Equitable Active-Reactive Power Envelopes for Distributed Energy Resources in Power Distribution Systems

APPENDIX

F. Real-world 455-bus system

Tables A.I and A.II give the bus and branch data of the real-world 455-bus system, respectively, in which the base power and base voltage are 1MVA and 10kV, respectively. Table A.III gives the installed capacity and bus location of DERs.

TABLE A.I
BUS DATA

Bus	Type	Active power of load (pu)	Reactive power of load (pu)
1	Slack	0.0000E+00	0.0000E+00
2	PQ	0.0000E+00	0.0000E+00
3	PQ	0.0000E+00	0.0000E+00
4	PQ	5.6691E-02	2.7457E-02
5	PQ	0.0000E+00	0.0000E+00
6	PQ	6.1967E-02	3.0012E-02
7	PQ	7.3945E-02	3.5813E-02
8	PQ	4.6097E-02	2.2326E-02
9	PQ	4.1477E-03	2.0088E-03
10	PQ	2.8717E-02	1.3908E-02
11	PQ	7.7100E-02	3.7341E-02
12	PQ	0.0000E+00	0.0000E+00
13	PQ	2.3351E-02	1.1309E-02
14	PQ	1.0185E-01	4.9330E-02
15	PQ	6.1254E-02	2.9666E-02
16	PQ	0.0000E+00	0.0000E+00
17	PQ	7.5418E-02	3.6526E-02
18	PQ	3.7099E-02	1.7968E-02
19	PQ	3.1152E-02	1.5088E-02
20	PQ	5.6475E-02	2.7352E-02
21	PQ	0.0000E+00	0.0000E+00
22	PQ	3.6387E-02	1.7623E-02
23	PQ	0.0000E+00	0.0000E+00
24	PQ	0.0000E+00	0.0000E+00
25	PQ	7.5848E-02	3.6735E-02
26	PQ	3.9662E-02	1.9209E-02
27	PQ	7.3818E-02	3.5752E-02
28	PQ	6.8040E-02	3.2953E-02
29	PQ	0.0000E+00	0.0000E+00
30	PQ	4.0342E-02	1.9538E-02
31	PQ	6.1780E-02	2.9921E-02
32	PQ	0.0000E+00	0.0000E+00
33	PQ	4.1379E-02	2.0041E-02
34	PQ	1.9977E-02	9.6755E-03
35	PQ	0.0000E+00	0.0000E+00
36	PQ	2.5763E-02	1.2478E-02
37	PQ	0.0000E+00	0.0000E+00
38	PQ	3.0105E-02	1.4581E-02
39	PQ	3.4752E-02	1.6831E-02
40	PQ	4.7895E-02	2.3196E-02
41	PQ	1.2749E-01	6.1747E-02
42	PQ	9.7391E-02	4.7169E-02
43	PQ	0.0000E+00	0.0000E+00
44	PQ	0.0000E+00	0.0000E+00
45	PQ	1.5430E-01	7.4729E-02
46	PQ	1.3556E-01	6.5656E-02
47	PQ	1.2691E-01	6.1464E-02
48	PQ	0.0000E+00	0.0000E+00
49	PQ	2.7597E-01	1.3366E-01
50	PQ	3.5674E-02	1.7278E-02
51	PQ	0.0000E+00	0.0000E+00
52	PQ	9.0470E-01	4.3817E-01
53	PQ	0.0000E+00	0.0000E+00
54	PQ	9.2800E-03	4.4945E-03
55	PQ	0.0000E+00	0.0000E+00
56	PQ	7.5478E-02	3.6555E-02
57	PQ	1.9949E-02	9.6615E-03
58	PQ	0.0000E+00	0.0000E+00
59	PQ	0.0000E+00	0.0000E+00
60	PQ	0.0000E+00	0.0000E+00
61	PQ	8.9903E-02	4.3542E-02
62	PQ	7.0385E-02	3.4089E-02
63	PQ	8.6719E-02	4.2000E-02
64	PQ	0.0000E+00	0.0000E+00
65	PQ	9.4461E-02	4.5750E-02
66	PQ	6.2736E-02	3.0384E-02
67	PQ	7.6144E-02	3.6878E-02
68	PQ	0.0000E+00	0.0000E+00
69	PQ	6.6505E-02	3.2210E-02
70	PQ	5.8817E-02	2.8486E-02
71	PQ	2.5020E-02	1.2118E-02
72	PQ	0.0000E+00	0.0000E+00
73	PQ	0.0000E+00	0.0000E+00
74	PQ	8.9526E-02	4.3359E-02
75	PQ	1.2120E-01	5.8698E-02
76	PQ	1.0122E-01	4.9024E-02
77	PQ	9.6022E-02	4.6506E-02
78	PQ	1.4386E-01	6.9676E-02
79	PQ	3.0621E-02	1.4830E-02
80	PQ	6.8186E-02	3.3024E-02
81	PQ	1.6678E-02	8.0777E-03
82	PQ	4.7362E-02	2.2939E-02
83	PQ	0.0000E+00	0.0000E+00
84	PQ	4.7513E-01	2.3011E-01
85	PQ	0.0000E+00	0.0000E+00
86	PQ	1.6592E-02	8.0360E-03
87	PQ	1.2788E-01	6.1933E-02
88	PQ	1.5255E-01	7.3884E-02
89	PQ	0.0000E+00	0.0000E+00
90	PQ	0.0000E+00	0.0000E+00
91	PQ	6.5070E-02	3.1515E-02
92	PQ	0.0000E+00	0.0000E+00
93	PQ	3.4260E-01	1.6593E-01
94	PQ	1.3810E-01	6.6885E-02
95	PQ	9.3924E-02	4.5490E-02
96	PQ	1.0298E-01	4.9873E-02
97	PQ	1.0262E-01	4.9700E-02
98	PQ	3.4882E-02	1.6894E-02
99	PQ	0.0000E+00	0.0000E+00
100	PQ	0.0000E+00	0.0000E+00
101	PQ	7.6048E-02	3.6832E-02
102	PQ	0.0000E+00	0.0000E+00
103	PQ	8.7091E-02	4.2180E-02
104	PQ	6.7068E-02	3.2483E-02
105	PQ	0.0000E+00	0.0000E+00
106	PQ	9.1303E-02	4.4220E-02
107	PQ	3.8440E-02	1.8617E-02
108	PQ	8.5021E-02	4.1177E-02
109	PQ	2.9653E-02	1.4362E-02
110	PQ	1.7326E-01	8.3913E-02
111	PQ	2.0130E-01	9.7493E-02
112	PQ	0.0000E+00	0.0000E+00
113	PQ	0.0000E+00	0.0000E+00
114	PQ	2.1475E-02	1.0401E-02
115	PQ	0.0000E+00	0.0000E+00
116	PQ	2.2323E-02	1.0812E-02

