Commonwealth Energy Biogas/PV Mini-Grid Renewable Resources Program

Making Renewables Part of an Affordable and Diverse Electric System in California

Contract No. 500-00-036

Data Collection and Development of Mini-Grid T&D Information

Project No. 1.1 Program Planning and Analysis

Task 1.1.6 Final Report

Prepared For:
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Public Interest Energy Research Renewable Program

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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program is managed by the California Energy Commission (Commission) and annually awards up to $62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions. PIER RD&D funding efforts are focused on the following six program areas:

- Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research

For more information on the PIER Program, please visit the Commission's Web site at: http://www.energy.ca.gov/research/index.html or contact the Commission's Publications Unit at 916-654-5200.

For Commonwealth Program-specific information, please visit http://www.pierminigrid.org. This inventory report is prepared under the **California Energy Commission, Public Interest Energy Research Program, Contract Number 500-00-036,** conducted by the **Commonwealth Energy Team**. The report is entitled **Collection and Development of Mini-Grid T&D System Information**. This project contributes to the **Renewable Energy** Program.

1

Introduction and Background

1.1 Commonwealth PIER Biogas/BI-PV Mini-Grid Program Overview

In June 2001, the Commonwealth Energy Team was awarded a programmatic contract under the California Energy Commission's Public Interest Energy Research (PIER) Program to conduct research on strategies for making renewable energy more affordable in California. The Commonwealth Energy approach involves assessing the combined potential of biogas and photovoltaic (PV) resources in a defined study area and identifying how these resources could be developed in a complementary and cost-effective manner. The Commonwealth Energy Team conducted this research in a real world setting so that the findings could be applied elsewhere in California and therefore benefit more California ratepayers. The local area Commonwealth Energy selected for its renewable energy research activities is the Chino Basin located southeast of Los Angeles, referred to in this report as the "study area."

The Chino Basin is rich in PV and biogas resources. Moreover, it is a rapidly growing area with substantial and yet increasing electrical loads. The underlying goal of the Commonwealth Energy Program is to identify potential Chino Basin Building-Integrated PV (BI-PV) and biogas energy projects, bring innovative technologies and business practices to these projects, assess the benefit to the local electricity distribution system (the "mini-grid"), and then use the findings to develop a business model for siting cost-effective, renewable energy projects.

This report summarizes the methods and data collected on the transmission anddistribution system operated by Southern California Edison (SCE) in the mini-grid area.

1.2 Planning and Analysis Project Objectives

The primary objectives of the Commonwealth PIER Program Planning and Analysis Project are to:

- Define the initial study area,
- Inventory the study area's potential photovoltaic and biogas resources to assess the potential of such resources and to identify potential demonstration projects,

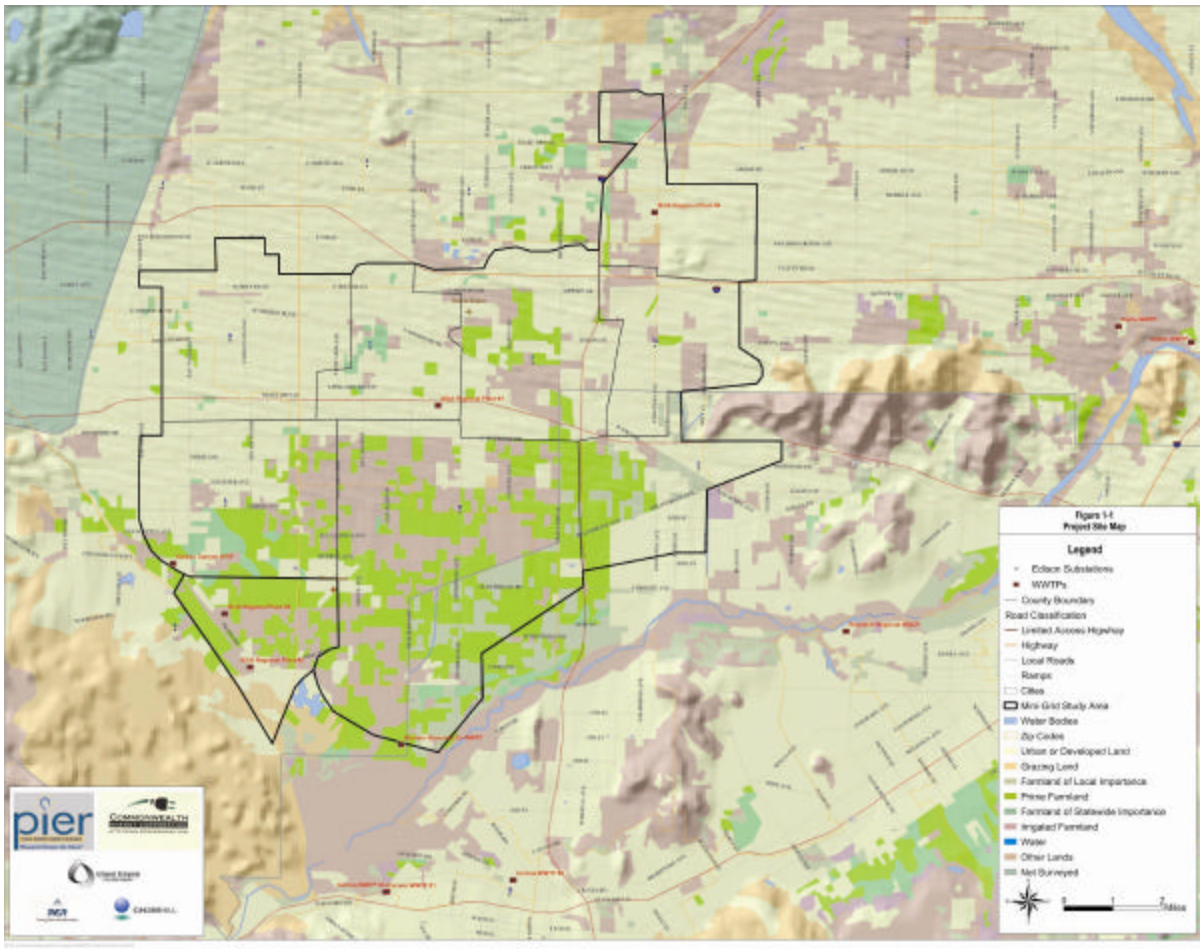
- Identify a mini-grid where the potential impact of the development of such resources can be assessed,
- Conduct power flow studies to identify and quantify the benefits of renewable energy projects on the local electric distribution system,
- Identify and prioritize individual demonstration projects, and
- Identify cost savings and benefits that would accrue by developing complementary resources.

A multidisciplinary team led by Itron/RER and supported by CH_2MHill, Zaininger Engineering Company (ZECO) and the Renewable Energy Development Institute (REDI), is responsible for meeting these program planning objectives. CH_2MHill is responsible for undertaking the various biogas resource inventory assessments. RER and REDI jointly develop estimates of BI-PV technical potential while Itron/RER was responsible for developing the current and future projections of biogas and PV market potential in the mini-grid. Power flow and other studies related to the mini-grid are being undertaken by ZECO .

1.3 Purpose of Mini-Grid T&D Data Collection & Development

The purpose of this task is to collect detailed information related to the electric transmission and distribution (T&D) systems within the Chino mini-grid area. These data will be used to develop a power flow model of the Southern California Edison T&D system for the purposes of estimating the potential impacts of developing biogas and building integrated photovoltaic (BI-PV) distributed generation within the non-residential market sectors of the mini-grid. The power flow modeling, to be completed under Task 1.1.9 of the Program, will compare a "base case" scenario to an estimate of the market potential of affordable renewable distributed generation. Figure 1-1 below provides a geographical overview, and outlines the influence zone of each substation. For a more detailed overview, please see Appendix A of this report.

Figure 1-1 T&D Mini-Grid Map



1.4 Organization of Report

Both transmission and distribution system information have been developed for the Commonwealth Program mini-grid area. The data collection and development process is discussed in Section 2, while the resulting data and associated information are covered in Section 3.

2

Data Collection and Development Overview

2.1 Goals and Objectives of Task 1.1.6

The goal of this task is to develop a useful *representative* local mini-grid electrical T&D system database using the best available information collected, and supplemented with appropriate assumptions.

The objectives of this sixth task under the Commonwealth PIER Renewables Planning and Analysis Project include:

- Collect information on the transmission/distribution system operated by Southern California Edison (SCE), a subsidiary of Edison International, which is the primary electric utility serving the Chino basin study area.
- Establish a mutually beneficial relationship with the appropriate SCE utility personnel to discuss Program goals objectives that will meet Commission and SCE needs and subsequently obtain suitable existing and planned local subtransmission and distribution system characteristics.
- Obtain expected local load growth information over the next 5 and 10 years from SCE if available or from the Commission.
- Acquire customer segment load models, load shape data and coincidence factors for local residential, commercial and industrial loads.

2.2 Local Transmission and Distribution Systems

Following a number of iterations, considering the overlap of the T&D and renewable resources, the resulting Commonwealth Program local mini-grid area was determined as shown in the mini-grid map contained in Appendix A of this report. The customer electric loads in the mini-grid area are served by nine local 66/12 kV substations, designated as A, B, C, D, E, F, G, I and U for the purposes of this study. The boundaries of influence for each substation are shown in yellow on the mini-grid map. Each of the nine 66/12 kV substations serve separate 12 kV distribution primary systems. A total of 72 -12 kV feeders emanating from the nine 66/12 kV substations serve the all of the major loads in the Commonwealth Program mini-grid.

2.3 Intended Results

The intended result of this task is to gather sufficient information to develop a local Chino Basin mini-grid electrical T&D system database, inclusive of the nine local 66/12 kV substations and 72 -12 kV feeders that serve the area where biogas and BI-PV resources are most prominent. The local T&D system database consists of appropriate electrical parameters suitable for performing detailed power flow, voltage and VAR calculations of the local mini-grid T&D system to be performed with the General Electric (GE) Positive Sequence Load Flow (PSLF) program in Task 1.1.9.

3

Local Transmission and Distribution System Data Collection and Development

3.1 Approach Employed

Zaininger Engineering Company (ZECO) has arranged and participated in two meetings with Southern California Edison (SCE) utility personnel at SCE to discuss and obtain appropriate current and planned local Chino area T&D system characteristics. ZECO has also closely interacted by phone and email with SCE personnel during the course of developing the local mini-grid database.

3.2 Information Resources

In summary, adequate data have been collected to develop a representative local Chino area mini-grid T&D database suitable for conducting a power flow analysis to evaluate T&D impacts in Task 1.1.9 of this project. The following local Chino area distribution data have been obtained.

