	1.11	1.14	1.15	1.15	1.14	1.13	1.13
13:15	1.13	1.14	1.13	1.13	1.13	1.13	1.13	1.08	1.13	1.1	1.1	1.13	1.13	1.13	1.13	1.11	1.11
13:30	1.14	1.14	1.14	1.13	1.13	1.13	1.13	1.08	1.13	1.1	1.1	1.13	1.14	1.14	1.13	1.12	1.11
13:45	1.13	1.13	1.13	1.13	1.12	1.12	1.12	1.08	1.12	1.1	1.1	1.12	1.13	1.13	1.12	1.11	1.11
14:00	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.08	1.12	1.1	1.1	1.12	1.13	1.13	1.12	1.11	1.11
14:15	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.08	1.12	1.09	1.09	1.12	1.12	1.12	1.12	1.1	1.1
14:30	1.12	1.13	1.12	1.12	1.12	1.12	1.12	1.08	1.12	1.1	1.1	1.12	1.12	1.12	1.12	1.1	1.1
14:45	1.12	1.12	1.12	1.11	1.11	1.11	1.11	1.07	1.11	1.09	1.09	1.11	1.11	1.12	1.11	1.09	1.09
15:00	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.07	1.1	1.08	1.08	1.1	1.1	1.1	1.1	1.08	1.08
15:15	1.09	1.1	1.09	1.09	1.09	1.09	1.09	1.06	1.09	1.08	1.08	1.09	1.09	1.09	1.09	1.07	1.07
15:30	1.09	1.09	1.09	1.08	1.08	1.08	1.08	1.06	1.08	1.07	1.07	1.08	1.08	1.09	1.08	1.07	1.06

15:45	1.08	1.08	1.08	1.07	1.07	1.07	1.07	1.06	1.07	1.06	1.06	1.07	1.08	1.08	1.07	1.06	1.06
16:00	1.07	1.07	1.07	1.07	1.07	1.06	1.06	1.05	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.05	1.05
16:15	1.06	1.06	1.06	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.05	1.04	1.04
16:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
16:45	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1	1
17:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.01	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
17:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
17:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
17:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
18:00	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.96	0.96	0.96	0.96	0.95	0.95
18:15	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.96	0.98	0.98	0.96	0.96	0.96	0.96	0.94	0.94
18:30	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.96	0.98	0.98	0.96	0.95	0.95	0.96	0.94	0.93
18:45	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.99	0.95	0.97	0.97	0.95	0.95	0.95	0.95	0.93	0.93
19:00	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.99	0.95	0.97	0.97	0.95	0.94	0.94	0.95	0.92	0.92
19:15	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
19:30	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
19:45	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
20:00	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
20:15	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
20:30	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.96	0.96	0.93	0.93	0.93	0.93	0.91	0.91
20:45	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.99	0.94	0.97	0.96	0.94	0.93	0.93	0.94	0.91	0.91
21:00	0.93	0.93	0.93	0.94	0.94	0.93	0.93	0.99	0.94	0.97	0.97	0.94	0.94	0.93	0.94	0.91	0.91
21:15	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.99	0.94	0.97	0.97	0.94	0.94	0.94	0.94	0.92	0.92
21:30	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.99	0.95	0.97	0.97	0.94	0.94	0.94	0.94	0.92	0.92
21:45	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.96	0.98	0.98	0.95	0.95	0.95	0.95	0.93	0.93
22:00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.96	0.98	0.98	0.95	0.95	0.95	0.95	0.93	0.93
22:15	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.95	0.98	0.98	0.95	0.95	0.95	0.95	0.93	0.93
22:30	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1	0.96	0.98	0.98	0.96	0.95	0.95	0.96	0.94	0.94
22:45	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.96	0.98	0.98	0.96	0.96	0.96	0.96	0.94	0.94
23:00	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.96	0.96	0.96	0.96	0.95	0.94
23:15	0.96	0.96	0.96	0.97	0.97	0.96	0.96	1	0.97	0.99	0.99	0.97	0.97	0.96	0.97	0.95	0.95
23:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
23:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
0:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96