Bus	Type	Active power of load (pu)	Reactive power of load (pu)
117	PQ	0.0000E+00	0.0000E+00
118	PQ	4.0199E-02	1.9469E-02
119	PQ	3.6658E-02	1.7754E-02
120	PQ	0.0000E+00	0.0000E+00
121	PQ	4.1365E-02	2.0034E-02
122	PQ	5.0153E-02	2.4290E-02
123	PQ	5.0467E-02	2.4442E-02
124	PQ	0.0000E+00	0.0000E+00
125	PQ	5.3204E-02	2.5768E-02
126	PQ	0.0000E+00	0.0000E+00
127	PQ	2.3285E-02	1.1277E-02
128	PQ	5.1143E-02	2.4770E-02
129	PQ	0.0000E+00	0.0000E+00
130	PQ	1.9085E-02	9.2432E-03
131	PQ	9.2526E-03	4.4813E-03
132	PQ	0.0000E+00	0.0000E+00
133	PQ	1.2939E-02	6.2668E-03
134	PQ	4.7388E-02	2.2951E-02
135	PQ	0.0000E+00	0.0000E+00
136	PQ	1.1415E-02	5.5287E-03
137	PQ	0.0000E+00	0.0000E+00
138	PQ	1.7542E-02	8.4959E-03
139	PQ	1.2172E-02	5.8950E-03
140	PQ	0.0000E+00	0.0000E+00
141	PQ	1.2334E-01	5.9734E-02
142	PQ	0.0000E+00	0.0000E+00
143	PQ	5.1727E-02	2.5052E-02
144	PQ	1.1229E-02	5.4385E-03
145	PQ	7.9035E-02	3.8278E-02
146	PQ	0.0000E+00	0.0000E+00
147	PQ	3.2165E-02	1.5578E-02
148	PQ	4.1382E-02	2.0042E-02
149	PQ	4.4430E-02	2.1519E-02
150	PQ	8.7005E-02	4.2139E-02
151	PQ	6.9751E-02	3.3782E-02
152	PQ	0.0000E+00	0.0000E+00
153	PQ	0.0000E+00	0.0000E+00
154	PQ	6.1028E-02	2.9557E-02
155	PQ	1.1325E-01	5.4849E-02
156	PQ	2.2062E-02	1.0685E-02
157	PQ	1.0147E-02	4.9143E-03
158	PQ	0.0000E+00	0.0000E+00
159	PQ	9.1396E-03	4.4265E-03
160	PQ	0.0000E+00	0.0000E+00
161	PQ	2.4868E-02	1.2044E-02
162	PQ	1.1988E-02	5.8059E-03
163	PQ	0.0000E+00	0.0000E+00
164	PQ	0.0000E+00	0.0000E+00
165	PQ	7.8094E-02	3.7823E-02
166	PQ	4.7290E-02	2.2903E-02
167	PQ	0.0000E+00	0.0000E+00
168	PQ	9.9506E-03	4.8193E-03
169	PQ	0.0000E+00	0.0000E+00
170	PQ	0.0000E+00	0.0000E+00
171	PQ	5.1156E-02	2.4776E-02
172	PQ	9.4772E-03	4.5900E-03
173	PQ	0.0000E+00	0.0000E+00
174	PQ	0.0000E+00	0.0000E+00
175	PQ	3.6816E-02	1.7831E-02
176	PQ	0.0000E+00	0.0000E+00
177	PQ	1.8753E-03	9.0825E-04
178	PQ	0.0000E+00	0.0000E+00
179	PQ	3.8377E-02	1.8587E-02
180	PQ	6.0310E-03	2.9209E-03
181	PQ	0.0000E+00	0.0000E+00
182	PQ	4.5600E-02	2.2085E-02
183	PQ	0.0000E+00	0.0000E+00
184	PQ	9.3109E-03	4.5095E-03
185	PQ	0.0000E+00	0.0000E+00
186	PQ	6.4201E-02	3.1094E-02
187	PQ	1.2610E-02	6.1074E-03
188	PQ	0.0000E+00	0.0000E+00
189	PQ	0.0000E+00	0.0000E+00
190	PQ	1.8686E-03	9.0500E-04
191	PQ	0.0000E+00	0.0000E+00
192	PQ	1.1497E-02	5.5683E-03
193	PQ	0.0000E+00	0.0000E+00
194	PQ	2.3632E-02	1.1446E-02
195	PQ	0.0000E+00	0.0000E+00
196	PQ	1.0103E-02	4.8933E-03
197	PQ	0.0000E+00	0.0000E+00
198	PQ	1.5292E-02	7.4063E-03
199	PQ	0.0000E+00	0.0000E+00
200	PQ	9.8561E-03	4.7735E-03
201	PQ	0.0000E+00	0.0000E+00
202	PQ	0.0000E+00	0.0000E+00
203	PQ	0.0000E+00	0.0000E+00
204	PQ	4.0035E-02	1.9390E-02
205	PQ	7.8775E-02	3.8153E-02
206	PQ	0.0000E+00	0.0000E+00
207	PQ	0.0000E+00	0.0000E+00
208	PQ	6.6475E-02	3.2195E-02
209	PQ	1.6674E-02	8.0754E-03
210	PQ	1.2101E-02	5.8607E-03
211	PQ	0.0000E+00	0.0000E+00
212	PQ	1.5708E-01	7.6079E-02
213	PQ	0.0000E+00	0.0000E+00
214	PQ	6.1913E-02	2.9986E-02
215	PQ	0.0000E+00	0.0000E+00
216	PQ	4.3408E-02	2.1023E-02
217	PQ	1.0703E-02	5.1836E-03
218	PQ	4.7658E-02	2.3082E-02
219	PQ	0.0000E+00	0.0000E+00
220	PQ	3.4295E-02	1.6610E-02
221	PQ	0.0000E+00	0.0000E+00
222	PQ	8.4907E-02	4.1122E-02
223	PQ	0.0000E+00	0.0000E+00
224	PQ	3.7360E-02	1.8094E-02
225	PQ	0.0000E+00	0.0000E+00
226	PQ	0.0000E+00	0.0000E+00
227	PQ	0.0000E+00	0.0000E+00
228	PQ	0.0000E+00	0.0000E+00
229	PQ	0.0000E+00	0.0000E+00
230	PQ	9.6715E-02	4.6841E-02
231	PQ	0.0000E+00	0.0000E+00
232	PQ	4.3427E-02	2.1033E-02
233	PQ	0.0000E+00	0.0000E+00
234	PQ	1.4745E-01	7.1412E-02
235	PQ	4.7639E-02	2.3073E-02
236	PQ	0.0000E+00	0.0000E+00
237	PQ	2.9036E-01	1.4063E-01
238	PQ	0.0000E+00	0.0000E+00
239	PQ	1.1851E-01	5.7396E-02
240	PQ	1.1213E-01	5.4305E-02
241	PQ	1.2345E-01	5.9787E-02
242	PQ	0.0000E+00	0.0000E+00
243	PQ	1.5677E-01	7.5927E-02
244	PQ	1.0935E-01	5.2963E-02
245	PQ	0.0000E+00	0.0000E+00
246	PQ	3.8567E-02	1.8679E-02
247	PQ	1.6033E-02	7.7649E-03
248	PQ	7.8582E-02	3.8059E-02
249	PQ	7.4401E-02	3.6034E-02
250	PQ	0.0000E+00	0.0000E+00
251	PQ	0.0000E+00	0.0000E+00
252	PQ	1.1485E-01	5.5623E-02
253	PQ	1.5479E-01	7.4968E-02
254	PQ	9.2659E-02	4.4877E-02
255	PQ	9.8731E-02	4.7818E-02
256	PQ	0.0000E+00	0.0000E+00
257	PQ	0.0000E+00	0.0000E+00
258	PQ	0.0000E+00	0.0000E+00
259	PQ	4.5570E-02	2.2070E-02
260	PQ	0.0000E+00	0.0000E+00
261	PQ	0.0000E+00	0.0000E+00
262	PQ	8.2588E-02	3.9999E-02