ZECO has obtained the following (mostly proprietary) local SCE system configuration and electrical data for nine 66/12 kV distribution substations and associated 12 kV feeders serving the local Chino area mini-grid. These data include:

- General location of the nine 66/12 kV distribution substations.
- 66/12 kV transformer bank ratings for the nine subs.
- Projected 2003 peak substation loads for seven 66/12 kV subs.
- Coincident relative12 kV feeder loadings at seven 66/12 kV substations during hot summer conditions in 2002, and non-coincident 12 kV feeder loadings at the other two 66/12 kV substations.
- Maps of 12 kV main feeders and laterals showing geographical layout, conductor size and type (aluminum or copper), construction type (overhead or underground), distribution transformer (load) locations and size of some of the larger transformers (larger load locations) for each of the 72 12 kV feeders.
- Shunt locations, switch locations, fuse locations.
- Standard SCE conductor sizes and current ratings.

3.3 Assumptions

ZECO is using SCE supplied proprietary distribution data along with representative publicly available electrical parameters for the SCE conductor sizes and types to develop a representative local mini-grid 66/12 kV substation and12 kV feeder database.

The assumptions used to develop the local mini-grid database are presented in Table 3-1. In the following mini-grid database, assumed three phase 66/12 kV transformer bank ratings are based on SCE supplied data and vary for each of the substations. Electrical impedance data were not available from SCE for the transformers. Transformer bank resistance (R) and reactance (X) for the database were obtained from typical transformer impedance data in the EPRI synthetic utility system report[1]. R is assumed negligible. X is assumed to be .10 PU (Per Unit) on full load nameplate transformer MVA base.

Standard SCE conductor sizes and thermal capacity in amps were supplied by SCE as shown in Table 1 for both overhead and underground 12 kV conductors. In the mini-grid database, three phase 12 kV feeder ratings are limited to less than 600 amps or about 12 MVA. This is compatible with the continuous current ratings of switching equipment and fault detection practices commonly used in 12 kV distribution systems. This limit is also compatible with the capacity of 1000 kcmil (1000 circular mills) CLP (cross linked polyethylene) underground cable which is commonly used for a get-a-way out of the 66/12 kV substations, and is higher than the 400 to 450 amp limit assumed in the SCE case study[2] report.

Resistance (R) and reactance (X) assumptions in PU/mi (Per Unit per mile) on a 100 MVA base for the various conductor sizes and types in Table 1 for the mini-grid database were derived from several sources. R and X assumptions for the larger 336.4, 653.9 and 954 kcmil ACSR (Aluminum Conductor Steel Reinforced) overhead conductors were derived from the EHV Transmission Line Reference Book[3]. R and X assumptions for the smaller 4/0, 1/0, #2, and #4 AWG (American Wire Gauge) ACSR overhead conductors and the 1000 kcmil, 750 kcmil, 350 kcmil, 1/0 AWG and #2 CLP underground conductors were derived from the Aluminum Electrical Conductor Handbook[4]. R and X assumptions for the 4/0, 2/0, #2, #4,

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1 *Synthetic Electric Utility Systems for Evaluating Advanced Technologies*, EPRI EM-285, February 1977, (co-authors: H.W. Zaininger, et al.).
2 *The Integration of Renewable Energy Sources into Electric Power Distribution Systems, Vol. II. Utility Case Assessments*, ORNL-6775/V2, Martin Marietta Energy Systems, Inc. for the U.S. Department of Energy, June, 1994, (co-authors: H.W. Zaininger, P.R. Ellis and J.C. Schaefer).
3 *EHV Transmission Line Reference Book*, Edison Electric Institute, 1968.
4 *Aluminum Electrical Conductor Handbook*, First Edition, The Aluminum Association, 1971.

and #6 AWG Cu (Copper) conductors were derived from the Elements of Power System Analysis[5] textbook. Capacitive susceptance (B) is assumed negligible for both overhead and underground conductors at 12 kV.

Peak load growth rates for expanding the mini-grid will be based on the "most likely" growth rate forecasts in the CEC "2002-2012 Electricity Outlook Report": Table II-1-1, which are about 3% per year through 2007, and about 1.7% between 2007 and 2012.

Load profiles for various SCE residential, commercial and industrial customer classes are available on the SCE website (www.sce.com). In this study, we will use the customer load profiles from electric rate class D for residential, GS-1 for small commercial, GS-2 for medium commercial, TOU-8 for large commercial/industrial, and PA-1 for agricultural.

Table 3-1: Mini-Grid 66/12 kV Transformer and 12 kV Feeder Assumptions

	Rating	**Rating**	**R**	**X**
	Amps	**MVA**	**PU**	**PU**
66/12 kV Transformer Bank	Variable	Variable	Negligible	0.10
12 kV Feeder Conductors				
	Rating	**Rating**	**R**	**X**
	Amps	**MVA**	**PU/Mi**	**PU/Mi**
Overhead Construction				
954 kcmil ACSR	1090	12.0	0.074	0.446
653.9 kcmil ACSR	920	12.0	0.108	0.468
336.4 kcmil ACSR	605	12.0	0.208	0.496
4/0 AWG ACSR	415	8.6	0.395	0.561
1/0 AWG ACSR	280	5.8	0.731	0.597
#2 AWG ACSR	210	4.4	1.131	0.621
#4 AWG ACSR	160	3.3	1.749	0.655
4/0 AWG Cu	540	11.0	0.210	0.525
2/0 AWG Cu	405	8.4	0.334	0.545
#2 AWG Cu	260	5.4	0.669	0.574
#4 AWG Cu	190	3.9	1.044	0.598
#6 AWG Cu	140	2.9	1.66	.618

5 W. D. Stevenson, Jr., *Elements of Power System Analysis*, Second Edition, McGraw Hill, 1962.

Table 3-1: Mini-Grid 66/12 kV Transformer and 12 kV Feeder Assumptions (Cont'd)

12 kV Feeder Conductors				
	Rating	Rating	R	X
	Amps	MVA	PU/Mi	PU/Mi
Underground Construction				
1000 kcmil CLP	610	12.0	0.077	0.127
750 kcmil CLP	530	11.0	0.102	0.131
350 kcmil CLP	355	7.4	0.216	0.147
1/0 kcmil CLP	180	3.7	0.714	0.179
#2 AWG CLP	140	2.9	1.107	0.183

3.4 Present Mini-Grid Database Developed

The electrical data for the nine 66/12 kV substations in the mini-grid are presented in Table 3-2. Each substation has a high side 66 kV from bus[6] and a low side 12 kV to bus, which are assigned bus numbers and bus names. The bus names identify the substation and bus voltage. The transformer bank impedance is presented in per unit on a 100 MVA base. For each substation, the transformer bank rating is shown in MVA. Observe that the transformer banks for Substations A and E are assumed to be fully loaded in 2003.

Table 3-2: Summary of Mini-Grid 66/12 kV Substation Characteristics

						100 MVA	
From	From	From	To	To	To	Base	Rating
Bus No.	Bus Name	Bus kV	Bus No.	Bus Name	Bus kV	X PU	MVA
1502	66A	66	3000	12A	12	0.161	81
1541	66B	66	3500	12B	12	0.124	102
1503	66C	66	4000	12C	12	0.144	89
1513	66D	66	4500	12D	12	0.232	56
1598	66E	66	5000	12E	12	0.374	35
1555	66F	66	5500	12F	12	0.094	138
1601	66G	66	6000	12G	12	0.138	94
1515	66U	66	6500	12U	12	0.188	70
1602	66I	66	7000	12I	12	0.105	129

[6] Note that a bus is a node or point in the electrical network. These points can be connected by a transformer to change the voltage, or by a line segment at the same voltage.

Appendix B of this report presents the projected peak load assumptions for 2003 for each of the mini-grid distribution substations. Data are presented for total projected substation loads in MVA. First, comparing the projected 2003 peak MVA loads with the substation MVA ratings in Table 3-1, observe that the 66/12 kV transformer banks for Substations A and E are assumed to be fully loaded in 2003.

Projected 12 kV feeder MW and MVAR flows at each substation for projected 2003 peak load conditions are also listed for the 72 -12 kV feeders serving the mini-grid area. 12 kV feeders at each substation have been assigned numbers in this database. Substation A contains 10 feeders; Substation B contains 12 feeders; Substation C contains 10 feeders; Substation D contains 7 feeders; Substation E contains 4 feeders; Substation F contains 14 feeders; and Substation G contains 10 feeders. Two feeders, designated Feeders 2 and 7 are modeled in the mini-grid database for Substation U. Three feeders, designated Feeders 13, 4 and 9 are modeled in the mini-grid database for Substation I. The remaining projected 2003 peak loads for Subs U and I are inserted at the substation 12 kV bus for this study. Total resulting MW and MVAR flows and power factor (pf) at the low side at each substation are also shown for each substation.

Appendix C of this report presents the electrical data for each of the 72 – 12 kV feeders modeled in the mini-grid database. Each of the 72 feeders has been laid out using feeder maps supplied by SCE and local street maps, as appropriate electrical data for modeling the feeders in a load flow study were not available. The feeders are divided into separate branches connecting several nodes where loads or shunts or generators can be added. The number of nodes has been determined from studying the feeder maps and varies from feeder to feeder. Each feeder branch has a "from" bus and "to" bus, which are assigned bus numbers and bus names. The bus names identify the bus voltage, substation and feeder number, followed by a dash and another number identifying a node on the feeder. The mileage for each feeder segment was estimated using the appropriate street map and feeder map. The resistance (R) and reactance (X) in per unit on a 100 MVA base was then determined using the mileage, appropriate feeder conductor sizes and associated electrical characteristics in Table 3-1. The branch rating was then determined using the conductor with the lowest MVA rating.

Appendix D of this report presents the assumed load distribution along each of the 72 feeders corresponding to the 2003 peak feeder loads at the substations shown in Appendix B. Load bus number and bus name along with the corresponding bus load MW and MVAR are shown in Appendix D. Generally feeder loads were assumed to be distributed equally at each of the load busses along each feeder. However, in feeders at locations where large distribution transformer kVA were identified on the feeder maps, load distribution was weighted accordingly. All MVAR loads have been assumed to be corrected to unity power factor at

each load point in this study, as individual load MW and MVAR distribution characteristics were not available.

4

Summary of T&D Data Development Process

4.1 Summary of Results

The results of this Project 1.1 Planning and Analysis task deliverable includes a local mini-grid electrical T&D system database that encompasses nine local 66/12 kV substations and 72 -12 kV feeders serving customer loads in the local mini-grid area. The resulting product, a local T&D system database, provides representative electrical characteristics of the local SCE 66/12 kV substations and the associated 12 kV distribution feeders serving the local mini-grid area, was developed using available data and, where required, reasonable assumptions and SCE's peak load projections for 2003, which at their current peak total approximately 565 MVA for the Commonwealth Program Mini-grid area.