Appendix J: Voltages of bus 800-834 (PV and ES connected to bus 838)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
0:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
0:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
1:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
7:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
8:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
8:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02
8:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
9:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
9:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
15:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
16:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
16:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02
16:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
16:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
17:00	1.05	1.05	1.05	1.04	1.04	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
17:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
17:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.98
17:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
18:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
18:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
18:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
18:45	1.05	1.05	1.05	1.04	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.98	0.97
19:00	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.98	0.97
19:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
19:30	1.05	1.05	1.05	1.03	1.03	1.01	1	1	1	1	1	1	1	0.99	0.98	0.97	0.96
19:45	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96

20:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.98	0.97	0.96
20:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.98	0.97	0.96
20:30	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
20:45	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
21:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
21:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
21:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
21:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	1	0.98	0.98
22:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	1	0.98	0.98
22:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.98	0.98
22:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
22:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
23:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
23:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
23:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
23:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
0:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97

Appendix J: Voltage of bus 838-890 (PV and ES connected to bus 838)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
1:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
3:45	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:00	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	1
4:15	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
4:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
5:00	0.99	0.99	0.99	1	1	0.99	0.99	1.02	1	1.01	1.01	1	1	0.99	1	0.99	0.98
5:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
5:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
5:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
6:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
6:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
6:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
6:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
7:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
7:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
8:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
8:15	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.03	1.01	1.02	1.02	1.01	1.01	1.01	1.01	1	1
8:30	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1	1
8:45	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1.01
9:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
9:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
9:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
9:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
10:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
10:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
11:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
11:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:30	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.01
15:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01

16:00	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1
16:15	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1	1
16:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
16:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.98	0.98
17:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
17:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
17:30	0.97	0.98	0.97	0.98	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
17:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
18:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.01	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
18:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.96
18:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
18:45	0.98	0.98	0.98	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.98	0.98	0.96	0.95
19:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
19:15	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.97	0.96	0.96	0.97	0.94	0.94
19:30	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.96	0.96	0.96	0.96	0.94	0.94
19:45	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.97	0.96	0.96	0.97	0.94	0.94
20:00	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.97	0.96	0.96	0.97	0.94	0.94
20:15	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.97	0.96	0.96	0.97	0.94	0.94
20:30	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.97	0.96	0.96	0.97	0.94	0.94
20:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.94	0.94
21:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.94	0.94
21:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
21:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
21:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	0.99	0.99	0.98	0.98	0.98	0.98	0.96	0.95
22:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.96
23:00	0.99	0.99	0.99	0.99	0.99	0.99	0.98	1.01	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
23:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
23:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
23:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
0:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96

Appendix K: Voltages of bus 800-834 (PV bus 838 and ES 2 buses)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
0:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
0:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
1:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
7:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
8:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
8:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02
8:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
9:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
9:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
15:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
16:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
16:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02
16:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
16:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
17:00	1.05	1.05	1.05	1.04	1.04	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
17:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
17:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.98
17:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
18:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
18:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
18:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
18:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.98	0.98
19:00	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.98	0.97
19:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
19:30	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	0.99	0.98	0.97	0.96
19:45	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96

20:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
20:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.98	0.97	0.96
20:30	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
20:45	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
21:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
21:15	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1	1	1	1	1	1	1	0.99	0.97	0.97
21:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
21:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	1	0.98	0.98
22:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1	1	1	0.98	0.98
22:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1	1	1	1	0.99	0.98	0.98
22:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
22:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
23:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
23:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
23:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
23:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
0:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97

Appendix K: Voltages of bus 838-890 (PV bus 838 and ES 2 buses)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
1:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
3:45	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:00	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	1
4:15	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
4:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
5:00	0.99	0.99	0.99	1	1	0.99	0.99	1.02	1	1.01	1.01	1	1	0.99	1	0.99	0.98
5:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
5:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
5:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
6:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
6:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
6:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
6:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
7:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
7:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
8:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
8:15	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.03	1.01	1.02	1.02	1.01	1.01	1.01	1.01	1	1
8:30	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1	1
8:45	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1.01
9:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
9:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
9:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
9:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
10:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
10:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
11:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
11:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:30	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.01

15:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
16:00	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1
16:15	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1	1
16:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
16:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.98	0.98
17:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
17:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
17:30	0.97	0.98	0.97	0.98	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
17:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
18:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.01	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
18:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.96
18:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
18:45	0.98	0.98	0.98	0.98	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.98	0.98	0.98	0.96	0.95
19:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
19:15	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.97	0.96	0.97	0.97	0.94	0.94
19:30	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.96	0.96	0.96	0.96	0.94	0.94
19:45	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.97	0.96	0.96	0.97	0.94	0.94
20:00	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.97	0.96	0.96	0.97	0.94	0.94
20:15	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.97	0.96	0.96	0.97	0.94	0.94
20:30	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.97	0.96	0.96	0.97	0.94	0.94
20:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.94	0.94
21:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.94	0.94
21:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
21:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
21:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	0.99	0.99	0.98	0.98	0.98	0.98	0.96	0.96
22:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.96
23:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.01	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
23:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
23:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
23:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
0:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96

Appendix L: Voltages of bus 800-834 (PV bus 838 and ES 3 buses)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
0:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
0:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
1:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
1:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
7:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
8:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
8:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02
8:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
9:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
9:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
13:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
14:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
15:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
15:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
16:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
16:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.02
16:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
16:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
17:00	1.05	1.05	1.05	1.04	1.04	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
17:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
17:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.98
17:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
18:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
18:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
18:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
18:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.98	0.98
19:00	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.98	0.97
19:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
19:30	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	0.99	0.98	0.97	0.96
19:45	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96

20:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
20:15	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.98	0.97	0.96
20:30	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
20:45	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
21:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.97
21:15	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1	1	1	1	1	1	1	0.99	0.97	0.97
21:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
21:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	1	0.98	0.98
22:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1	1	1	0.98	0.98
22:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1	1	1	1	0.99	0.98	0.98
22:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
22:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.98
23:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
23:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
23:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
23:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
0:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97

Appendix L: Voltages of bus 838-890 (PV bus 838 and ES 3 buses)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
0:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
1:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
1:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
3:45	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:00	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	1
4:15	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
4:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
5:00	0.99	0.99	0.99	1	1	0.99	0.99	1.02	1	1.01	1.01	1	1	0.99	1	0.99	0.98
5:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
5:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
5:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
6:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
6:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
6:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
6:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
7:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
7:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
8:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
8:15	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.03	1.01	1.02	1.02	1.01	1.01	1.01	1.01	1	1
8:30	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1	1
8:45	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1.01
9:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
9:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
9:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
9:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
10:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
10:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
11:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
11:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:30	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.01

15:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
16:00	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1
16:15	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1	1
16:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
16:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.98	0.98
17:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
17:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
17:30	0.97	0.98	0.97	0.98	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
17:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
18:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.01	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
18:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.96
18:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
18:45	0.98	0.98	0.98	0.98	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.98	0.98	0.98	0.96	0.95
19:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
19:15	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.97	0.96	0.97	0.97	0.94	0.94
19:30	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.96	0.96	0.96	0.96	0.94	0.94
19:45	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.97	0.96	0.96	0.97	0.94	0.94
20:00	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.97	0.96	0.96	0.97	0.94	0.94
20:15	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.98	0.98	0.97	0.96	0.96	0.97	0.94	0.94
20:30	0.96	0.97	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.97	0.96	0.96	0.97	0.94	0.94
20:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.94	0.94
21:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.94	0.94
21:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
21:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
21:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	0.99	0.99	0.98	0.98	0.98	0.98	0.96	0.96
22:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.96	0.96
22:45	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.99	1	1	0.98	0.98	0.98	0.98	0.97	0.96
23:00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.01	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
23:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
23:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
23:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96
0:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.97	0.97	0.97	0.97	0.96	0.96

Appendix M: Voltages of bus 800-834 (PV 2 buses and ES 1 bus Scenario 7)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
0:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
0:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
7:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.01	1.01
8:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
8:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
8:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
12:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
16:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
17:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
17:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	0.99	0.99
17:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
17:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
18:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
18:15	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
18:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
18:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03

20:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:45	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
23:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
23:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.03	1.04
23:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.03	1.04
23:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.04	1.04	1.03	1.04
0:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04

