

Congestion Analysis Using PROBE

- PROBE
 - Software Available at NYISO to Mirror the SCUC
 - Assumes Given Unit Commitment
 - Hourly Power Flow Models Available
 - Viewer Mode for Analyzing History
 - Simulator Mode for “What If “ Analysis



Congestion Analysis Using PROBE

- Idea
 - Use the PROBE Software to Analyze 2003 Congestion Cost and Causes
 - Attribute Congestion Cost to Constraints
 - Adjust Cost to Remove “Unusual Events”
 - Use Results to Inform Grid Planning
 - Perform Monthly Assessments Going Forward



PROBE Test

- Idea
 - Pick One Month from 2003
 - Get Experience in Using PROBE
 - Shed Light on How to Calculate Congestion Cost
 - Create Test Bed for Resolving Procedural Issues
 - Reference Location
 - “Under the Surface” Constraints
 - Calculation Assumptions
 - Identify Needed PROBE Enhancements

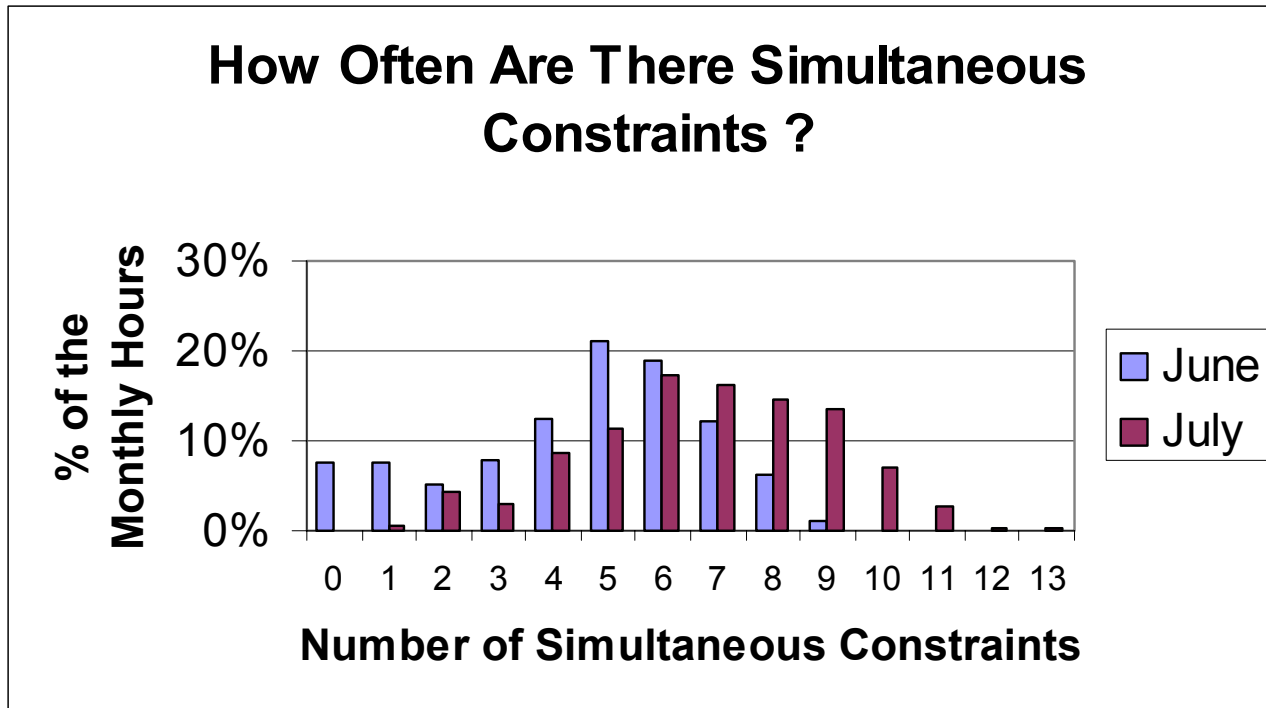


Test Results

- July 2003 Chosen as Test Month (Compared to June)
 - 100% of Hours Congested
 - Wider Variety of Constraints
 - More NY Zones Involved
 - Data Availability
- July Cost Attributed to Constraints
 - Straightforward but Repetitive
 - Some Conventions & Procedures Need to be Agreed Upon
- “What If” Analysis Just Beginning
 - Some Data Problems to Work Out



June and July 2003



Limiting Element	June Hours	June Rank	July Hours	July Rank
HUDS_AVE 138 JAMAICA_ 138 2	503	1	622	2
RAINEY_ 138 VERNON_ 138 1	465	2	576	3
DUNWODIE 345 SHORE_RD 345 1	451	3	647	1
E179THST 138 HELLGT_E 138 1	419	4	399	5
VALLYSTR 138 EGRDNCTY 138 1	367	5	390	6
FRESHKLS 138 WILLWBRK 138 1	307	6	473	4
RAINEY_ 345 DUNWODIE 345 2	134	7	86	18
NRTHPORT 138 PILGRIM_ 138 1	88	8	130	11
PJ - NY	82	9	156	8
W49TH_ST 345 SPRNBRK_ 345 1	74	10	29	23
ACTIVE DNI	64	11	108	15
CENTRAL EAST - VC	60	12	141	9
ELWOOD_W 138 GREENLWN 138 1	52	13	97	17
HQ - NY	28	14	24	25
EDIC/PTR 345 MARCY_ 345 1	23	15		
E13THSTA 345 W49TH_ST 345 1	20	16		
GOETHLSS 345 GOWANUSS 345 1	17	17		
PLSNTVLY 345 LEEDS_ 345 1	17	18		
LEEDS_ 345 N.SCTLND 345 1	16	19	138	10
QUENBRDG 138 VERNON_ 138 1	16	20		
HELLGT_W 138 E179THST 138 1	14	21	50	22
OAKDALE_ 230 WATRCURE 230 1	13	22	27	24
BUCHAN_S 345 LADENTWN 345 1	12	23	1	30