Bus	Type	Active power of load (pu)	Reactive power of load (pu)
263	PQ	0.0000E+00	0.0000E+00
264	PQ	8.1554E-02	3.9498E-02
265	PQ	6.3706E-02	3.0854E-02
266	PQ	0.0000E+00	0.0000E+00
267	PQ	0.0000E+00	0.0000E+00
268	PQ	6.0899E-02	2.9495E-02
269	PQ	0.0000E+00	0.0000E+00
270	PQ	5.2698E-02	2.5523E-02
271	PQ	0.0000E+00	0.0000E+00
272	PQ	6.7901E-02	3.2886E-02
273	PQ	3.1701E-01	1.5353E-01
274	PQ	7.2135E-02	3.4937E-02
275	PQ	0.0000E+00	0.0000E+00
276	PQ	4.2702E-02	2.0681E-02
277	PQ	0.0000E+00	0.0000E+00
278	PQ	7.3833E-02	3.5759E-02
279	PQ	9.5901E-02	4.6447E-02
280	PQ	0.0000E+00	0.0000E+00
281	PQ	1.8544E-02	8.9814E-03
282	PQ	4.5564E-02	2.2068E-02
283	PQ	7.0766E-02	3.4274E-02
284	PQ	0.0000E+00	0.0000E+00
285	PQ	8.0251E-02	3.8867E-02
286	PQ	0.0000E+00	0.0000E+00
287	PQ	2.1765E-02	1.0541E-02
288	PQ	2.5371E-02	1.2288E-02
289	PQ	0.0000E+00	0.0000E+00
290	PQ	0.0000E+00	0.0000E+00
291	PQ	0.0000E+00	0.0000E+00
292	PQ	1.4699E-02	7.1191E-03
293	PQ	9.1924E-03	4.4521E-03
294	PQ	0.0000E+00	0.0000E+00
295	PQ	2.0782E-01	1.0065E-01
296	PQ	0.0000E+00	0.0000E+00
297	PQ	0.0000E+00	0.0000E+00
298	PQ	0.0000E+00	0.0000E+00
299	PQ	0.0000E+00	0.0000E+00
300	PQ	2.8986E-02	1.4039E-02
301	PQ	0.0000E+00	0.0000E+00
302	PQ	3.8326E-02	1.8562E-02
303	PQ	0.0000E+00	0.0000E+00
304	PQ	3.0170E-02	1.4612E-02
305	PQ	0.0000E+00	0.0000E+00
306	PQ	0.0000E+00	0.0000E+00
307	PQ	5.0300E-02	2.4362E-02
308	PQ	1.1105E-01	5.3785E-02
309	PQ	0.0000E+00	0.0000E+00
310	PQ	3.2388E-02	1.5686E-02
311	PQ	0.0000E+00	0.0000E+00
312	PQ	1.9672E-02	9.5274E-03
313	PQ	0.0000E+00	0.0000E+00
314	PQ	4.8506E-02	2.3492E-02
315	PQ	6.4137E-02	3.1063E-02
316	PQ	0.0000E+00	0.0000E+00
317	PQ	0.0000E+00	0.0000E+00
318	PQ	7.5259E-02	3.6450E-02
319	PQ	0.0000E+00	0.0000E+00
320	PQ	3.4574E-02	1.6745E-02
321	PQ	5.3868E-02	2.6089E-02
322	PQ	0.0000E+00	0.0000E+00
323	PQ	5.6963E-02	2.7588E-02
324	PQ	4.6135E-02	2.2344E-02
325	PQ	3.9373E-02	1.9069E-02
326	PQ	0.0000E+00	0.0000E+00
327	PQ	7.1445E-02	3.4602E-02
328	PQ	6.8390E-02	3.3123E-02
329	PQ	5.6332E-02	2.7283E-02
330	PQ	0.0000E+00	0.0000E+00
331	PQ	0.0000E+00	0.0000E+00
332	PQ	4.5700E-02	2.2133E-02
333	PQ	2.6219E-01	1.2698E-01
334	PQ	1.1951E-01	5.7884E-02
335	PQ	1.1499E-01	5.5691E-02
336	PQ	6.8090E-02	3.2978E-02
337	PQ	5.8406E-02	2.8287E-02
338	PQ	0.0000E+00	0.0000E+00
339	PQ	0.0000E+00	0.0000E+00
340	PQ	4.8380E-02	2.3432E-02
341	PQ	5.8252E-02	2.8213E-02
342	PQ	5.6461E-02	2.7346E-02
343	PQ	0.0000E+00	0.0000E+00
344	PQ	3.8983E-02	1.8880E-02
345	PQ	5.1707E-02	2.5043E-02
346	PQ	0.0000E+00	0.0000E+00
347	PQ	0.0000E+00	0.0000E+00
348	PQ	4.6525E-02	2.2533E-02
349	PQ	2.3995E-02	1.1621E-02
350	PQ	6.5202E-03	3.1579E-03
351	PQ	0.0000E+00	0.0000E+00
352	PQ	1.1067E-01	5.3600E-02
353	PQ	0.0000E+00	0.0000E+00
354	PQ	3.9192E-02	1.8982E-02
355	PQ	5.7672E-02	2.7932E-02
356	PQ	7.6673E-02	3.7135E-02
357	PQ	0.0000E+00	0.0000E+00
358	PQ	9.6024E-02	4.6506E-02
359	PQ	7.7659E-02	3.7612E-02
360	PQ	6.1721E-02	2.9893E-02
361	PQ	5.5168E-02	2.6719E-02
362	PQ	6.4550E-02	3.1263E-02
363	PQ	7.3098E-02	3.5403E-02
364	PQ	1.0350E-01	5.0126E-02
365	PQ	0.0000E+00	0.0000E+00
366	PQ	7.6436E-02	3.7019E-02
367	PQ	2.2792E-02	1.1039E-02
368	PQ	0.0000E+00	0.0000E+00
369	PQ	7.0448E-02	3.4120E-02
370	PQ	7.2912E-02	3.5313E-02
371	PQ	0.0000E+00	0.0000E+00
372	PQ	3.1839E-02	1.5420E-02
373	PQ	0.0000E+00	0.0000E+00
374	PQ	0.0000E+00	0.0000E+00
375	PQ	7.1473E-02	3.4616E-02
376	PQ	6.3726E-02	3.0864E-02
377	PQ	8.7451E-02	4.2354E-02
378	PQ	1.0385E-01	5.0297E-02
379	PQ	6.4764E-02	3.1366E-02
380	PQ	1.2858E-01	6.2272E-02
381	PQ	6.8335E-02	3.3096E-02
382	PQ	7.4956E-02	3.6303E-02
383	PQ	2.5491E-03	1.2346E-03
384	PQ	2.3757E-03	1.1506E-03
385	PQ	4.4363E-02	2.1486E-02
386	PQ	0.0000E+00	0.0000E+00
387	PQ	3.2577E-02	1.5778E-02
388	PQ	0.0000E+00	0.0000E+00
389	PQ	0.0000E+00	0.0000E+00
390	PQ	1.4040E-02	6.8001E-03
391	PQ	2.4538E-02	1.1884E-02
392	PQ	0.0000E+00	0.0000E+00
393	PQ	7.3503E-02	3.5599E-02
394	PQ	5.6523E-02	2.7375E-02
395	PQ	7.1393E-02	3.4577E-02
396	PQ	0.0000E+00	0.0000E+00
397	PQ	5.4499E-02	2.6395E-02
398	PQ	5.5904E-02	2.7076E-02
399	PQ	4.2118E-02	2.0399E-02
400	PQ	7.6114E-02	3.6864E-02
401	PQ	7.2641E-02	3.5182E-02
402	PQ	7.0576E-02	3.4182E-02
403	PQ	6.6562E-02	3.2237E-02
404	PQ	5.5759E-02	2.7005E-02
405	PQ	6.9682E-02	3.3748E-02
406	PQ	3.9237E-02	1.9003E-02
407	PQ	0.0000E+00	0.0000E+00
408	PQ	9.7920E-02	4.7425E-02