T&D Mini-Grid Map

The Commonwealth Program Mini-grid map presented in Appendix A of this report illustrates the geographic boundaries of each of the nine substations that comprise the Commonwealth Program Mini-grid region. This combination of substations and feeders in this region provides a resource mix that should make it possible to further study a rich combination of renewable distributed generation under the Commonwealth Program mini-grid market assessment performed under Task 1.1.7, and the subsequent T&D power flow modeling efforts performed under Task 1.1.9 of the Planning and Analysis project.

Conclusions Relevant to Power Flow Modeling Effort

The Commonwealth Program Mini-grid database contains appropriate electrical parameters and load distribution information suitable for inserting into a local T&D load flow model, which is expected to be expanded out in time five and ten years to 2007 and 2012. The Commonwealth PIER Mini-grid T&D model is expected to be capable of performing detailed power flow, voltage and VAR calculations of the projected future local mini-grid T&D system, assessing the differences with and without renewable distributed generation.

Appendix A

T&D Mini-Grid Map

Appendix B

Projected Peak Substation and Feeder Loads Database

Table B-1 Projected Peak Substation and Feeder Loads

Sub Loads		Sub A	Sub B	Sub C	Sub D	Sub E	Sub F	Sub G	Sub U	Sub I
	MVA	80	92	77	49	35	110	80	58	116
	MW	79.9	91.7	77.1	49.3	34.6	110.2	80.0	57.5	116.1
	MVAR	2.2	4.9	1.8	0.1	-0.1	2.2	1.7	0.0	2.3
	pf	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12 kV Bus Loads										
	MW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	84.4
	MVAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feeder Loads[i]										
1	**MW**	6.5	6.3	9.5	6.3	5.9	6.9	10.2		
1	**MVAR**	0.1	0.3	0.4	0.3	-1.5	0.1	0.1		
2	**MW**	8.4	3.7	6.0	7.8	11.4	6.7	8.2	6.2	
2	**MVAR**	0.3	0.0	0.1	0.4	0.4	0.1	0.4	-0.1	
3	**MW**	9.5	7.3	5.5	8.6	9.0	11.6	6.7		7.8
3	**MVAR**	0.3	0.0	0.1	-0.2	0.6	-0.1	0.0		0.2
4	**MW**	7.8	6.5	9.4	6.1	8.3	5.5	6.0		11.9
4	**MVAR**	0.3	0.4	0.1	0.4	0.4	0.1	0.1		0.8
5	**MW**	9.4	5.8	7.5	10.0		10.7	10.3		
5	**MVAR**	0.5	0.3	0.2	-1.3		0.5	0.1		
6	**MW**	9.1	7.7	5.1	4.7		5.6	6.3		
6	**MVAR**	0.2	0.7	0.0	0.1		0.2	0.2		
7	**MW**	10.7	9.5	10.8	5.8		4.3	9.0	5.7	
7	**MVAR**	0.1	0.8	0.4	0.4		0.0	0.1	0.1	
8	**MW**	8.5	11.1	3.9			7.6	6.6		
8	**MVAR**	0.3	0.7	0.0			0.1	0.2		
9	**MW**	7.7	9.7	10.8			9.7	7.7		12.0
9	**MVAR**	0.1	0.3	0.4			0.3	0.2		1.3
10	**MW**	2.3	5.4	8.6			7.5	9.0		
10	**MVAR**	0.0	0.2	0.1			0.2	0.3		

Table B-1 Projected Peak Substation and Feeder Loads (continued)

Sub Loads		Sub A	Sub B	Sub C	Sub D	Sub E	Sub F	Sub G	Sub U	Sub I
11	**MVA**		8.4				9.6			
11	**MVAR**		0.6				0.2			
12	**MW**		10.3				5.6			
12	**MVAR**		0.6				0.1			
13	**MW**						10.6			
13	**MVAR**						0.2			
14	**MW**						8.3			
14	**MVAR**						0.2			

[i] Positive MW indicates MW flow into the feeder. Positive MVAR indicates inductive MVAR being supplied to feeder. Negative MVAR indicates that inductive MVAR are being absorbed from feeder.

Appendix C

12 kV Feeder Database

Table C-1 Mini-grid 12 kV Feeder Database

From Bus No.	From Bus Name	To Bus No.	To Bus Name	100 MVA Base R PU	100 MVA Base X PU	Rating MVA	Length Mi.
3000	12A	3001	12A9-1	0.105	0.201	11	1.0
3000	12A	3004	12A6-1	0.077	0.127	11	1.0
3000	12A	3012	12A10-1	0.22	0.54	11	2.0
3000	12A	3015	12A7-1	0.051	0.2	12	0.5
3000	12A	3031	12A2-1	0.039	0.063	12	0.5
3000	12A	3036	12A1-1	0.084	0.13	11	1.0
3000	12A	3041	12A5-1	0.082	0.25	12	0.9
3000	12A	3046	12A4-1	0.13	0.34	12	0.7
3000	12A	3052	12A3-1	0.08	0.13	12	1.0
3000	12A	3057	12A8-1	0.096	0.19	12	0.9
3001	12A9-1	3002	12A9-2	0.02	0.026	11	0.2
3002	12A9-2	3003	12A9-3	0.031	0.039	11	0.3
3004	12A6-1	3005	12A6-2	0.031	0.039	11	0.3
3005	12A6-2	3006	12A6-3	0.041	0.086	11	0.4
3006	12A6-3	3007	12A6-4	0.022	0.094	12	0.2
3006	12A6-3	3010	12A6-7	0.043	0.029	7.3	0.2
3007	12A6-4	3008	12A6-5	0.031	0.039	11	0.3
3008	12A6-5	3009	12A6-6	0.031	0.039	11	0.3
3010	12A6-7	3011	12A6-8	0.065	0.044	7.3	0.3
3012	12A10-1	3013	12A10-2	0.22	0.15	7.3	1.0
3012	12A10-1	3014	12A10-3	0.22	0.15	7.3	1.0
3015	12A7-1	3016	12A7-2	0.43	0.71	8.4	1.3
3015	12A7-1	3017	12A7-3	0.063	0.15	12	0.3
3017	12A7-3	3018	12A7-4	0.069	0.11	11	0.9
3017	12A7-3	3020	12A7-6	0.17	0.4	12	0.8
3018	12A7-4	3019	12A7-5	0.062	0.1	11	0.8
3020	12A7-6	3021	12A7-7	0.062	0.13	11	0.4
3021	12A7-7	3022	12A7-8	0.1	0.25	12	0.5

				100 MVA	100 MVA		
From	**From**	**To**	**To**	**Base**	**Base**	**Rating**	**Length**
Bus No.	**Bus Name**	**Bus No.**	**Bus Name**	**R PU**	**X PU**	**MVA**	**Mi.**
3021	12A7-7	3026	12A7-12	0.15	0.3	12	0.6
3022	12A7-8	3023	12A7-9	0.44	0.36	5.8	0.6
3022	12A7-8	3025	12A7-11	0.4	0.65	8.4	1.2
3023	12A7-9	3024	12A7-10	2	0.74	2.9	1.2
3026	12A7-12	3027	12A7-13	0.58	0.48	5.8	0.8
3026	12A7-12	3028	12A7-14	0.15	0.3	12	0.6
3028	12A7-14	3029	12A7-15	0.041	0.053	11	0.4
3028	12A7-14	3030	12A7-16	0.041	0.053	11	0.4
3031	12A2-1	3032	12A2-2	0.3	0.68	12	1.9
3032	12A2-2	3033	12A2-3	0.03	0.039	11	0.3
3033	12A2-3	3034	12A2-4	0.063	0.15	12	0.3
3033	12A2-3	3035	12A2-5	0.52	0.2	3.3	0.3
3036	12A1-1	3037	12A1-2	0.031	0.039	11	0.3
3037	12A1-2	3038	12A1-3	0.2	0.28	12	0.5
3037	12A1-2	3039	12A1-4	0.054	0.23	12	0.5
3039	12A1-4	3040	12A1-5	0.061	0.079	11	0.6
3041	12A5-1	3042	12A5-2	0.14	0.39	12	0.8
3042	12A5-2	3043	12A5-3	0.053	0.15	11	0.5
3043	12A5-3	3044	12A5-4	0.071	0.16	12	0.5
3044	12A5-4	3045	12A5-5	0.52	0.74	8.6	1.4
3046	12A4-1	3047	12A4-2	0.1	0.25	12	0.5
3047	12A4-2	3048	12A4-3	0.1	0.25	12	0.5
3047	12A4-2	3049	12A4-4	0.37	0.3	5.8	0.5
3047	12A4-2	3050	12A4-5	0.16	0.48	12	1.0
3050	12A4-5	3051	12A4-6	0.1	0.25	12	0.5
3052	12A3-1	3053	12A3-2	0.054	0.23	12	0.5
3053	12A3-2	3054	12A3-3	0.1	0.25	12	0.5
3054	12A3-3	3055	12A3-4	0.043	0.029	7.3	0.2
3055	12A3-4	3056	12A3-5	0.015	0.025	12	0.2
3057	12A8-1	3058	12A8-2	0.1	0.25	12	0.5
3058	12A8-2	3059	12A8-3	0.13	0.3	12	0.6
3059	12A8-3	3060	12A8-4	0.087	0.059	7.3	0.4
3060	12A8-4	3061	12A8-5	0.083	0.2	12	0.4
3500	12B	3501	12B12-1	0.11	0.45	12	1.1
3500	12B	3509	12B10-1	0.1	0.4	12	1.0
3500	12B	3518	12B1-1	0.11	0.39	12	1.2

