

## APPENDIX

*1. Indices*

- $a$  - Index of links
- $\omega$  - Index of O-D pairs
- $k$  - Index of paths
- $i, j$  - Indices of nodes in the transportation network or buses in the power network

*Sets in the Transportation Network*

- $T_N$  - Set of nodes in the transportation network
- $T_A$  - Set of links in the transportation network
- $\Lambda^{(|N| \times |A|)}$  - Node-link incidence matrix
- $Q$  - Set of travel demand
- $K_g, K_e$  - Set of paths in the network for GV's and EV's, respectively
- $W$  - Set of travel demand O-D pairs
- $\mathcal{L}$  - Set of energy levels for EV's
- $I^{|W|}$  - Binary matrix indicating the origins and destinations of O-D pairs
- $R$  - Set of unsatisfied travel demands
- $\lambda$  - Set of electricity prices at charging stations

*Variables in the Transportation Network*

- $x_a$  - Number of vehicles on link  $a$
- $f_k^w$  - Number of vehicles assigned to path  $k$  for O-D pair  $w$
- $F_i^{w_e l_0}$  - Charging demand at node  $i$  for vehicles in O-D pair  $w_e$  with initial battery level  $l_0$
- $L_i^{w_e l_0}$  - Energy level at node  $i$  for vehicles in O-D pair  $w_e$  with initial battery level  $l_0$
- $v_a^w$  - Binary variable indicating whether O-D pair  $w$  traverses link  $a$
- $s_{k_e}^{w_e l}$  - Charging cost associated with selecting path  $k_e$  for O-D pair  $w_e$  with initial energy level  $l$

*Parameters in the Transportation Network*

- $\delta_{ak}^w$  - Binary parameter indicating whether path  $k$  includes link  $a$
- $c_a$  - Maximum vehicle capacity of link  $a$
- $q_w$  - Travel demand for O-D pair  $w$
- $\lambda_i$  - Electricity price at charging station  $i$
- $c_i$  - Time required to charge per unit battery level at station  $i$
- $d_a$  - Length of link  $a$
- $\omega$  - Energy consumption rate of EV's
- $M, N$  - Sufficiently large constants
- $t_a^0$  - Free-flow travel time on link  $a$

*Sets in the Power Network*

- $P_N$  - Set of buses
- $P_L$  - Set of transmission lines
- $\Gamma^{-1}(j)$  - Set of predecessor buses of bus  $j$
- $\Gamma(j)$  - Set of successor buses of bus  $j$
- $G$  - Set of generation buses

*Variables in the Power Network*

- $p_j^g$  - Power generation at bus  $j$
- $p_j^{dc}$  - Power demand for EV charging at bus  $j$
- $p_{ij}$  - Power flow on transmission line  $ij$
- $\theta_i$  - Phase angle at bus  $i$

*Parameters in the Power Network*

$a_j^g, b_j^g, c_j^g$  - Power generation cost coefficients at generator bus  $j$

$B_{ij}$  - Susceptance of transmission line  $ij$

$p_j^{\text{base}}$  - Base load at bus  $j$

$\bar{p}_{ij}$  - Maximum power capacity of transmission line  $ij$

$\bar{p}_j$  - Maximum power generation at bus  $j$

$\underline{p}_j$  - Minimum power generation at bus  $j$

TABLE I: Sioux Falls network data

ID	O	D	$t_a^0$	$c_a$
1	1	2	6	25900.2
2	1	3	4	23403.47
3	2	1	6	25900.2
4	2	6	5	4958.181
5	3	1	4	23403.47
6	3	4	4	17110.52
7	3	12	4	23403.47
8	4	3	4	17110.52
9	4	5	2	17782.79
10	4	11	6	4908.827
11	5	4	2	17782.79
12	5	6	4	4947.995
13	5	9	5	10000
14	6	2	5	4958.181
15	6	5	4	4947.995
16	6	8	2	4898.588
17	7	8	3	7841.811
18	7	18	2	23403.47
19	8	6	2	4898.588
20	8	7	3	7841.811
21	8	9	10	5050.193
22	8	16	5	5045.823
23	9	5	5	10000
24	9	8	10	5050.193
25	9	10	3	13915.79
26	10	9	3	13915.79
27	10	11	5	10000
28	10	15	6	13512
29	10	16	4	4854.918
30	10	17	8	4993.511
31	11	4	6	4908.827
32	11	10	5	10000
33	11	12	6	4908.827
34	11	14	4	4876.508
35	12	3	4	23403.47
36	12	11	6	4908.827
37	12	13	3	25900.2
38	13	12	3	25900.2
39	13	24	4	5091.256
40	14	11	4	4876.508
41	14	15	5	5127.526
42	14	23	4	4924.791
43	15	10	6	13512
44	15	14	5	5127.526

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Table I: Sioux Falls network data

ID	O	D	$t_a^0$	$c_a$
45	15	19	3	14564.75
46	15	22	3	9599.181
47	16	8	5	5045.823
48	16	10	4	4854.918
49	16	17	2	5229.91
50	16	18	3	19679.9
51	17	10	8	4993.511
52	17	16	2	5229.91
53	17	19	2	4823.951
54	18	7	2	23403.47
55	18	16	3	19679.9
56	18	20	4	23403.47
57	19	15	3	14564.75
58	19	17	2	4823.951
59	19	20	4	5002.608
60	20	18	4	23403.47
61	20	19	4	5002.608
62	20	21	6	5059.912
63	20	22	5	5075.697
64	21	20	6	5059.912
65	21	22	2	5229.91
66	21	24	3	4885.358
67	22	15	3	9599.181
68	22	20	5	5075.697
69	22	21	2	5229.91
70	22	23	4	5000
71	23	14	4	4924.791
72	23	22	4	5000
73	23	24	2	5078.508
74	24	13	4	5091.256
75	24	21	3	4885.358
76	24	23	2	5078.508

TABLE II: O-D travel demand

O	D	$l$	demand
1	20	9	500
1	20	12	500
20	1	9	500
20	1	12	500
2	13	9	500
2	13	12	500
13	2	9	500
13	2	12	500
3	15	9	500
15	3	9	500
4	18	9	500
4	18	12	500
18	4	9	500
6	14	9	500
14	6	9	500
14	6	12	500

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TABLE II: O-D travel demand

O	D	$l$	Demand
12	7	12	500
12	7	9	500
1	20	15	500
20	1	15	500
2	13	15	500
13	2	15	500
3	15	15	500
15	3	15	500
4	18	15	500
18	4	15	500
10	13	9	500
13	10	9	500
10	13	15	500
13	10	15	500
10	20	9	500
10	20	9	500
20	10	15	500
20	10	15	500
8	14	9	500
8	14	9	500
14	8	15	500

TABLE III  
GENERATOR DATA

Bus	$P_g$	$p_j^{\text{base}}$	$P_{\max}$	$P_{\min}$
1	23.54	100	64	0
2	60.97	100	64	0
22	21.59	100	40	0
27	26.91	100	44	0
23	19.2	100	24	0
13	37	100	32	0

TABLE IV  
COST DATA FOR GENERATOR

Bus	$a$	$b$	$c$
1	0.2	70	0
2	0.175	61.25	0
22	0.625	35	0
27	0.0834	113.75	0
23	0.25	105	0
13	0.25	105	0