Bus	Type	Active power of load (pu)	Reactive power of load (pu)
409	PQ	9.3774E-03	4.5417E-03
410	PQ	0.0000E+00	0.0000E+00
411	PQ	3.0026E-02	1.4542E-02
412	PQ	1.4757E-01	7.1471E-02
413	PQ	4.5368E-02	2.1973E-02
414	PQ	0.0000E+00	0.0000E+00
415	PQ	0.0000E+00	0.0000E+00
416	PQ	4.0131E-02	1.9436E-02
417	PQ	0.0000E+00	0.0000E+00
418	PQ	4.7373E-02	2.2944E-02
419	PQ	0.0000E+00	0.0000E+00
420	PQ	0.0000E+00	0.0000E+00
421	PQ	5.9678E-02	2.8903E-02
422	PQ	7.5254E-02	3.6447E-02
423	PQ	0.0000E+00	0.0000E+00
424	PQ	3.6618E-02	1.7735E-02
425	PQ	1.4522E-01	7.0334E-02
426	PQ	0.0000E+00	0.0000E+00
427	PQ	0.0000E+00	0.0000E+00
428	PQ	0.0000E+00	0.0000E+00
429	PQ	1.5353E-01	7.4358E-02
430	PQ	2.2973E-01	1.1126E-01
431	PQ	1.0893E-01	5.2755E-02
432	PQ	1.0860E-01	5.2595E-02
433	PQ	9.6743E-02	4.6855E-02
434	PQ	1.2221E-01	5.9190E-02
435	PQ	0.0000E+00	0.0000E+00
436	PQ	7.7673E-02	3.7619E-02
437	PQ	6.4368E-03	3.1175E-03
438	PQ	0.0000E+00	0.0000E+00
439	PQ	4.5002E-02	2.1795E-02
440	PQ	0.0000E+00	0.0000E+00
441	PQ	0.0000E+00	0.0000E+00
442	PQ	0.0000E+00	0.0000E+00
443	PQ	8.8282E-02	4.2757E-02
444	PQ	4.0256E-02	1.9497E-02
445	PQ	0.0000E+00	0.0000E+00
446	PQ	6.0907E-02	2.9498E-02
447	PQ	1.0206E-01	4.9431E-02
448	PQ	7.8003E-02	3.7779E-02
449	PQ	1.0239E-01	4.9589E-02
450	PQ	8.8707E-02	4.2963E-02
451	PQ	0.0000E+00	0.0000E+00
452	PQ	6.0124E-02	2.9119E-02
453	PQ	1.4006E-01	6.7835E-02
454	PQ	7.2833E-02	3.5275E-02
455	PQ	0.0000E+00	0.0000E+00

TABLE A.II
BRANCH DATA

Branch	From	To	Resistance (pu)	Reactance (pu)
1	1	8	1.0000E-08	1.0000E-08
2	1	7	1.0000E-08	1.0000E-08
3	1	6	1.0000E-08	1.0000E-08
4	1	5	1.0000E-08	1.0000E-08
5	1	4	1.0000E-08	1.0000E-08
6	1	3	1.0000E-08	1.0000E-08
7	1	2	1.0000E-08	1.0000E-08
8	2	9	2.3232E-03	2.0781E-03
9	9	16	2.6880E-04	3.4440E-05
10	9	17	2.5600E-04	3.2800E-05
11	17	32	2.5840E-04	5.7760E-05
12	32	59	1.2240E-04	2.7360E-05
13	17	33	2.8800E-04	3.6900E-05
14	33	60	8.9600E-04	1.1480E-04
15	60	89	1.5300E-04	3.4200E-05
16	60	90	1.7340E-04	3.8760E-05
17	90	122	1.5300E-04	3.4200E-05
18	122	151	1.5300E-04	3.4200E-05
19	122	152	1.5300E-04	3.4200E-05
20	9	18	7.2900E-05	1.9980E-05
21	18	34	2.4300E-04	6.6600E-05
22	34	61	1.2150E-04	3.3300E-05
23	34	62	2.1870E-04	5.9940E-05
24	62	91	1.2150E-04	3.3300E-05
25	34	63	8.9100E-05	2.4420E-05
26	63	92	7.2900E-05	1.9980E-05
27	92	123	9.9900E-05	2.7380E-05
28	92	124	1.0530E-04	2.8860E-05
29	124	153	4.2930E-04	1.1766E-04
30	153	190	5.1680E-04	1.1552E-04
31	153	191	2.8800E-04	3.6900E-05
32	153	192	1.3600E-04	3.0400E-05
33	192	225	8.1600E-05	1.8240E-05
34	124	154	1.2960E-04	3.5520E-05
35	154	193	1.9200E-04	2.4600E-05
36	154	194	1.3770E-04	3.7740E-05
37	194	226	1.2150E-04	3.3300E-05
38	226	253	2.6880E-04	3.4440E-05
39	253	271	3.0720E-04	3.9360E-05
40	226	254	2.0250E-04	5.5500E-05
41	254	272	2.1760E-04	2.7880E-05
42	254	273	6.4800E-05	1.7760E-05
43	273	285	1.2150E-04	3.3300E-05
44	273	286	1.9440E-04	5.3280E-05
45	286	299	1.2150E-04	3.3300E-05
46	286	300	1.2150E-04	3.3300E-05
47	300	310	1.2150E-04	3.3300E-05
48	3	10	1.1313E-03	1.7178E-03
49	10	19	2.4180E-03	3.3480E-04
50	19	35	7.8000E-05	1.0800E-05
51	35	64	5.2000E-05	7.2000E-06
52	10	20	4.7264E-04	4.3888E-04
53	20	36	1.8415E-04	8.1280E-05
54	20	37	2.3400E-04	3.2400E-05
55	20	38	1.7584E-04	1.6328E-04
56	38	65	2.3400E-04	3.2400E-05
57	38	66	5.1810E-04	5.2595E-04
58	66	93	1.4720E-04	2.5280E-05
59	93	125	1.8860E-04	3.2390E-05
60	125	155	1.4122E-03	2.4253E-04
61	125	156	5.8880E-04	1.0112E-04
62	156	195	2.0700E-04	3.5550E-05
63	66	94	1.0539E-03	2.6402E-04
64	94	126	1.5120E-04	7.6860E-05
65	126	157	3.3642E-04	8.6940E-05
66	126	158	4.5390E-04	1.1730E-04
67	126	159	8.0100E-05	2.0700E-05
68	126	160	2.2440E-04	1.1407E-04
69	160	196	1.0500E-04	1.1700E-05
70	160	197	3.4710E-04	8.9700E-05
71	197	227	8.7500E-04	9.7500E-05
72	94	127	2.3920E-04	4.1080E-05
73	127	161	7.3600E-04	1.2640E-04
74	127	162	2.5418E-04	9.3720E-05
75	162	198	2.0700E-04	3.5550E-05
76	94	128	8.9500E-05	3.3000E-05
77	128	163	1.1020E-04	4.8640E-05
78	163	199	8.8110E-05	2.2770E-05
79	163	200	8.8110E-05	2.2770E-05
80	200	228	1.2015E-04	3.1050E-05
81	163	201	2.1360E-04	5.5200E-05
82	201	229	3.6579E-04	9.4530E-05
83	128	164	2.4840E-04	4.2660E-05
84	128	165	2.5418E-04	9.3720E-05
85	165	202	1.4850E-04	1.5075E-04
86	202	230	6.3030E-04	6.3985E-04
87	10	21	3.1864E-04	2.9588E-04
88	21	39	7.2800E-05	1.0080E-05
89	21	40	1.1480E-04	1.0660E-04
90	40	67	3.6400E-04	4.0560E-05
91	40	68	2.6134E-04	9.6360E-05
92	68	95	1.6120E-04	2.2320E-05
93	40	69	2.9288E-04	2.7196E-04
94	69	96	1.8256E-04	1.6952E-04