				100 MVA	100 MVA		
From	**From**	**To**	**To**	**Base**	**Base**	**Rating**	**Length**
Bus No.	**Bus Name**	**Bus No.**	**Bus Name**	**R PU**	**X PU**	**MVA**	**Mi.**
3500	12B	3527	12B5-1	0.12	0.48	12	1.1
3500	12B	3534	12B2-1	0.11	0.21	5.8	0.5
3500	12B	3540	12B4-1	0.16	0.63	12	1.5
3500	12B	3545	12B7-1	0.23	0.77	12	1.6
3500	12B	3552	12B11-1	0.098	0.42	12	0.9
3500	12B	3562	12B6-1	0.13	0.33	11	0.7
3500	12B	3571	12B8-1	0.098	0.42	12	0.9
3500	12B	3579	12B3-1	0.36	2.05	12	4.9
3500	12B	3587	12B9-1	0.12	0.27	12	0.7
3501	12B12-1	3502	12B12-2	0.1	0.25	12	0.5
3501	12B12-1	3506	12B12-6	0.063	0.15	12	0.3
3502	12B12-2	3503	12B12-3	0.29	0.24	5.8	0.4
3502	12B12-2	3504	12B12-4	0.1	0.25	12	0.5
3502	12B12-2	3505	12B12-5	0.29	0.24	5.8	0.4
3506	12B12-6	3507	12B12-7	0.37	0.3	5.8	0.5
3506	12B12-6	3508	12B12-8	0.065	0.044	7.3	0.3
3509	12B10-1	3510	12B10-2	0.033	0.14	12	0.3
3510	12B10-2	3511	12B10-3	0.033	0.14	12	0.3
3511	12B10-3	3512	12B10-4	0.033	0.14	12	0.3
3512	12B10-4	3513	12B10-5	0.067	0.11	8.4	0.2
3512	12B10-4	3514	12B10-6	0.087	0.37	12	0.8
3514	12B10-6	3515	12B10-7	0.042	0.099	12	0.2
3515	12B10-7	3516	12B10-8	0.44	0.36	5.8	0.6
3515	12B10-7	3517	12B10-9	0.022	0.094	12	0.2
3518	12B1-1	3519	12B1-2	0.076	0.33	12	0.7
3519	12B1-2	3520	12B1-3	0.37	0.3	5.8	0.5
3519	12B1-2	3521	12B1-4	0.033	0.14	12	0.3
3521	12B1-4	3522	12B1-5	0.37	0.3	5.8	0.5
3521	12B1-4	3523	12B1-6	0.022	0.094	12	0.2
3523	12B1-6	3524	12B1-7	0.031	0.039	11	0.3
3523	12B1-6	3525	12B1-8	0.095	0.29	12	0.6
3523	12B1-6	3526	12B1-9	0.031	0.039	11	0.3
3527	12B5-1	3528	12B5-2	0.082	0.11	11	0.8
3527	12B5-1	3529	12B5-3	0.065	0.28	12	0.6
3529	12B5-3	3530	12B5-4	0.082	0.11	11	0.8
3529	12B5-3	3531	12B5-5	0.19	0.47	11	0.9

				100 MVA	100 MVA		
From	**From**	**To**	**To**	**Base**	**Base**	**Rating**	**Length**
Bus No.	**Bus Name**	**Bus No.**	**Bus Name**	**R PU**	**X PU**	**MVA**	**Mi.**
3531	12B5-5	3532	12B5-6	0.033	0.14	12	0.3
3532	12B5-6	3533	12B5-7	0.17	0.27	8.4	0.5
3534	12B2-1	3535	12B2-2	0.033	0.14	12	0.3
3535	12B2-2	3536	12B2-3	0.042	0.099	12	0.2
3535	12B2-2	3537	12B2-4	0.033	0.14	12	0.3
3537	12B2-4	3538	12B2-5	0.02	0.026	11	0.2
3537	12B2-4	3539	12B2-6	0.083	0.2	12	0.4
3540	12B4-1	3541	12B4-2	0.1	0.25	12	0.5
3541	12B4-2	3542	12B4-3	0.1	0.25	12	0.5
3542	12B4-3	3543	12B4-4	0.042	0.99	12	0.2
3542	12B4-3	3544	12B4-5	0.29	0.24	5.8	0.4
3545	12B7-1	3546	12B7-2	0.042	0.099	12	0.2
3546	12B7-2	3547	12B7-3	0.13	0.088	7.3	0.6
3546	12B7-2	3548	12B7-4	0.1	0.25	12	0.5
3546	12B7-2	3549	12B7-5	0.083	0.2	12	0.4
3546	12B7-2	3550	12B7-6	0.1	0.25	12	0.5
3550	12B7-6	3551	12B7-7	0.084	0.21	11	0.4
3552	12B11-1	3553	12B11-2	0.45	0.4	5.8	0.7
3552	12B11-1	3554	12B11-3	0.15	0.36	11	0.7
3554	12B11-3	3555	12B11-4	0.11	0.26	11	0.5
3555	12B11-4	3556	12B11-5	0.1	0.16	8.4	0.3
3555	12B11-4	3558	12B11-7	0.067	0.11	8.4	0.3
3558	12B11-7	3559	12B11-8	0.015	0.025	12	0.2
3559	12B11-8	3560	12B11-9	0.1	0.25	12	0.5
3559	12B11-8	3561	12B11-10	0.054	0.23	12	0.5
3562	12B6-1	3563	12B6-2	0.063	0.16	11	0.3
3563	12B6-2	3564	12B6-3	0.04	0.1	11	0.2
3564	12B6-3	3565	12B6-4	0.55	0.71	5.4	1.3
3565	12B6-4	3566	12B6-5	0.023	0.038	12	0.3
3566	12B6-5	3567	12B6-6	0.023	0.038	12	0.3
3566	12B6-5	3568	12B6-7	0.13	0.31	11	0.6
3568	12B6-7	3569	12B6-8	0.043	0.029	7.3	0.2
3568	12B6-7	3570	12B6-9	0.12	0.27	11	0.5
3571	12B8-1	3572	12B8-2	0.22	0.18	5.8	0.3
3571	12B8-1	3574	12B8-4	0.065	0.28	12	0.6
3572	12B8-2	3573	12B8-3	0.22	0.18	5.8	0.3

				100 MVA	100 MVA		
From	From	To	To	Base	Base	Rating	Length
Bus No.	Bus Name	Bus No.	Bus Name	R PU	X PU	MVA	Mi.
3574	12B8-4	3575	12B8-5	0.022	0.094	12	0.2
3575	12B8-5	3576	12B8-6	0.02	0.026	11	0.2
3576	12B8-6	3577	12B8-7	0.067	0.11	8.4	0.2
3576	12B8-6	3578	12B8-8	0.022	0.094	12	0.2
3579	12B3-1	3580	12B3-2	0.1	0.25	12	0.5
3579	12B3-1	3582	12B3-4	0.28	0.39	8.6	0.7
3580	12B3-2	3581	12B3-3	0.1	0.25	12	0.5
3582	12B3-4	3583	12B3-5	0.065	0.044	7.3	0.3
3583	12B3-5	3585	12B3-7	0.065	0.044	7.3	0.3
3584	12B3-6	3586	12B3-8	0.22	0.18	5.8	0.3
3585	12B3-7	3586	12B3-8	0.37	0.3	5.8	0.5
3587	12B9-1	3588	12B9-2	0.21	0.52	11	1.0
3588	12B9-2	3589	12B9-3	0.37	0.3	5.8	0.5
3588	12B9-2	3590	12B9-4	0.11	0.26	11	0.5
3590	12B9-4	3591	12B9-5	0.1	0.25	12	0.5
3590	12B9-4	3592	12B9-6	0.063	0.16	11	0.3
3592	12B9-6	3593	12B9-7	0.063	0.15	12	0.3
3593	12B9-7	3594	12B9-8	0.015	0.025	12	0.2
3593	12B9-7	3596	12B9-10	0.063	0.15	12	0.3
3594	12B9-8	3595	12B9-9	0.042	0.099	12	0.2
4000	12C	4001	12C3-1	0.054	0.089	12	0.7
4000	12C	4007	12C4-1	0.054	0.089	12	0.7
4000	12C	4014	12C5-1	0.086	0.23	12	1.0
4000	12C	4021	12C2-1	0.015	0.025	12	0.2
4000	12C	4027	12C10-1	0.031	0.051	12	0.4
4000	12C	4032	12C7-1	0.015	0.025	12	0.2
4000	12C	4041	12C1-1	0.015	0.025	12	0.2
4000	12C	4052	12C9-1	0.15	0.25	12	2.0
4000	12C	4058	12C6-1	0.023	0.038	12	0.3
4000	12C	4064	12C8-1	0.16	0.27	12	2.1
4001	12C3-1	4002	12C3-2	0.041	0.099	12	0.3
4002	12C3-2	4003	12C3-3	0.1	0.25	12	0.5
4003	12C3-3	4004	12C3-4	0.1	0.25	12	0.5
4004	12C3-4	4005	12C3-5	0.065	0.044	7.3	0.3
4005	12C3-5	4006	12C3-6	0.065	0.044	7.3	0.3
4007	12C4-1	4008	12C4-2	0.023	0.038	12	0.3

				100 MVA	100 MVA		
From	**From**	**To**	**To**	**Base**	**Base**	**Rating**	**Length**
Bus No.	**Bus Name**	**Bus No.**	**Bus Name**	**R PU**	**X PU**	**MVA**	**Mi.**
4008	12C4-2	4009	12C4-3	0.065	0.28	12	0.6
4008	12C4-2	4011	12C4-5	0.051	0.066	11	0.5
4009	12C4-3	4010	12C4-4	0.1	0.25	12	0.5
4011	12C4-5	4012	12C4-6	0.1	0.25	12	0.5
4012	12C4-6	4013	12C4-7	0.063	0.15	12	0.3
4014	12C5-1	4015	12C5-2	0.023	0.038	12	0.3
4015	12C5-2	4016	12C5-3	0.042	0.099	12	0.2
4015	12C5-2	4020	12C5-7	0.023	0.038	12	0.2
4016	12C5-3	4017	12C5-4	0.042	0.099	12	0.2
4019	12C5-6	4018	12C5-5	0.043	0.039	12	0.2
4020	12C5-7	4019	12C5-6	0.043	0.039	12	0.2
4021	12C2-1	4022	12C2-2	0.062	0.1	12	0.8
4022	12C2-2	4023	12C2-3	0.043	0.19	12	0.4
4023	12C2-3	4024	12C2-4	0.022	0.094	12	0.2
4024	12C2-4	4025	12C2-5	0.031	0.039	11	0.3
4024	12C2-4	4026	12C2-6	0.022	0.094	12	0.2
4027	12C10-1	4028	12C10-2	0.023	0.038	12	0.3
4028	12C10-2	4029	12C10-3	0.063	0.15	12	0.3
4028	12C10-2	4030	12C10-4	0.19	0.49	12	1.0
4030	12C10-4	4031	12C10-5	0.022	0.094	12	0.2
4032	12C7-1	4033	12C7-2	0.023	0.038	12	0.3
4033	12C7-2	4034	12C7-3	0.1	0.16	8.4	0.3
4033	12C7-2	4035	12C7-4	0.13	0.3	12	0.6
4035	12C7-4	4036	12C7-5	0.063	0.15	12	0.3
4036	12C7-5	4037	12C7-6	0.063	0.15	12	0.3
4036	12C7-5	4039	12C7-8	0.15	0.12	5.8	0.2
4037	12C7-6	4038	12C7-7	0.031	0.039	11	0.3
4039	12C7-8	4040	12C7-9	0.22	0.18	5.8	0.3
4041	12C1-1	4042	12C1-2	0.031	0.051	12	0.4
4042	12C1-2	4043	12C1-3	0.022	0.094	12	0.2
4043	12C1-3	4044	12C1-4	0.022	0.094	12	0.2
4044	12C1-4	4045	12C1-5	0.098	0.42	12	0.9
4045	12C1-5	4046	12C1-6	0.1	0.25	12	0.5
4046	12C1-6	4047	12C1-7	0.063	0.15	12	0.3
4047	12C1-7	4048	12C1-8	0.083	0.2	12	0.4
4047	12C1-7	4050	12C1-10	0.29	0.24	5.8	0.4