Appendix M: Voltages of bus 838-890 (PV 2 buses and ES 1 bus)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
1:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
3:45	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:00	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	1
4:15	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
4:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
5:00	0.99	0.99	0.99	1	1	0.99	0.99	1.02	1	1.01	1.01	1	1	0.99	1	0.99	0.98
5:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
5:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
5:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
6:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
6:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
6:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
6:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
7:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
7:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
7:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	1	0.99	0.99	1	0.98	0.98
8:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.03	1.01	1.02	1.02	1.01	1.01	1.01	1.01	1	1
8:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
8:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
8:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
9:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
10:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
10:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
11:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
11:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:45	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:00	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
13:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
13:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02

15:45	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:00	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
16:45	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1	1
17:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.01	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
17:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
17:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
17:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
18:00	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.96	0.96	0.96	0.96	0.95	0.95
18:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
18:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
18:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
19:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
19:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
19:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
19:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
21:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
21:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
21:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
21:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
23:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
23:15	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.04	1.03	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02
23:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.03	1.04	1.04	1.03	1.02	1.02
23:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02

Appendix N: Voltages of bus 800-834 (PV 2 buses and ES 2 buses Scenario 8)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
0:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
0:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
7:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.01	1.01
8:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
8:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
8:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
12:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
16:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
17:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
17:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	0.99	0.99
17:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
17:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
18:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
18:15	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
18:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
18:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03

19:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:45	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
23:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
23:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.03	1.04
23:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.03	1.04
23:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.04	1.04	1.03	1.04
0:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04

Appendix N: Voltages of bus 838-890 (PV 2 buses and ES 2 buses)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
1:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
3:45	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:00	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	1
4:15	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
4:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
5:00	0.99	0.99	0.99	1	1	0.99	0.99	1.02	1	1.01	1.01	1	1	0.99	1	0.99	0.98
5:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
5:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
5:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
6:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
6:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
6:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
6:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
7:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
7:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
7:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	1	0.99	0.99	1	0.98	0.98
8:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.03	1.01	1.02	1.02	1.01	1.01	1.01	1.01	1	1
8:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
8:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
8:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
9:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
10:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
10:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
11:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
11:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:45	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:00	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
13:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
13:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02

15:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:45	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:00	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
16:45	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1	1
17:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.01	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
17:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
17:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
17:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
18:00	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.96	0.96	0.96	0.96	0.95	0.95
18:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
18:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
18:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
19:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
19:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
19:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
19:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
21:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
21:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
21:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
21:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
23:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
23:15	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.04	1.03	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02
23:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.03	1.04	1.04	1.03	1.02	1.02
23:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02

Appendix O: Voltages of bus 800-822 (PV 2 buses and ES 3 buses Scenario 9)

Time	800	804	806	808	810	812	814	816	818	820	822	824	826	828	830	832	834
0:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
0:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
0:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
1:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
2:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
3:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
3:45	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:15	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:30	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1
4:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	1
5:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
5:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
5:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
6:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
6:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
6:30	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
6:45	1.05	1.05	1.05	1.03	1.03	1.02	1.01	1.01	1.01	1	1	1	1	1	0.99	0.97	0.97
7:00	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
7:15	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
7:30	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.99	0.99
7:45	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1	0.99
8:00	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.01	1.01
8:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
8:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
8:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
9:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
10:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
11:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
12:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
12:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
13:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
14:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03
15:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
16:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
16:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
17:00	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
17:15	1.05	1.05	1.05	1.04	1.04	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	0.99	0.99
17:30	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1	0.98	0.98
17:45	1.05	1.05	1.05	1.04	1.04	1.02	1.01	1.01	1.01	1.01	1.01	1	1	1	0.99	0.98	0.97
18:00	1.05	1.05	1.05	1.03	1.03	1.02	1	1	1	1	1	1	1	1	0.99	0.97	0.96
18:15	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
18:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
18:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03

19:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
19:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
20:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:30	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
21:45	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:00	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:15	1.05	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:30	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
22:45	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
23:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.03	1.03	1.03
23:15	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.03	1.04
23:30	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.03	1.04
23:45	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.04	1.04	1.03	1.04
0:00	1.05	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04

Appendix o: Voltages of bus 838-890 (PV 2 buses and ES 3 buses Scenario 9)