Branch	From	To	Resistance (pu)	Reactance (pu)
95	96	129	5.1800E-04	5.7720E-05
96	96	130	1.5176E-04	1.4092E-04
97	130	166	7.3425E-04	1.8975E-04
98	130	167	7.6440E-04	1.0584E-04
99	167	203	3.9000E-04	5.4000E-05
100	167	204	4.5240E-04	6.2640E-05
101	204	231	3.3800E-04	4.6800E-05
102	130	168	3.9860E-04	9.1680E-05
103	168	205	6.4000E-05	8.2000E-06
104	130	169	7.0000E-05	6.5000E-05
105	169	206	1.4000E-04	1.5600E-05
106	169	207	9.1700E-04	1.0218E-04
107	96	131	1.2252E-03	2.3074E-04
108	131	170	8.0550E-05	2.9700E-05
109	170	208	1.8437E-04	6.7980E-05
110	208	232	8.6400E-04	1.1070E-04
111	208	233	4.2780E-04	5.3760E-05
112	208	234	9.2800E-04	1.1890E-04
113	234	255	5.7600E-04	7.3800E-05
114	255	274	1.1455E-04	5.0560E-05
115	274	287	2.9370E-04	7.5900E-05
116	69	97	5.2650E-04	1.4430E-04
117	97	132	1.4450E-03	6.4600E-04
118	97	133	6.8000E-04	3.0400E-04
119	133	171	2.6350E-04	1.1780E-04
120	97	134	2.7270E-04	7.4740E-05
121	134	172	4.4820E-04	1.2284E-04
122	172	209	6.6300E-04	2.9640E-04
123	209	235	5.6950E-04	2.5460E-04
124	172	210	4.8060E-04	1.3172E-04
125	210	236	5.9500E-04	2.6600E-04
126	236	256	1.4875E-03	6.6500E-04
127	210	237	1.9170E-04	5.2540E-05
128	237	257	9.5580E-04	2.6196E-04
129	257	275	2.4650E-04	1.1020E-04
130	257	276	1.4040E-04	3.8480E-05
131	276	288	5.1000E-04	2.2800E-04
132	276	289	6.1200E-04	2.7360E-04
133	276	290	6.1290E-04	1.6798E-04
134	290	301	2.7200E-04	1.2160E-04
135	290	302	4.5360E-04	1.2432E-04
136	302	311	3.1050E-04	8.5100E-05
137	311	316	5.1000E-03	2.2800E-03
138	311	317	9.0990E-04	2.4938E-04
139	317	321	7.5330E-04	2.0646E-04
140	321	325	1.5555E-03	6.9540E-04
141	321	326	1.1070E-04	3.0340E-05
142	326	331	3.4040E-04	2.6492E-04
143	331	337	2.7600E-04	2.1480E-04
144	337	343	1.4720E-04	2.5280E-05
145	343	350	1.4720E-04	2.5280E-05
146	343	351	5.2440E-04	9.0060E-05
147	351	358	3.4000E-04	1.5200E-04
148	351	359	6.0720E-04	1.0428E-04
149	359	368	2.0240E-04	3.4760E-05
150	368	375	6.3940E-04	1.0981E-04
151	375	386	1.0752E-03	1.3776E-04
152	386	399	8.5120E-04	1.0906E-04
153	399	413	7.6800E-05	9.8400E-06
154	413	426	6.4000E-04	8.2000E-05
155	426	438	3.5200E-04	4.5100E-05
156	375	387	9.6600E-04	1.6590E-04
157	387	400	7.6925E-03	3.4390E-03
158	400	414	1.2580E-03	5.6240E-04
159	400	415	5.8395E-03	2.6106E-03
160	415	427	1.2325E-03	5.5100E-04
161	387	401	1.4720E-04	2.5280E-05
162	401	416	2.6864E-03	4.6136E-04
163	416	428	1.2144E-03	2.0856E-04
164	428	439	2.0700E-04	3.5550E-05
165	416	429	1.7850E-04	7.9800E-05
166	429	440	1.8700E-04	8.3600E-05
167	326	332	4.7250E-04	1.2950E-04
168	332	338	1.2578E-02	7.1208E-03
169	332	339	7.5600E-05	2.0720E-05
170	339	344	1.9170E-04	5.2540E-05
171	344	352	8.2080E-04	2.2496E-04
172	352	360	2.6520E-03	1.1856E-03
173	352	361	9.5850E-04	2.6270E-04
174	361	369	2.8900E-04	6.4600E-05
175	369	376	2.6180E-04	5.8520E-05
176	369	377	6.1200E-05	1.3680E-05
177	361	370	9.7560E-04	2.9100E-04
178	370	378	2.0315E-03	9.0820E-04
179	378	388	3.7400E-04	1.6720E-04
180	388	402	3.8250E-04	1.7100E-04
181	378	389	1.1900E-03	5.3200E-04
182	389	403	2.2100E-03	9.8800E-04
183	403	417	4.3350E-04	1.9380E-04
184	403	418	1.0115E-03	4.5220E-04
185	370	379	8.8290E-04	2.4198E-04
186	379	390	1.0400E-03	1.4400E-04
187	379	391	1.5201E-03	4.1662E-04
188	391	404	5.5250E-04	2.4700E-04
189	404	419	3.8250E-04	1.7100E-04
190	391	405	3.8070E-04	1.0434E-04
191	405	420	5.3460E-04	1.4652E-04
192	420	430	8.4240E-04	2.3088E-04
193	420	431	7.6700E-04	4.3424E-04
194	431	441	7.3100E-04	3.2680E-04
195	431	442	9.8800E-04	5.5936E-04
196	442	444	9.5200E-04	4.2560E-04
197	444	447	1.7000E-04	7.6000E-05
198	442	445	1.3855E-03	6.1940E-04
199	445	448	7.5820E-03	3.3896E-03
200	448	450	7.6500E-04	3.4200E-04
201	448	451	2.6945E-03	1.2046E-03
202	451	453	5.8055E-03	2.5954E-03
203	453	455	4.2500E-04	1.9000E-04
204	451	454	4.5390E-03	2.0292E-03
205	4	11	1.0948E-03	1.0166E-03
206	11	22	4.5976E-04	4.2692E-04
207	22	41	1.0400E-03	1.4400E-04
208	22	42	7.5400E-04	1.0440E-04
209	22	43	4.1216E-04	3.8272E-04
210	11	23	2.9904E-04	2.7768E-04
211	23	44	7.7480E-04	1.0728E-04
212	23	45	2.0328E-04	1.8876E-04
213	45	70	1.5218E-04	2.0971E-04
214	70	98	1.7493E-03	2.8905E-03
215	98	135	7.2800E-04	1.0080E-04
216	98	136	9.5340E-04	1.4903E-03
217	136	173	2.2750E-04	1.2880E-04
218	136	174	1.1193E-03	1.6671E-03
219	174	211	8.5000E-05	3.8000E-05
220	211	238	8.5000E-05	3.8000E-05
221	174	212	2.7930E-04	3.8855E-04
222	212	239	2.2890E-04	3.7823E-04
223	239	258	3.8250E-04	1.7100E-04
224	239	259	1.2390E-04	2.0473E-04
225	259	277	1.4000E-05	1.3000E-05
226	259	278	7.3500E-05	1.2145E-04
227	278	291	1.0920E-04	1.8044E-04
228	278	292	1.1200E-05	1.0400E-05
229	5	12	1.4393E-03	9.0358E-04
230	12	24	1.9320E-04	1.7940E-04
231	12	25	7.1360E-05	3.0920E-05
232	25	46	7.7440E-04	9.9220E-05
233	25	47	1.4310E-04	3.9220E-05
234	47	71	4.4800E-05	5.7400E-06
235	47	72	6.6420E-04	1.8204E-04
236	72	99	3.9520E-04	5.4720E-05
237	72	100	3.9420E-04	1.0804E-04
238	100	137	1.2420E-04	3.4040E-05
239	137	175	1.3440E-04	1.7220E-05
240	137	176	2.4570E-04	6.7340E-05