From Bus No.	From Bus Name	To Bus No.	To Bus Name	100 MVA Base R PU	100 MVA Base X PU	Rating MVA	Length Mi.
4048	12C1-8	4049	12C1-9	0.22	0.18	5.8	0.3
4050	12C1-10	4051	12C1-11	0.15	0.12	5.8	0.2
4052	12C9-1	4053	12C9-2	0.023	0.038	12	0.3
4053	12C9-2	4054	12C9-3	0.031	0.039	11	0.3
4054	12C9-3	4055	12C9-4	0.065	0.044	7.3	0.3
4054	12C9-3	4056	12C9-5	0.065	0.044	7.3	0.3
4056	12C9-5	4057	12C9-6	0.12	0.17	12	0.3
4058	12C6-1	4059	12C6-2	0.051	0.066	11	0.5
4059	12C6-2	4060	12C6-3	0.051	0.066	11	0.5
4059	12C6-2	4061	12C6-4	0.062	0.13	11	0.4
4061	12C6-4	4062	12C6-5	0.087	0.37	12	0.8
4062	12C6-5	4063	12C6-6	0.1	0.13	11	1.0
4064	12C8-1	4065	12C8-2	0.031	0.039	11	0.3
4500	12D	4501	12D5-1	0.25	0.6	12	1.2
4500	12D	4508	12D3-1	0.23	0.55	12	1.1
4500	12D	4526	12D7-1	0.21	0.9	12	2.0
4500	12D	4533	12D6-1	0.14	0.52	12	1.4
4500	12D	4537	12D2-1	0.031	0.051	12	0.4
4500	12D	4546	12D1-1	0.083	0.2	12	0.4
4500	12D	4553	12D4-1	0.29	0.69	12	1.4
4501	12D5-1	4502	12D5-2	0.21	0.5	12	1.0
4502	12D5-2	4503	12D5-3	0.1	0.25	12	0.5
4503	12D5-3	4504	12D5-4	0.083	0.2	12	0.4
4503	12D5-3	4506	12D5-6	0.21	0.5	12	1.0
4504	12D5-4	4505	12D5-5	0.083	0.2	12	0.4
4506	12D5-6	4507	12D5-7	0.21	0.5	12	1.0
4508	12D3-1	4509	12D3-2	0.1	0.25	12	0.5
4509	12D3-2	4510	12D3-3	0.33	0.54	8.4	1.0
4509	12D3-2	4511	12D3-4	0.23	0.55	12	1.1
4511	12D3-4	4512	12D3-5	0.21	0.5	12	1.0
4511	12D3-4	4515	12D3-8	0.051	0.066	11	0.5
4512	12D3-5	4513	12D3-6	0.66	0.54	5.8	0.9
4512	12D3-5	4514	12D3-7	0.51	0.42	5.8	0.7
4515	12D3-8	4516	12D3-9	0.087	0.059	7.3	0.4
4516	12D3-9	4517	12D3-10	0.64	0.49	2.9	0.9
4516	12D3-9	4518	12D3-11	0.1	0.25	12	0.5

				100 MVA	100 MVA		
From	**From**	**To**	**To**	**Base**	**Base**	**Rating**	**Length**
Bus No.	**Bus Name**	**Bus No.**	**Bus Name**	**R PU**	**X PU**	**MVA**	**Mi.**
4516	12D3-9	4524	12D3-17	0.44	0.36	5.8	0.6
4518	12D3-11	4519	12D3-12	1.2	0.43	2.9	0.7
4518	12D3-11	4520	12D3-13	0.1	0.25	12	0.5
4520	12D3-13	4521	12D3-14	0.43	0.83	8.4	1.6
4520	12D3-13	4522	12D3-15	0.21	0.5	12	1.0
4522	12D3-15	4523	12D3-16	1.3	0.49	2.9	0.8
4524	12D3-17	4525	12D3-18	0.86	0.71	5.4	1.2
4526	12D7-1	4527	12D7-2	0.33	0.54	8.4	1.0
4526	12D7-1	4528	12D7-3	0.21	0.5	12	1.0
4528	12D7-3	4529	12D7-4	0.1	0.25	12	0.5
4528	12D7-3	4530	12D7-5	0.2	0.28	8.6	0.5
4530	12D7-5	4531	12D7-6	0.11	0.074	7.3	0.5
4530	12D7-5	4532	12D7-7	0.054	0.023	12	0.5
4533	12D6-1	4534	12D6-2	0.1	0.25	12	0.5
4534	12D6-2	4535	12D6-3	0.042	0.099	12	0.2
4534	12D6-2	4536	12D6-4	0.087	0.059	7.3	0.4
4537	12D2-1	4538	12D2-2	0.11	0.47	12	1.0
4538	12D2-2	4539	12D2-3	0.083	0.2	12	0.4
4538	12D2-2	4540	12D2-4	0.054	0.23	12	0.5
4540	12D2-4	4541	12D2-5	0.83	0.31	2.9	0.5
4540	12D2-4	4542	12D2-6	0.13	0.31	11	0.6
4542	12D2-6	4543	12D2-7	0.1	0.25	12	0.5
4543	12D2-7	4544	12D2-8	0.042	0.099	12	0.2
4544	12D2-8	4545	12D2-9	0.019	0.06	12	0.2
4546	12D1-1	4547	12D1-2	0.051	0.066	11	0.5
4546	12D1-1	4549	12D1-4	0.083	0.2	12	0.4
4547	12D1-2	4548	12D1-3	0.031	0.039	11	0.3
4549	12D1-4	4550	12D1-5	0.21	0.5	12	1.0
4550	12D1-5	4551	12D1-6	0.29	0.69	12	1.4
4551	12D1-6	4552	12D1-7	0.1	0.2	11	0.7
4553	12D4-1	4554	12D4-2	0.13	0.3	12	0.6
4553	12D4-1	4557	12D4-5	0.17	0.27	8.4	0.5
4554	12D4-2	4555	12D4-3	0.17	0.4	12	0.8
4555	12D4-3	4556	12D4-4	0.17	0.27	8.4	0.5
4557	12D4-5	4558	12D4-6	0.17	0.27	8.4	0.5
4557	12D4-5	4561	12D4-9	0.2	0.33	8.4	0.6

From Bus No.	From Bus Name	To Bus No.	To Bus Name	100 MVA Base R PU	100 MVA Base X PU	Rating MVA	Length Mi.
4558	12D4-6	4559	12D4-7	0.43	0.71	8.4	1.3
4559	12D4-7	4560	12D4-8	1.2	0.43	2.9	0.7
4561	12D4-9	4562	12D4-10	0.1	0.25	12	0.5
4562	12D4-10	4563	12D4-11	0.082	0.11	11	0.8
4562	12D4-10	4564	12D4-12	0.17	0.24	8.4	1.2
4564	12D4-12	4565	12D4-13	0.15	0.34	7.3	1.0
4564	12D4-12	4566	12D4-14	0.8	0.53	2.9	0.9
4564	12D4-12	4567	12D4-15	0.27	0.44	8.4	0.8
5000	12E	5001	12E1-1	0.13	0.3	12	0.6
5000	12E	5002	12E1-2	0.63	0.15	12	0.3
5000	12E	5010	12E2-1	0.083	0.2	12	0.4
5000	12E	5020	12E3-1	0.13	0.56	12	1.2
5000	12E	5026	12E4-1	0.15	0.35	12	0.7
5002	12E1-2	5003	12E1-3	0.21	0.5	12	1.0
5003	12E1-3	5004	12E1-4	0.35	0.39	5.8	0.7
5003	12E1-3	5006	12E1-6	0.2	0.17	5.4	0.3
5004	12E1-4	5005	12E1-5	0.51	0.42	5.8	0.7
5006	12E1-6	5007	12E1-7	0.59	0.41	3.9	0.7
5007	12E1-7	5008	12E1-8	0.22	0.18	5.8	0.3
5008	12E1-8	5009	12E1-9	0.63	0.36	3.9	0.6
5010	12E2-1	5011	12E2-2	0.041	0.053	11	0.4
5010	12E2-1	5015	12E2-6	0.078	0.17	12	0.5
5011	12E2-2	5012	12E2-3	0.02	0.026	11	0.2
5012	12E2-3	5013	12E2-4	0.02	0.026	11	0.2
5013	12E2-4	5014	12E2-5	0.02	0.026	11	0.2
5015	12E2-6	5016	12E2-7	0.063	0.15	12	0.3
5016	12E2-7	5017	12E2-8	0.44	0.36	5.8	0.6
5017	12E2-8	5018	12E2-9	0.22	0.18	5.8	0.3
5018	12E2-9	5019	12E2-10	0.22	0.18	5.8	0.3
5020	12E3-1	5021	12E3-2	0.054	0.23	12	0.5
5020	12E3-1	5022	12E3-3	0.031	0.039	11	0.3
5020	12E3-1	5023	12E3-4	0.21	0.5	12	1.0
5023	12E3-4	5024	12E3-5	0.17	0.33	7.3	0.8
5024	12E3-5	5025	12E3-6	0.63	0.36	3.9	0.6
5026	12E4-1	5027	12E4-2	0.19	0.45	12	0.9
5026	12E4-1	5033	12E4-8	0.19	0.45	12	0.9