Time	836	838	840	842	844	846	848	850	852	854	856	858	860	862	864	888	890
0:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
1:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
1:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:30	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
2:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:00	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:15	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
3:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
3:45	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:00	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	1
4:15	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1	1	1	1	1	0.99
4:30	1	1	1	1	1	1	1	1.03	1.01	1.02	1.02	1.01	1	1	1.01	1	1
4:45	1	1	1	1	1	1	1	1.02	1	1.01	1.01	1	1	1	1	0.99	0.99
5:00	0.99	0.99	0.99	1	1	0.99	0.99	1.02	1	1.01	1.01	1	1	0.99	1	0.99	0.98
5:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
5:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.98	0.98
5:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
6:00	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
6:15	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
6:30	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
6:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.97	0.99	0.99	0.97	0.97	0.97	0.97	0.95	0.95
7:00	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
7:15	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
7:30	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1	1	0.99	0.99	0.99	0.99	0.97	0.97
7:45	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	1	1.01	1.01	1	0.99	0.99	1	0.98	0.98
8:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.03	1.01	1.02	1.02	1.01	1.01	1.01	1.01	1	1
8:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
8:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
8:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
9:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
9:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
10:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
10:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03
10:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
11:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.02
11:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
11:45	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:00	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
12:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
13:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
13:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
13:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
14:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.02	1.02
14:45	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02

15:00	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:15	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:30	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
15:45	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:00	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:15	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
16:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02
16:45	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.03	1.03	1.02	1.02	1.02	1.02	1	1
17:00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.01	1.02	1.02	1.01	1.01	1.01	1.01	0.99	0.99
17:15	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.02	0.99	1.01	1.01	0.99	0.99	0.99	0.99	0.98	0.98
17:30	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.01	0.98	1	1	0.98	0.98	0.98	0.98	0.97	0.97
17:45	0.97	0.97	0.97	0.97	0.97	0.97	0.97	1.01	0.98	0.99	0.99	0.98	0.97	0.97	0.98	0.96	0.96
18:00	0.96	0.96	0.96	0.96	0.96	0.96	0.96	1	0.97	0.99	0.99	0.96	0.96	0.96	0.96	0.95	0.95
18:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
18:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
18:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
19:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
19:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
19:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
19:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
20:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
21:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1	1
21:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
21:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
21:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:15	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:30	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
22:45	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
23:00	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01
23:15	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.04	1.03	1.04	1.04	1.03	1.03	1.03	1.03	1.02	1.02
23:30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.03	1.04	1.04	1.03	1.02	1.02
23:45	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02
0:00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.02	1.02

Appendix P: Sensitivity of system Losses

Bus	dP_L/dP_i 1 PV	dP_L/dP_i 2 PVs	Scenario 10 and 11
804	-0.003903	0.000619	0.000584
806	-0.006531	0.001033	0.000976
808	-0.055971	0.00916	0.008683
810	-0.056070	0.009127	0.00865
812	-0.117111	0.018685	-0.00877
814	-0.168967	0.026178	-0.02229
816	-0.169804	0.0263	-0.02251
818	-0.169885	0.026205	-0.02261
820	-0.172170	0.023517	-0.02558
822	-0.172822	0.022903	-0.02626
824	-0.196391	0.030783	-0.02885
826	-0.196413	0.030744	-0.0289
828	-0.198437	0.031164	-0.02936
830	-0.248153	0.040434	-0.04147
832	-0.315368	0.057905	-0.06206
834	-0.332065	0.064337	-0.06593
836	-0.333622	0.068084	-0.0664
838	-0.333665	0.072509	-0.06645
840	-0.333622	0.068067	-0.06642
842	-0.332314	0.064294	-0.06599
844	-0.333510	0.064084	-0.06626
846	-0.333627	0.06395	-0.06644
848	-0.333629	0.063937	-0.06645
850	-0.168993	0.026181	-0.0223
852	-0.315350	0.057901	-0.06206
854	-0.249443	0.040678	-0.04177
856	-0.251156	0.040649	-0.0418
858	-0.323708	0.060834	-0.06385
860	-0.333184	0.065881	-0.06622
862	-0.333665	0.068326	-0.0664
864	-0.323910	0.060833	-0.06385
888	-0.320018	0.049568	-0.07275
890	-0.320394	0.048637	-0.07394

VITA

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