Branch	From	To	Resistance (pu)	Reactance (pu)
241	176	213	1.8437E-04	6.7980E-05
242	213	240	2.0292E-04	5.2440E-05
243	240	260	2.8600E-04	3.9600E-05
244	176	214	1.0638E-03	2.9156E-04
245	214	241	5.0943E-04	1.5436E-04
246	241	261	7.0000E-04	7.8000E-05
247	214	242	8.1200E-05	3.5840E-05
248	242	262	1.8560E-04	2.3780E-05
249	262	279	3.3280E-04	4.2640E-05
250	242	263	2.0480E-04	2.6240E-05
251	263	280	5.4400E-04	6.9700E-05
252	6	13	8.1312E-04	7.5504E-04
253	13	26	1.1481E-04	2.9670E-05
254	26	48	3.8480E-04	5.3280E-05
255	26	49	1.0290E-03	1.1466E-04
256	49	73	9.3100E-04	1.0374E-04
257	13	27	6.6332E-04	1.0689E-03
258	27	50	2.9040E-04	2.9480E-04
259	50	74	7.5900E-05	7.7050E-05
260	74	101	4.9600E-04	2.0480E-04
261	74	102	5.0050E-04	2.8336E-04
262	102	138	5.8500E-04	3.3120E-04
263	102	139	7.8000E-04	4.4160E-04
264	139	177	2.9250E-04	1.6560E-04
265	50	75	1.8480E-04	1.8760E-04
266	75	103	1.9800E-04	2.0100E-04
267	103	140	2.5080E-04	2.5460E-04
268	140	178	7.5900E-05	7.7050E-05
269	140	179	2.6000E-04	1.4720E-04
270	27	51	5.2500E-05	8.6750E-05
271	51	76	6.8200E-05	2.8160E-05
272	51	77	2.6880E-04	4.4416E-04
273	77	104	1.3200E-04	1.3400E-04
274	77	105	5.0690E-04	2.0060E-04
275	77	106	9.0300E-04	1.4921E-03
276	106	141	8.8200E-05	1.4574E-04
277	141	180	6.5310E-04	1.0792E-03
278	141	181	5.7120E-04	9.4384E-04
279	181	215	2.7900E-04	1.1520E-04
280	215	243	5.5800E-04	2.3040E-04
281	181	216	1.8900E-04	3.1230E-04
282	216	244	3.6400E-04	2.0608E-04
283	216	245	9.4500E-05	1.5615E-04
284	245	264	2.3000E-04	1.3300E-04
285	245	265	9.6600E-05	1.5962E-04
286	265	281	4.3254E-04	1.1178E-04
287	281	293	2.8800E-04	3.6900E-05
288	293	303	1.0430E-03	1.1622E-04
289	293	304	3.2000E-04	4.1000E-05
290	265	282	2.0790E-04	3.4353E-04
291	282	294	1.5232E-03	1.9516E-04
292	282	295	2.4150E-04	3.9905E-04
293	295	305	1.8600E-04	7.6800E-05
294	295	306	5.1660E-04	8.5362E-04
295	306	312	1.7640E-04	2.9148E-04
296	306	313	3.1915E-03	1.8069E-03
297	7	14	5.1954E-04	7.8795E-04
298	14	28	6.7760E-04	6.2920E-04
299	28	52	1.4952E-04	1.3884E-04
300	52	78	1.5280E-03	4.2702E-04
301	52	79	9.2400E-05	1.5268E-04
302	79	107	2.7900E-04	1.1520E-04
303	79	108	1.3440E-04	2.2208E-04
304	108	142	2.7900E-04	1.1520E-04
305	108	143	1.9740E-04	3.2618E-04
306	143	182	5.9500E-05	2.6600E-05
307	143	183	3.8250E-04	1.7100E-04
308	183	217	2.9750E-04	1.3300E-04
309	143	184	3.9480E-04	6.5236E-04
310	184	218	1.7850E-04	7.9800E-05
311	218	246	3.8250E-04	1.7100E-04
312	184	219	5.1000E-05	2.2800E-05
313	184	220	1.1550E-04	1.9085E-04
314	220	247	6.2000E-05	2.5600E-05
315	220	248	3.9520E-04	5.4720E-05
316	28	53	9.8130E-04	1.0096E-03
317	53	80	2.1240E-04	1.6638E-04
318	80	109	6.4000E-05	8.2000E-06
319	80	110	4.5000E-04	3.5250E-04
320	110	144	2.7900E-04	1.1520E-04
321	110	145	4.1040E-04	3.2148E-04
322	53	81	5.5040E-04	7.0520E-05
323	81	111	5.9520E-04	7.6260E-05
324	81	112	2.8800E-04	3.6900E-05
325	112	146	2.8800E-04	3.6900E-05
326	14	29	1.1200E-05	1.0400E-05
327	29	54	3.9520E-04	5.4720E-05
328	54	82	9.3440E-04	1.1972E-04
329	82	113	9.8000E-04	1.0920E-04
330	29	55	7.5610E-04	3.0802E-04
331	55	83	5.9400E-04	6.0300E-04
332	83	114	9.3600E-05	7.3320E-05
333	83	115	1.0440E-03	8.1780E-04
334	55	84	1.6109E-03	4.8330E-04
335	84	116	1.5600E-04	2.1600E-05
336	84	117	2.7000E-04	7.4000E-05
337	117	147	1.2420E-04	3.4040E-05
338	147	185	1.2150E-04	3.3300E-05
339	117	148	5.1300E-04	1.4060E-04
340	148	186	2.7900E-04	1.1520E-04
341	148	187	1.2150E-04	3.3300E-05
342	187	221	6.0210E-04	1.6502E-04
343	221	249	1.2150E-04	3.3300E-05
344	249	266	2.7900E-04	1.1520E-04
345	249	267	4.6980E-04	1.2876E-04
346	267	283	3.6180E-04	9.9160E-05
347	283	296	1.4310E-04	3.9220E-05
348	296	307	5.7600E-05	7.3800E-06
349	296	308	1.3500E-05	3.7000E-06
350	308	314	4.3200E-05	1.1840E-05
351	314	318	3.0780E-04	8.4360E-05
352	318	322	6.8000E-05	1.5200E-05
353	322	327	6.8000E-06	1.5200E-06
354	318	323	6.9250E-04	7.9360E-05
355	323	328	7.9920E-04	2.1904E-04
356	328	333	8.1000E-05	2.2200E-05
357	333	340	1.6197E-03	1.4440E-03
358	340	345	5.6660E-04	2.9254E-04
359	340	346	1.5556E-03	2.0646E-04
360	346	353	5.7600E-04	7.3800E-05
361	353	362	2.6000E-04	3.6000E-05
362	362	371	8.6400E-04	1.1070E-04
363	283	297	4.8370E-04	7.6075E-04
364	297	309	1.9950E-04	3.2965E-04
365	309	315	1.8900E-04	3.1230E-04
366	315	319	3.2900E-04	3.6660E-05
367	315	320	3.8850E-04	6.4195E-04
368	320	324	2.7300E-04	4.5110E-04
369	324	329	3.6400E-04	4.0560E-05
370	329	334	2.5900E-04	2.8860E-05
371	324	330	2.8350E-04	4.6845E-04
372	330	335	8.3300E-04	9.2820E-05
373	330	336	2.8350E-04	4.6845E-04
374	336	341	3.0552E-03	0.0000E+00
375	341	347	4.1080E-04	5.6880E-05
376	347	354	2.3400E-04	3.2400E-05
377	354	363	2.7560E-04	3.8160E-05
378	341	348	6.6560E-04	9.2160E-05
379	348	355	4.2640E-04	5.9040E-05
380	355	364	4.1080E-04	5.6880E-05
381	336	342	4.7250E-04	7.8075E-04
382	342	349	3.0030E-04	4.9621E-04
383	349	356	5.1570E-04	1.4134E-04
384	356	365	1.2150E-04	3.3300E-05
385	365	372	1.1200E-03	1.4350E-04
386	372	380	2.8800E-04	3.6900E-05