				100 MVA	100 MVA		
From	From	To	To	Base	Base	Rating	Length
Bus No.	Bus Name	Bus No.	Bus Name	R PU	X PU	MVA	Mi.
5027	12E4-2	5028	12E4-3	0.19	0.45	12	0.9
5027	12E4-2	5029	12E4-4	0.063	0.15	12	0.3
5029	12E4-4	5030	12E4-5	0.73	0.42	3.9	0.7
5029	12E4-4	5032	12E4-7	0.063	0.15	12	0.3
5030	12E4-5	5031	12E4-6	0.5	0.19	2.9	0.3
5033	12E4-8	5034	12E4-9	0.051	0.066	11	0.5
5033	12E4-8	5036	12E4-11	0.051	0.066	11	0.5
5034	12E4-9	5035	12E4-10	0.051	0.066	11	0.5
5036	12E4-11	5037	12E4-12	0.051	0.066	11	0.5
5500	12F	5501	12F3-1	0.077	0.13	12	1.0
5500	12F	5505	12F2-1	0.069	0.11	12	0.9
5500	12F	5509	12F11-1	0.077	0.13	12	1.0
5500	12F	5519	12F13-1	0.12	0.19	12	1.5
5500	12F	5523	12F5-1	0.15	0.25	12	2.0
5500	12F	5528	12F8-1	0.031	0.051	12	0.4
5500	12F	5535	12F9-1	0.15	0.25	12	2.0
5500	12F	5543	12F4-1	0.13	0.22	12	1.7
5500	12F	5546	12F14-1	0.13	0.22	12	1.7
5500	12F	5550	12F6-1	0.22	0.45	12	2.7
5500	12F	5557	12F7-1	0.054	0.089	12	0.7
5500	12F	5563	12F10-1	0.046	0.076	12	0.6
5500	12F	5568	12F12-1	0.085	0.14	12	1.1
5500	12F	5575	12F1-1	0.12	0.19	12	1.5
5501	12F3-1	5502	12F3-2	0.15	0.24	12	1.9
5502	12F3-2	5503	12F3-3	0.22	0.52	12	1.2
5503	12F3-3	5504	12F3-4	0.12	0.24	12	1.0
5505	12F2-1	5506	12F2-2	0.061	0.079	11	0.6
5506	12F2-2	5507	12F2-3	0.02	0.026	11	0.2
5507	12F2-3	5508	12F2-4	0.041	0.053	11	0.4
5509	12F11-1	5510	12F11-2	0.039	0.063	12	0.5
5509	12F11-1	5514	12F11-6	0.082	0.11	12	0.8
5510	12F11-2	5511	12F11-3	0.065	0.054	7.3	0.3
5511	12F11-3	5512	12F11-4	0.02	0.026	12	0.2
5512	12F11-4	5513	12F11-5	0.02	0.026	12	0.2
5514	12F11-6	5515	12F11-7	0.085	0.07	7.3	0.5
5514	12F11-6	5517	12F11-9	0.11	0.074	7.3	0.5

				100 MVA	100 MVA		
From	**From**	**To**	**To**	**Base**	**Base**	**Rating**	**Length**
Bus No.	**Bus Name**	**Bus No.**	**Bus Name**	**R PU**	**X PU**	**MVA**	**Mi.**
5514	12F11-6	5518	12F11-10	0.015	0.066	12	0.5
5515	12F11-7	5516	12F11-8	0.11	0.074	7.3	0.5
5519	12F13-1	5520	12F13-2	0.015	0.025	12	0.2
5520	12F13-2	5521	12F13-3	0.039	0.063	12	0.5
5520	12F13-2	5522	12F13-4	0.45	0.13	3.7	0.8
5523	12F5-1	5524	12F5-2	0.099	0.22	12	1.2
5524	12F5-2	5525	12F5-3	0.071	0.092	11	0.7
5525	12F5-3	5526	12F5-4	0.091	0.21	12	0.5
5525	12F5-3	5527	12F5-5	0.15	0.35	12	0.7
5528	12F8-1	5529	12F8-2	0.12	0.2	12	1.2
5529	12F8-2	5530	12F8-3	0.023	0.038	12	0.3
5530	12F8-3	5531	12F8-4	0.023	0.038	12	0.3
5530	12F8-3	5532	12F8-5	0.054	0.089	12	0.7
5532	12F8-5	5533	12F8-6	0.039	0.063	12	0.5
5533	12F8-6	5534	12F8-7	0.039	0.063	12	0.5
5535	12F9-1	5536	12F9-2	0.039	0.063	12	0.5
5535	12F9-1	5537	12F9-3	0.041	0.053	11	0.4
5537	12F9-3	5538	12F9-4	0.031	0.039	11	0.3
5538	12F9-4	5539	12F9-5	0.031	0.039	11	0.3
5539	12F9-5	5540	12F9-6	0.041	0.053	11	0.4
5540	12F9-6	5541	12F9-7	0.041	0.053	11	0.4
5541	12F9-7	5542	12F9-8	0.02	0.026	11	0.2
5543	12F4-1	5544	12F4-2	0.039	0.063	12	0.5
5544	12F4-2	5545	12F4-3	0.02	0.026	11	0.2
5546	12F14-1	5547	12F14-2	0.046	0.076	12	0.6
5547	12F14-2	5548	12F14-3	0.062	0.1	12	0.8
5548	12F14-3	5549	12F14-4	0.039	0.063	12	0.5
5550	12F6-1	5551	12F6-2	0.11	0.47	12	1.0
5550	12F6-1	5554	12F6-5	0.023	0.038	12	0.3
5551	12F6-2	5552	12F6-3	0.11	0.074	7.3	0.5
5552	12F6-3	5553	12F6-4	0.11	0.074	7.3	0.5
5554	12F6-5	5555	12F6-6	0.054	0.089	12	0.7
5555	12F6-6	5556	12F6-7	0.072	0.15	12	0.6
5557	12F7-1	5558	12F7-2	0.041	0.053	11	0.4
5558	12F7-2	5559	12F7-3	0.031	0.039	11	0.3
5559	12F7-3	5560	12F7-4	0.031	0.039	11	0.3

From Bus No.	From Bus Name	To Bus No.	To Bus Name	100 MVA Base R PU	100 MVA Base X PU	Rating MVA	Length Mi.
5559	12F7-3	5561	12F7-5	0.02	0.026	11	0.2
5559	12F7-3	5562	12F7-6	0.02	0.026	11	0.2
5563	12F10-1	5564	12F10-2	0.12	0.19	12	1.5
5564	12F10-2	5565	12F10-3	0.15	0.35	12	0.7
5565	12F10-3	5566	12F10-4	0.083	0.2	12	0.4
5566	12F10-4	5567	12F10-5	0.093	0.16	11	0.7
5568	12F12-1	5569	12F12-2	0.13	0.088	7.3	0.6
5568	12F12-1	5570	12F12-3	0.046	0.076	12	0.6
5570	12F12-3	5571	12F12-4	0.072	0.14	11	0.5
5571	12F12-4	5572	12F12-5	0.083	0.2	12	0.4
5571	12F12-4	5573	12F12-6	0.051	0.066	11	0.5
5573	12F12-6	5574	12F12-7	0.051	0.066	11	0.5
5575	12F1-1	5576	12F1-2	0.041	0.053	11	0.4
5575	12F1-1	5577	12F1-3	0.031	0.039	11	0.3
5575	12F1-1	5580	12F1-6	0.17	0.28	12	2.2
5577	12F1-3	5578	12F1-4	0.031	0.039	11	0.3
5578	12F1-4	5579	12F1-5	0.031	0.039	11	0.3
6000	12G	6001	12G3-1	0.015	0.025	12	0.2
6000	12G	6005	12G7-1	0.031	0.051	12	0.4
6000	12G	6011	12G6-1	0.11	0.18	12	1.4
6000	12G	6018	12G2-1	0.051	0.2	12	0.5
6000	12G	6025	12G9-1	0.054	0.089	12	0.7
6000	12G	6038	12G4-1	0.059	0.21	12	0.6
6000	12G	6042	12G8-1	0.17	0.34	12	1.5
6000	12G	6045	12G1-1	0.023	0.038	12	0.3
6000	12G	6051	12G5-1	0.031	0.051	12	0.4
6000	12G	6054	12G10-1	0.12	0.31	12	1.4
6001	12G3-1	6002	12G3-2	0.031	0.051	12	0.4
6002	12G3-2	6003	12G3-3	0.043	0.029	7.3	0.2
6003	12G3-3	6004	12G3-4	0.043	0.029	7.3	0.2
6005	12G7-1	6006	12G7-2	0.031	0.051	12	0.4
6006	12G7-2	6007	12G7-3	0.039	0.063	12	0.5
6006	12G7-2	6008	12G7-4	0.039	0.063	12	0.5
6006	12G7-2	6009	12G7-5	0.046	0.076	12	0.6
6009	12G7-5	6010	12G7-6	0.13	0.088	7.3	0.6
6011	12G6-1	6012	12G6-2	0.083	0.2	12	0.4

From Bus No.	From Bus Name	To Bus No.	To Bus Name	100 MVA Base R PU	100 MVA Base X PU	Rating MVA	Length Mi.
6012	12G6-2	6013	12G6-3	0.041	0.053	11	0.4
6013	12G6-3	6014	12G6-4	0.041	0.053	11	0.4
6014	12G6-4	6015	12G6-5	0.041	0.053	11	0.4
6014	12G6-4	6017	12G6-7	0.087	0.059	7.3	0.4
6015	12G6-5	6016	12G6-6	0.041	0.053	11	0.4
6018	12G2-1	6019	12G2-2	0.054	0.23	12	0.5
6019	12G2-2	6020	12G2-3	0.054	0.23	12	0.5
6020	12G2-3	6021	12G2-4	0.022	0.094	12	0.2
6020	12G2-3	6022	12G2-5	0.11	0.074	7.3	0.5
6022	12G2-5	6023	12G2-6	0.043	0.029	7.3	0.2
6023	12G2-6	6024	12G2-7	0.043	0.029	7.3	0.2
6025	12G9-1	6026	12G9-2	0.041	0.053	11	0.4
6026	12G9-2	6027	12G9-3	0.1	0.25	12	0.5
6026	12G9-2	6033	12G9-9	0.1	0.25	12	0.5
6027	12G9-3	6028	12G9-4	0.1	0.25	12	0.5
6028	12G9-4	6029	12G9-5	0.063	0.15	12	0.3
6029	12G9-5	6030	12G9-6	0.1	0.25	11	0.5
6029	12G9-5	6031	12G9-7	0.1	0.25	12	0.5
6031	12G9-7	6032	12G9-8	0.1	0.25	12	0.5
6033	12G9-9	6034	12G9-10	0.031	0.051	12	0.4
6034	12G9-10	6035	12G9-11	0.031	0.051	12	0.4
6035	12G9-11	6036	12G9-12	0.11	0.074	7.3	0.5
6036	12G9-12	6037	12G9-13	0.11	0.074	7.3	0.5
6038	12G4-1	6039	12G4-2	0.041	0.053	11	0.4
6039	12G4-2	6040	12G4-3	0.02	0.026	11	0.2
6040	12G4-3	6041	12G4-4	0.33	0.055	2.9	0.3
6042	12G8-1	6043	12G8-2	0.13	0.26	7.3	0.6
6043	12G8-2	6044	12G8-3	0.12	0.16	11	1.2
6045	12G1-1	6046	12G1-2	0.023	0.038	12	0.3
6046	12G1-2	6047	12G1-3	0.065	0.044	7.3	0.3
6046	12G1-2	6048	12G1-4	0.1	0.25	12	0.5
6048	12G1-4	6049	12G1-5	0.15	0.1	7.3	0.7
6049	12G1-5	6050	12G1-6	0.15	0.1	7.3	0.7
6051	12G5-1	6052	12G5-2	0.065	0.044	7.3	0.3
6051	12G5-1	6053	12G5-3	0.065	0.044	7.3	0.3

From	From	To	To	100 MVA Base	100 MVA Base		Rating	Length
Bus No.	Bus Name	Bus No.	Bus Name	R PU	X PU		MVA	Mi.
6054	12G10-1		6055	12G10-2	0.054	0.23	12	0.5
6054	12G10-1		6057	12G10-4	0.065	0.044	7.3	0.3
6055	12G10-2		6056	12G10-3	0.1	0.25	12	0.5
6057	12G10-4		6058	12G10-5	0.065	0.044	7.3	0.3
6058	12G10-5		6059	12G10-6	0.13	0.088	7.3	0.6
6059	12G10-6		6060	12G10-7	1.03	0.54	2.9	0.9
6500	12U		6501	12U2-1	0.23	0.64	12	1.4
6500	12U		6508	12U7-1	0.08	0.13	12	1.0
6501	12U2-1		6502	12U2-2	0.13	0.3	12	0.6
6502	12U2-2		6503	12U2-3	0.13	0.3	12	0.6
6503	12U2-3		6504	12U2-4	0.13	0.3	12	0.6
6504	12U2-4		6505	12U2-5	0.13	0.3	12	0.6
6505	12U2-5		6506	12U2-6	0.28	0.57	8.4	1.1
6506	12U2-6		6507	12U2-7	0.6	0.98	8.4	1.8
6508	12U7-1		6509	12U7-2	0.039	0.063	12	0.5
6509	12U7-2		6510	12U7-3	0.15	0.35	12	0.7

				100 MVA	100 MVA		
From	From	To	To	Base	Base	Rating	Length
Bus No.	Bus Name	Bus No.	Bus Name	R PU	X PU	MVA	Mi.
6509	12U7-2	6511	12U7-4	0.12	0.3	12	0.6
6511	12U7-4	6512	12U7-5	0.3	0.69	12	1.4
6511	12U7-4	6513	12U7-6	0.083	0.2	12	0.4
6513	12U7-6	6514	12U7-7	1.3	0.49	2.9	0.8
6513	12U7-6	6515	12U7-8	0.13	0.3	12	0.6
6513	12U7-6	6516	12U7-9	0.35	0.84	12	1.7
7000	12I	7001	12I4-1	0.039	0.063	12	0.5
7000	12I	7012	12I9-1	0.21	0.87	12	2.0
7000	12I	7017	12I13-1	0.023	0.038	12	0.3
7001	12I4-1	7002	12I4-2	0.3	0.67	12	1.8
7002	12I4-2	7003	12I4-3	0.065	0.28	12	0.6
7003	12I4-3	7004	12I4-4	0.054	0.23	12	0.5
7004	12I4-4	7005	12I4-5	0.051	0.066	11	0.5
7005	12I4-5	7006	12I4-6	0.1	0.25	12	0.5
7006	12I4-6	7007	12I4-7	0.12	0.16	11	1.2
7007	12I4-7	7008	12I4-8	0.1	0.25	12	0.5
7008	12I4-8	7009	12I4-9	0.1	0.25	12	0.5
7008	12I4-8	7010	12I4-10	0.031	0.039	11	0.3
7010	12I4-10	7011	12I4-11	0.051	0.066	11	0.5
7012	12I9-1	7013	12I9-2	0.15	0.35	12	0.7
7012	12I9-1	7014	12I9-3	0.062	0.1	12	0.8
7014	12I9-3	7015	12I9-4	0.14	0.036	3.7	0.2
7014	12I9-3	7016	12I9-5	0.015	0.025	12	0.2
7017	12I13-1	7018	12I13-2	0.054	0.23	12	0.5
7018	12I13-2	7019	12I13-3	0.1	0.25	12	0.5
7018	12I13-2	7021	12I13-5	0.17	0.4	12	0.5
7019	12I13-3	7020	12I13-4	0.1	0.25	12	0.5
7021	12I13-5	7022	12I13-6	0.19	0.19	12	1.5
7022	12I13-6	7023	12I13-7	0.5	0.13	3.7	0.7