Branch	From	To	Resistance (pu)	Reactance (pu)
387	380	392	2.5600E-04	3.2800E-05
388	392	406	3.2000E-04	4.1000E-05
389	380	393	6.5920E-04	8.4460E-05
390	393	407	2.7900E-04	1.1520E-04
391	393	408	7.8080E-04	1.0004E-04
392	365	373	5.8240E-04	7.4620E-05
393	373	381	1.7280E-04	4.7360E-05
394	373	382	1.2150E-04	3.3300E-05
395	382	394	1.2150E-04	3.3300E-05
396	373	383	2.9970E-04	8.2140E-05
397	383	395	3.0780E-04	8.4360E-05
398	395	409	2.3220E-04	6.3640E-05
399	383	396	1.8900E-04	5.1800E-05
400	396	410	4.0770E-04	1.1174E-04
401	410	421	3.6450E-04	9.9900E-05
402	421	432	1.3770E-04	3.7740E-05
403	432	443	2.4300E-04	6.6600E-05
404	443	446	2.0790E-04	5.6980E-05
405	446	449	1.8360E-04	5.0320E-05
406	449	452	1.0530E-04	2.8860E-05
407	349	357	1.8900E-04	3.1230E-04
408	357	366	4.1080E-04	5.6880E-05
409	357	367	1.0080E-04	1.6656E-04
410	367	374	8.5050E-04	1.4054E-03
411	374	384	2.9700E-04	3.0780E-04
412	384	397	1.4850E-04	1.5390E-04
413	374	385	1.6380E-04	2.7066E-04
414	385	398	1.7850E-04	2.9495E-04
415	398	411	4.2840E-04	7.0788E-04
416	411	422	3.2000E-04	4.1000E-05
417	422	433	2.7520E-04	3.5260E-05
418	411	423	2.7720E-04	4.5804E-04
419	423	434	1.6926E-03	2.7968E-03
420	398	412	8.6400E-04	1.1070E-04
421	412	424	1.8560E-03	2.3780E-04
422	424	435	9.0880E-04	1.1644E-04
423	412	425	1.2416E-03	1.5908E-04
424	425	436	9.0880E-04	1.1644E-04
425	425	437	1.4016E-03	1.7958E-04
426	8	15	5.5664E-04	5.1688E-04
427	15	30	2.5200E-05	2.3400E-05
428	30	56	1.9448E-03	2.6928E-04
429	56	85	2.0020E-03	2.7720E-04
430	30	57	2.3920E-03	3.3120E-04
431	57	86	1.6952E-03	2.3472E-04
432	86	118	2.0020E-03	2.7720E-04
433	15	31	2.8000E-05	2.6000E-05
434	31	58	1.6576E-04	1.5392E-04
435	58	87	1.6120E-04	2.2320E-05
436	87	119	3.2760E-04	4.5360E-05
437	58	88	8.7360E-05	8.1120E-05
438	88	120	2.2400E-04	2.4960E-05
439	88	121	8.1200E-05	7.5400E-05
440	121	149	7.2500E-05	3.2000E-05
441	121	150	6.7760E-05	6.2920E-05
442	150	188	1.0400E-04	1.4400E-05
443	188	222	1.0400E-04	1.4400E-05
444	150	189	6.1040E-05	5.6680E-05
445	189	223	9.3600E-04	1.2960E-04
446	223	250	2.0800E-03	2.8800E-04
447	250	268	2.8800E-04	3.6900E-05
448	268	284	3.1920E-04	4.1220E-05
449	284	298	3.5840E-04	4.5920E-05
450	189	224	1.2656E-04	1.1752E-04
451	224	251	8.0080E-04	1.1088E-04
452	251	269	6.1360E-04	8.4960E-05
453	224	252	2.0328E-04	1.8876E-04
454	252	270	6.2160E-05	5.7720E-05

TABLE A.III
INSTALLED CAPACITY AND BUS LOCATION OF DERS

DER Index	Bus Location	Installed Capacity (MW)	DER Index	Bus Location	Installed Capacity (MW)
1	22	1.5	26	160	1.5
2	30	1.5	27	161	0.5
3	31	1	28	163	0.5
4	35	2	29	174	3
5	50	1.5	30	180	2
6	53	3	31	188	2
7	81	1.5	32	193	1
8	82	2	33	210	2
9	92	1.5	34	212	1
10	95	1	35	213	1.5
11	97	2	36	215	1
12	98	2.5	37	236	2
13	100	1.5	38	239	0.5
14	101	1.5	39	258	2
15	105	0.5	40	269	1
16	108	2	41	277	2.5
17	109	1.5	42	280	1
18	110	2	43	286	3
19	114	1.5	44	294	1.5
20	115	2	45	297	2
21	117	1.5	46	303	1.5
22	120	3	47	338	1.5
23	121	2	48	356	0.5
24	125	2.5	49	360	2.5
25	157	2	50	364	2

G. Configuration of Devices Controlled by DNO in the 455-Bus System

TABLE A.IV
CONFIGURATION INFORMATION OF DEVICES

Device	Parameter	Location
OLTC	±1.25%×8	Primary side of the transformer
CBs 1-25	0.5Mvar×4	Buses 9, 12, 16, 24, 41, 44, 47, 50, 62, 71, 75, 76, 88, 91, 92, 94, 98, 103, 106, 121, 123, 149, 164, 180, 252
DG 1	P^{L}=0 MW P^{U}=1.5 MW S^{lim}=1.8 MVA	Replacing DER 1
DG 2	P^{L}=0 MW P^{U}=1.5 MW S^{lim}=1.8 MVA	Replacing DER 2
DG 3	P^{L}=0 MW P^{U}=2.0 MW S^{lim}=2.4 MVA	Replacing DER 11
DG 4	P^{L}=0 MW P^{U}=2.5 MW S^{lim}=3.0 MVA	Replacing DER 12
DG 5	P^{L}=0 MW P^{U}=2.0 MW S^{lim}=2.4 MVA	Replacing DER 16
DG 6	P^{L}=0 MW P^{U}=1.5 MW S^{lim}=1.8 MVA	Replacing DER 17
DG 7	P^{L}=0 MW P^{U}=3.0 MW S^{lim}=3.6 MVA	Replacing DER 29
DG 8	P^{L}=0 MW P^{U}=2.0 MW S^{lim}=2.4 MVA	Replacing DER 30
DG 9	P^{L}=0 MW P^{U}=2.0 MW S^{lim}=2.4 MVA	Replacing DER 31
DG 10	P^{L}=0 MW P^{U}=1.0 MW S^{lim}=1.2 MVA	Replacing DER 32
DG 11	P^{L}=0 MW P^{U}=3.0 MW S^{lim}=3.6 MVA	Replacing DER 43
DG 12	P^{L}=0 MW P^{U}=1.5 MW S^{lim}=1.8 MVA	Replacing DER 44
DG 13	P^{L}=0 MW P^{U}=1.5 MW S^{lim}=1.8 MVA	Replacing DER 47
DG 14	P^{L}=0 MW P^{U}=0.5 MW S^{lim}=0.6 MVA	Replacing DER 48
DG 15	P^{L}=0 MW P^{U}=2.5 MW S^{lim}=3.0 MVA	Replacing DER 49
DG 16	P^{L}=0 MW P^{U}=2.0 MW S^{lim}=2.4 MVA	Replacing DER 50

H. Control Strategies of Devices

TABLE A.V
CONTROL STRATEGIES FOR MAXIMIZING ACTIVE POWER IMPORT IN THE 33-BUS SYSTEM

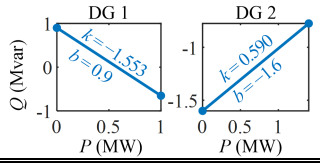
DG	OLTC and CB
	Tap position of OLTC: -3 Position level of CB 1: 0 Position level of CB 2: 0 Position level of CB 3: 4 Position level of CB 4: 2