Appendix D

Load Distribution Database

Table D-1 Mini-grid 12 kV Feeder Load Distribution

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
3001	12A9-1	2.62	0
3002	12A9-2	2.52	0
3003	12A9-3	2.52	0
3004	12A6-1	1.07	0
3005	12A6-2	1.07	0
3006	12A6-3	1.07	0
3007	12A6-4	1.17	0
3008	12A6-5	1.17	0
3009	12A6-6	1.17	0
3010	12A6-7	1.17	0
3011	12A6-8	1.17	0
3012	12A10-1	0.78	0
3013	12A10-2	0.78	0
3014	12A10-3	0.78	0
3015	12A7-1	0.78	0
3016	12A7-2	0.87	0
3018	12A7-4	0.87	0
3019	12A7-5	0.87	0
3020	12A7-6	0.87	0
3023	12A7-9	0.87	0
3024	12A7-10	0.87	0
3025	12A7-11	0.87	0
3027	12A7-13	0.87	0
3028	12A7-14	0.87	0
3029	12A7-15	0.87	0
3030	12A7-16	0.87	0
3031	12A2-1	2.43	0
3032	12A2-2	2.43	0
3034	12A2-4	2.43	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
3035	12A2-5	0.97	0
3036	12A1-1	1.26	0
3037	12A1-2	1.26	0
3038	12A1-3	1.26	0
3039	12A1-4	1.26	0
3040	12A1-5	1.36	0
3041	12A5-1	1.84	0
3042	12A5-2	1.84	0
3043	12A5-3	1.84	0
3044	12A5-4	1.84	0
3045	12A5-5	1.84	0
3046	12A4-1	1.26	0
3047	12A4-2	1.26	0
3048	12A4-3	1.26	0
3049	12A4-4	1.26	0
3050	12A4-5	1.26	0
3051	12A4-6	1.36	0
3052	12A3-1	1.84	0
3053	12A3-2	1.84	0
3054	12A3-3	1.84	0
3055	12A3-4	1.84	0
3056	12A3-5	1.94	0
3057	12A8-1	1.65	0
3058	12A8-2	1.65	0
3059	12A8-3	1.65	0
3060	12A8-4	1.65	0
3061	12A8-5	1.75	0
3502	12B12-2	1.53	0
3503	12B12-3	1.72	0
3504	12B12-4	1.72	0
3505	12B12-5	1.72	0
3507	12B12-7	1.72	0
3508	12B12-8	1.72	0
3509	12B10-1	0.76	0
3510	12B10-2	0.76	0
3511	12B10-3	0.76	0
3513	12B10-5	0.76	0
3514	12B10-6	0.76	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
3516	12B10-8	0.76	0
3517	12B10-9	0.76	0
3518	12B1-1	1.05	0
3520	12B1-3	1.05	0
3522	12B1-5	1.05	0
3524	12B1-7	1.05	0
3525	12B1-8	1.05	0
3526	12B1-9	0.95	0
3528	12B5-2	0.95	0
3529	12B5-3	0.95	0
3530	12B5-4	0.95	0
3531	12B5-5	0.95	0
3532	12B5-6	0.95	0
3533	12B5-7	0.95	0
3534	12B2-1	0.67	0
3535	12B2-2	0.76	0
3536	12B2-3	0.76	0
3538	12B2-5	0.76	0
3539	12B2-6	0.76	0
3540	12B4-1	1.24	0
3541	12B4-2	1.24	0
3542	12B4-3	1.24	0
3543	12B4-4	1.24	0
3544	12B4-5	1.43	0
3545	12B7-1	1.53	0
3547	12B7-3	1.53	0
3548	12B7-4	1.53	0
3549	12B7-5	1.53	0
3550	12B7-6	1.53	0
3551	12B7-7	1.62	0
3552	12B11-1	0.76	0
3553	12B11-2	0.76	0
3554	12B11-3	0.95	0
3555	12B11-4	0.95	0
3556	12B11-5	0.95	0
3558	12B11-7	0.95	0
3559	12B11-8	0.95	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
3560	12B11-9	0.95	0
3561	12B11-10	0.95	0
3562	12B6-1	1.05	0
3563	12B6-2	1.05	0
3564	12B6-3	1.05	0
3565	12B6-4	1.05	0
3567	12B6-6	1.05	0
3569	12B6-8	1.05	0
3570	12B6-9	1.15	0
3571	12B8-1	1.15	0
3572	12B8-2	1.15	0
3573	12B8-3	1.15	0
3574	12B8-4	1.15	0
3575	12B8-5	1.15	0
3576	12B8-6	1.15	0
3577	12B8-7	1.15	0
3578	12B8-8	2.87	0
3579	12B3-1	0.86	0
3580	12B3-2	0.86	0
3581	12B3-3	0.86	0
3582	12B3-4	0.86	0
3583	12B3-5	0.86	0
3584	12B3-6	0.86	0
3585	12B3-7	0.86	0
3586	12B3-8	0.95	0
3587	12B9-1	1.15	0
3589	12B9-3	1.15	0
3591	12B9-5	1.15	0
3592	12B9-6	1.15	0
3593	12B9-7	1.15	0
3594	12B9-8	1.15	0
3595	12B9-9	1.24	0
3596	12B9-10	1.24	0
4001	12C3-1	1.03	0
4002	12C3-2	1.03	0
4003	12C3-3	1.13	0
4004	12C3-4	0.75	0
4005	12C3-5	0.75	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
4006	12C3-6	0.75	0
4007	12C4-1	3.75	0
4008	12C4-2	0.94	0
4009	12C4-3	0.94	0
4010	12C4-4	0.94	0
4011	12C4-5	0.94	0
4012	12C4-6	0.94	0
4013	12C4-7	0.94	0
4014	12C5-1	1.03	0
4015	12C5-2	1.22	0
4016	12C5-3	1.03	0
4017	12C5-4	1.03	0
4018	12C5-5	1.03	0
4019	12C5-6	1.03	0
4020	12C5-7	1.03	0
4021	12C2-1	1.50	0
4022	12C2-2	1.13	0
4023	12C2-3	1.13	0
4025	12C2-5	1.13	0
4026	12C2-6	1.13	0
4027	12C10-1	1.41	0
4028	12C10-2	1.41	0
4029	12C10-3	2.91	0
4030	12C10-4	1.41	0
4031	12C10-5	1.41	0
4032	12C7-1	1.31	0
4034	12C7-3	1.31	0
4035	12C7-4	1.31	0
4036	12C7-5	1.31	0
4037	12C7-6	1.31	0
4038	12C7-7	1.31	0
4039	12C7-8	1.31	0
4040	12C7-9	1.41	0
4041	12C1-1	0.84	0
4042	12C1-2	0.84	0
4043	12C1-3	0.84	0
4044	12C1-4	0.84	0
4045	12C1-5	0.84	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
4046	12C1-6	0.84	0
4047	12C1-7	0.84	0
4048	12C1-8	0.84	0
4049	12C1-9	0.84	0
4050	12C1-10	0.84	0
4051	12C1-11	0.94	0
4052	12C9-1	1.03	0
4053	12C9-2	1.41	0
4054	12C9-3	1.03	0
4055	12C9-4	4.69	0
4056	12C9-5	1.41	0
4057	12C9-6	1.03	0
4058	12C6-1	0.84	0
4059	12C6-2	0.84	0
4060	12C6-3	0.84	0
4061	12C6-4	0.84	0
4062	12C6-5	0.84	0
4063	12C6-6	0.84	0
4064	12C8-1	3.38	0
4065	12C8-2	0.47	0
4501	12D5-1	0.57	0
4502	12D5-2	0.57	0
4504	12D5-4	0.95	0
4505	12D5-5	0.95	0
4506	12D5-6	0.57	0
4507	12D5-7	5.72	0
4508	12D3-1	0.38	0
4509	12D3-2	0.38	0
4510	12D3-3	0.38	0
4511	12D3-4	1.05	0
4512	12D3-5	0.38	0
4513	12D3-6	0.38	0
4514	12D3-7	0.38	0
4515	12D3-8	1.05	0
4516	12D3-9	0.38	0
4517	12D3-10	0.38	0
4519	12D3-12	0.38	0
4521	12D3-14	1.14	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
4522	12D3-15	0.38	0
4523	12D3-16	0.38	0
4524	12D3-17	0.38	0
4525	12D3-18	0.38	0
4526	12D7-1	0.95	0
4527	12D7-2	0.95	0
4528	12D7-3	0.95	0
4529	12D7-4	0.95	0
4531	12D7-6	0.95	0
4532	12D7-7	0.95	0
4533	12D6-1	0.95	0
4534	12D6-2	0.95	0
4535	12D6-3	0.95	0
4536	12D6-4	1.81	0
4537	12D2-1	0.86	0
4538	12D2-2	0.86	0
4539	12D2-3	0.86	0
4540	12D2-4	0.86	0
4541	12D2-5	0.86	0
4542	12D2-6	0.86	0
4543	12D2-7	0.86	0
4544	12D2-8	0.86	0
4545	12D2-9	0.86	0
4546	12D1-1	0.48	0
4547	12D1-2	0.48	0
4548	12D1-3	0.48	0
4549	12D1-4	0.48	0
4550	12D1-5	0.48	0
4551	12D1-6	0.48	0
4552	12D1-7	3.34	0
4553	12D4-1	0.38	0
4554	12D4-2	0.38	0
4555	12D4-3	0.38	0
4556	12D4-4	0.38	0
4557	12D4-5	0.38	0
4558	12D4-6	0.38	0
4559	12D4-7	0.38	0
4560	12D4-8	0.38	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
4561	12D4-9	0.38	0
4562	12D4-10	0.38	0
4563	12D4-11	0.38	0
4564	12D4-12	0.38	0
4565	12D4-13	0.38	0
4566	12D4-14	0.48	0
4567	12D4-15	0.48	0
5001	12E1-1	0.58	0
5002	12E1-2	0.58	0
5003	12E1-3	0.58	0
5004	12E1-4	0.58	0
5005	12E1-5	0.58	0
5006	12E1-6	0.67	0
5007	12E1-7	0.67	0
5008	12E1-8	0.67	0
5009	12E1-9	0.67	0
5010	12E2-1	1.06	0
5011	12E2-2	1.06	0
5012	12E2-3	1.06	0
5013	12E2-4	1.06	0
5014	12E2-5	1.16	0
5015	12E2-6	1.16	0
5016	12E2-7	1.16	0
5017	12E2-8	1.16	0
5018	12E2-9	1.16	0
5019	12E2-10	1.16	0
5020	12E3-1	0.96	0
5021	12E3-2	0.96	0
5022	12E3-3	1.93	0
5023	12E3-4	2.89	0
5024	12E3-5	1.16	0
5025	12E3-6	0.96	0
5026	12E4-1	0.77	0
5028	12E4-3	0.77	0
5030	12E4-5	0.77	0
5031	12E4-6	0.77	0
5032	12E4-7	0.77	0
5033	12E4-8	0.77	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
5034	12E4-9	0.87	0
5035	12E4-10	0.87	0
5036	12E4-11	0.87	0
5037	12E4-12	0.87	0
5501	12F3-1	0.98	0
5502	12F3-2	0.98	0
5503	12F3-3	0.98	0
5504	12F3-4	8.07	0
5505	12F2-1	1.97	0
5506	12F2-2	0.98	0
5507	12F2-3	0.98	0
5508	12F2-4	2.76	0
5509	12F11-1	0.89	0
5510	12F11-2	0.89	0
5511	12F11-3	0.89	0
5512	12F11-4	0.89	0
5513	12F11-5	1.57	0
5514	12F11-6	0.89	0
5515	12F11-7	0.89	0
5516	12F11-8	0.89	0
5517	12F11-9	0.89	0
5518	12F11-10	0.89	0
5519	12F13-1	1.48	0
5520	12F13-2	1.48	0
5521	12F13-3	6.00	0
5522	12F13-4	1.48	0
5523	12F5-1	1.48	0
5524	12F5-2	1.48	0
5525	12F5-3	3.94	0
5526	12F5-4	2.07	0
5527	12F5-5	1.48	0
5528	12F8-1	0.98	0
5529	12F8-2	0.98	0
5530	12F8-3	1.28	0
5531	12F8-4	0.98	0
5532	12F8-5	0.98	0
5533	12F8-6	1.28	0
5534	12F8-7	0.98	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
5535	12F9-1	1.18	0
5536	12F9-2	1.18	0
5537	12F9-3	1.18	0
5538	12F9-4	1.18	0
5539	12F9-5	1.18	0
5540	12F9-6	1.18	0
5541	12F9-7	1.18	0
5542	12F9-8	1.28	0
5543	12F4-1	0.98	0
5544	12F4-2	0.98	0
5545	12F4-3	3.44	0
5546	12F14-1	1.97	0
5547	12F14-2	1.97	0
5548	12F14-3	1.97	0
5549	12F14-4	2.26	0
5550	12F6-1	0.79	0
5551	12F6-2	0.79	0
5552	12F6-3	0.79	0
5553	12F6-4	0.79	0
5554	12F6-5	0.79	0
5555	12F6-6	0.79	0
5556	12F6-7	0.79	0
5557	12F7-1	0.69	0
5558	12F7-2	0.69	0
5559	12F7-3	0.69	0
5560	12F7-4	0.69	0
5561	12F7-5	0.79	0
5562	12F7-6	0.79	0
5563	12F10-1	1.48	0
5564	12F10-2	1.48	0
5565	12F10-3	1.48	0
5566	12F10-4	1.48	0
5567	12F10-5	1.45	0
5569	12F12-2	0.59	0
5570	12F12-3	2.56	0
5571	12F12-4	0.59	0
5572	12F12-5	0.59	0
5573	12F12-6	0.59	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
5574	12F12-7	0.59	0
5575	12F1-1	0.98	0
5576	12F1-2	0.98	0
5577	12F1-3	0.98	0
5578	12F1-4	0.98	0
5579	12F1-5	2.46	0
5580	12F1-6	0.39	0
6001	12G3-1	1.68	0
6002	12G3-2	1.68	0
6003	12G3-3	1.68	0
6004	12G3-4	1.68	0
6005	12G7-1	1.03	0
6006	12G7-2	1.03	0
6007	12G7-3	1.96	0
6008	12G7-4	1.03	0
6009	12G7-5	1.96	0
6010	12G7-6	1.96	0
6011	12G6-1	0.84	0
6012	12G6-2	0.84	0
6013	12G6-3	0.84	0
6014	12G6-4	0.93	0
6015	12G6-5	0.93	0
6016	12G6-6	0.93	0
6017	12G6-7	0.93	0
6018	12G2-1	0.84	0
6019	12G2-2	0.84	0
6020	12G2-3	1.96	0
6021	12G2-4	1.96	0
6022	12G2-5	0.84	0
6023	12G2-6	0.84	0
6024	12G2-7	0.84	0
6025	12G9-1	0.56	0
6026	12G9-2	0.56	0
6027	12G9-3	0.65	0
6028	12G9-4	0.65	0
6030	12G9-6	0.65	0
6031	12G9-7	0.65	0
6032	12G9-8	0.65	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
6033	12G9-9	0.65	0
6034	12G9-10	0.65	0
6035	12G9-11	0.65	0
6036	12G9-12	0.65	0
6037	12G9-13	0.65	0
6038	12G4-1	0.65	0
6039	12G4-2	2.80	0
6040	12G4-3	1.87	0
6041	12G4-4	0.65	0
6042	12G8-1	1.59	0
6043	12G8-2	1.59	0
6044	12G8-3	3.27	0
6045	12G1-1	1.68	0
6046	12G1-2	1.68	0
6047	12G1-3	1.68	0
6048	12G1-4	1.68	0
6049	12G1-5	1.68	0
6050	12G1-6	1.68	0
6051	12G5-1	1.87	0
6052	12G5-2	1.87	0
6053	12G5-3	6.54	0
6054	12G10-1	1.21	0
6055	12G10-2	1.21	0
6056	12G10-3	1.21	0
6057	12G10-4	1.31	0
6058	12G10-5	1.31	0
6059	12G10-6	1.31	0
6060	12G10-7	1.31	0
6501	12U2-1	0.86	0
6502	12U2-2	0.86	0
6503	12U2-3	0.86	0
6504	12U2-4	0.86	0
6505	12U2-5	0.86	0
6506	12U2-6	0.86	0
6507	12U2-7	0.86	0
6508	12U7-1	0.48	0
6509	12U7-2	0.48	0
6510	12U7-3	1.15	0

		Load	Load
Bus No.	**Bus Name**	**MW**	**MVAR**
6511	12U7-4	0.48	0
6512	12U7-5	0.48	0
6513	12U7-6	1.15	0
6514	12U7-7	0.48	0
6515	12U7-8	0.48	0
6516	12U7-9	0.48	0
7001	12I4-1	1.05	0
7002	12I4-2	1.05	0
7003	12I4-3	1.05	0
7004	12I4-4	1.05	0
7005	12I4-5	1.05	0
7006	12I4-6	1.05	0
7007	12I4-7	1.05	0
7008	12I4-8	1.05	0
7009	12I4-9	1.05	0
7010	12I4-10	0.94	0
7011	12I4-11	0.94	0
7012	12I9-1	2.30	0
7013	12I9-2	2.30	0
7014	12I9-3	2.30	0
7015	12I9-4	2.30	0
7016	12I9-5	2.41	0
7017	12I13-1	1.05	0
7018	12I13-2	1.05	0
7019	12I13-3	1.26	0
7020	12I13-4	1.05	0
7021	12I13-5	1.05	0
7022	12I13-6	1.05	0
7023	12I13-7	1.26	0