TABLE A.VI
CONTROL STRATEGIES FOR MAXIMIZING ACTIVE POWER IMPORT IN THE REAL-WORLD 135-BUS SYSTEM

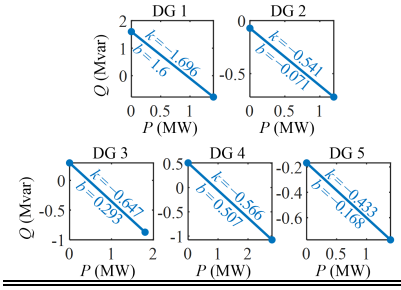
DG	OLTC and CB
	Tap position of OLTC: -3 Position level of CB 1: 0 Position level of CB 2: 4 Position level of CB 3: 0 Position level of CB 4: 0 Position level of CB 5: 2 Position level of CB 6: 0 Position level of CB 7: 0 Position level of CB 8: 0 Position level of CB 9: 4 Position level of CB 10: 3

TABLE A.VII
CONTROL STRATEGIES FOR MAXIMIZING THE SUM OF ACTIVE POWER IMPORT AND EXPORT IN THE 33-BUS SYSTEM

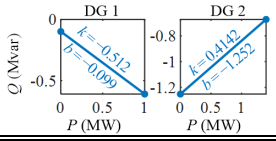
DG	OLTC and CB
	Tap position of OLTC: -3 Position level of CB 1: 1 Position level of CB 2: 0 Position level of CB 3: 1 Position level of CB 4: 3

TABLE A.VIII
CONTROL STRATEGIES FOR MAXIMIZING THE SUM OF ACTIVE POWER IMPORT AND EXPORT IN THE REAL-WORLD 135-BUS SYSTEM

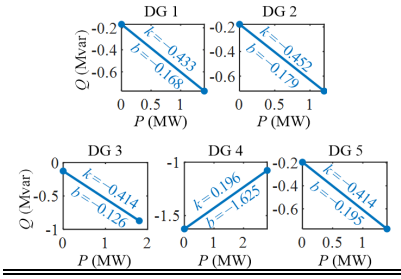
DG	OLTC and CB
	Tap position of OLTC: 0 Position level of CB 1: 0 Position level of CB 2:0 Position level of CB 3: 0 Position level of CB 4: 0 Position level of CB 5: 0 Position level of CB 7: 0 Position level of CB 8: 4 Position level of CB 9: 3 Position level of CB 10: 0

TABLE A.IX
CONTROL STRATEGIES FOR MAXIMIZING ACTIVE POWER EXPORT IN THE REAL-WORLD 455-BUS SYSTEM

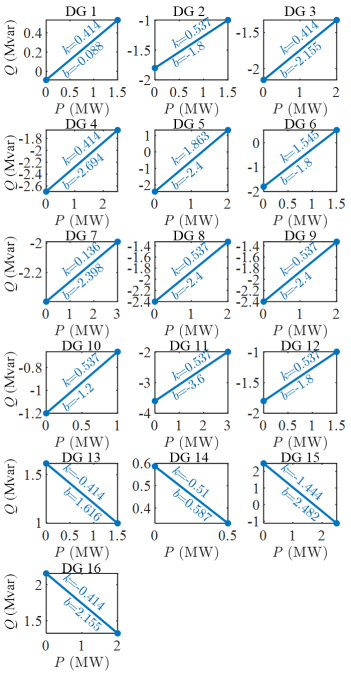
DG	OLTC and CB
	Tap position of OLTC: 1 Position level of CB 1: 0 Position level of CB 2: 0 Position level of CB 3: 0 Position level of CB 4: 0 Position level of CB 5: 0 Position level of CB 6: 0 Position level of CB 7: 0 Position level of CB 8: 0 Position level of CB 9: 0 Position level of CB 10: 0 Position level of CB 11: 4 Position level of CB 12: 0 Position level of CB 13: 0 Position level of CB 14: 0 Position level of CB 15: 0 Position level of CB 16: 4 Position level of CB 17: 0 Position level of CB 18: 0 Position level of CB 19: 0 Position level of CB 20: 0 Position level of CB 21: 0 Position level of CB 22: 0 Position level of CB 23: 4 Position level of CB 24: 4 Position level of CB 25: 0

TABLE A.X
CONTROL STRATEGIES FOR MAXIMIZING ACTIVE POWER IMPORT IN THE REAL-WORLD 455-BUS SYSTEM

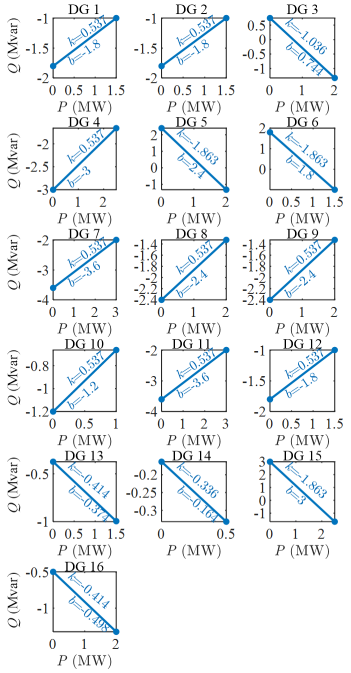
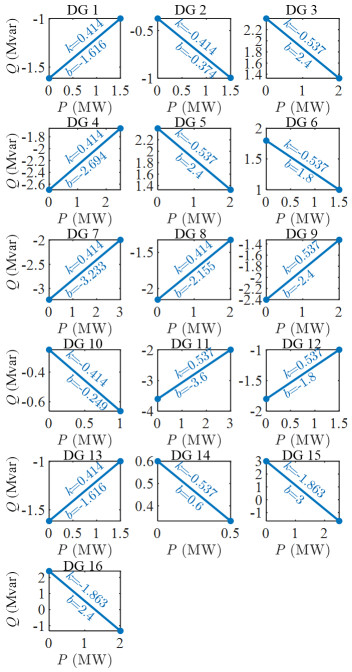
DG	OLTC and CB
	Tap position of OLTC: -3 Position level of CB 1: 0 Position level of CB 2: 4 Position level of CB 3: 0 Position level of CB 4: 4 Position level of CB 5: 0 Position level of CB 6: 0 Position level of CB 7: 4 Position level of CB 8: 4 Position level of CB 9: 0 Position level of CB 10: 4 Position level of CB 11: 4 Position level of CB 12: 0 Position level of CB 13: 0 Position level of CB 14: 0 Position level of CB 15: 0 Position level of CB 16: 4 Position level of CB 17: 0 Position level of CB 18: 4 Position level of CB 19: 0 Position level of CB 20: 0 Position level of CB 21: 0 Position level of CB 22: 0 Position level of CB 23: 4 Position level of CB 24: 0 Position level of CB 25: 0

TABLE A.XI
CONTROL STRATEGIES FOR MAXIMIZING THE SUM OF ACTIVE POWER IMPORT AND EXPORT IN THE REAL-WORLD 455-BUS SYSTEM

DG	OLTC and CB
	Tap position of OLTC: -3 Position level of CB 1: 0 Position level of CB 2: 0 Position level of CB 3: 0 Position level of CB 4: 0 Position level of CB 5: 0 Position level of CB 6: 0 Position level of CB 7: 0 Position level of CB 8: 0 Position level of CB 9: 0 Position level of CB 10: 0 Position level of CB 11: 0 Position level of CB 12: 0 Position level of CB 13: 0 Position level of CB 14: 0 Position level of CB 15: 0 Position level of CB 16: 4 Position level of CB 17: 0 Position level of CB 18: 0 Position level of CB 19: 0 Position level of CB 20: 0 Position level of CB 21: 0 Position level of CB 22: 0 Position level of CB 23: 0 Position level of CB 24: 0 Position level of CB 25: 0