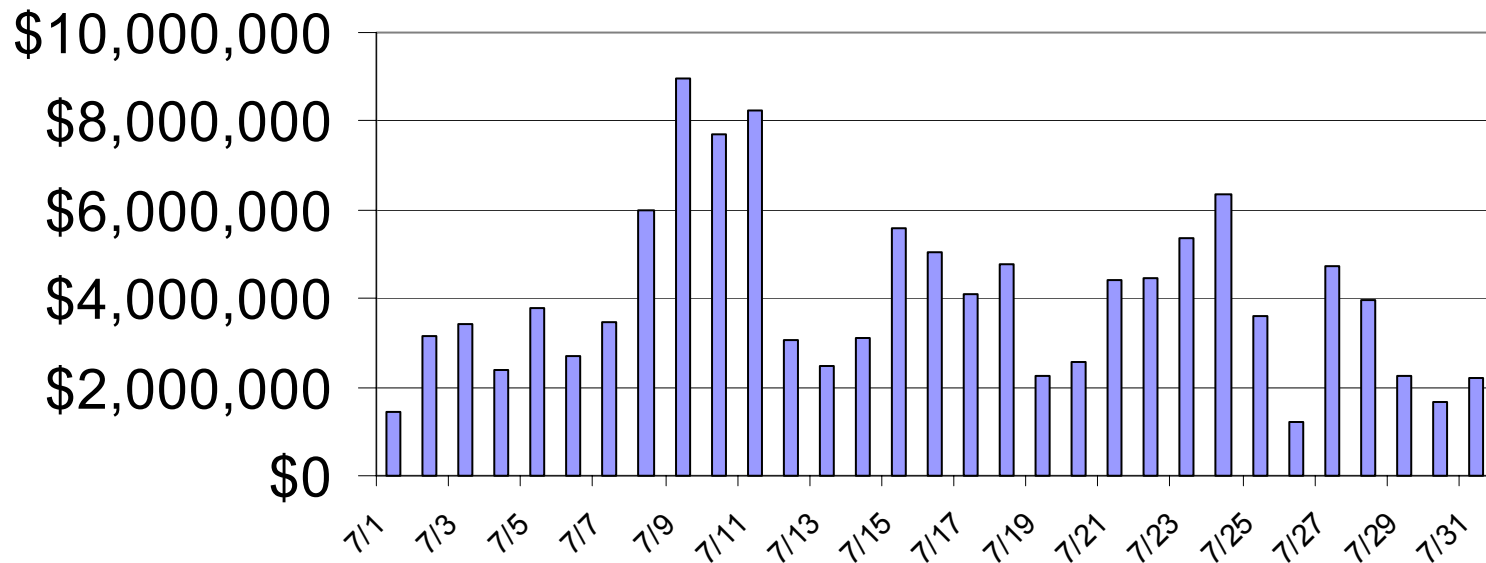
June and July Constraints

Limiting Element	June Hours	June Rank	July Hours	July Rank
GOETHSLN 345 GOWANUSN 345 1	9	24		
NRTHPORT 138 PILGRIM_ 138 2	7	26	20	26
E13THSTA 345 FARRAGUT 345 1	7	25	3	27
VERNON_ 138 KENTAVE_ 138 1	4	30	130	12
DYSINGER EAST	4	27	113	13
NIAGARA_ 345 ROCHESTR 345 1	4	29	85	19
GLENWDGT 138 ROSLYN_ 138 1	4	28		
W49TH_ST 345 SPRNBRK_ 345 2	3	31	68	21
CARLPLCE 138 EGRDNCTY 138 1	2	32	1	31
CENTRAL EAST	2	33		
HUDS_AVE 138 JAMAICA_ 138 1	2	34		
OAKDALE_ 345 FRASER_ 345 1	2	35		
NEWBRDGE 138 EGRDNCTY 138 1	1	36		
PLSNTVLY 345 LEEDS_ 345 1	1	37		
BARRETT_ 138 VALLYSTR 138 2			207	7
NEWBRDGE 138 FREEPORT 138 1			110	14
RAINEY_ 345 DUNWODIE 345 1			107	16
OH - NY			74	20
BUCHAN_N 345 EASTVIEW 345 1			2	28
E13THSTA 345 W49TH_ST 345 1			2	29
DUNWODIE 345 PLSNTVLE 345 1			1	32
OAKDALE_ 345 FRASER_ 345 1			1	33
ROCHESTR 345 PANNELL_ 345 1			1	34
ROCKTVRN 345 RAMAPO_ 345 1			1	35



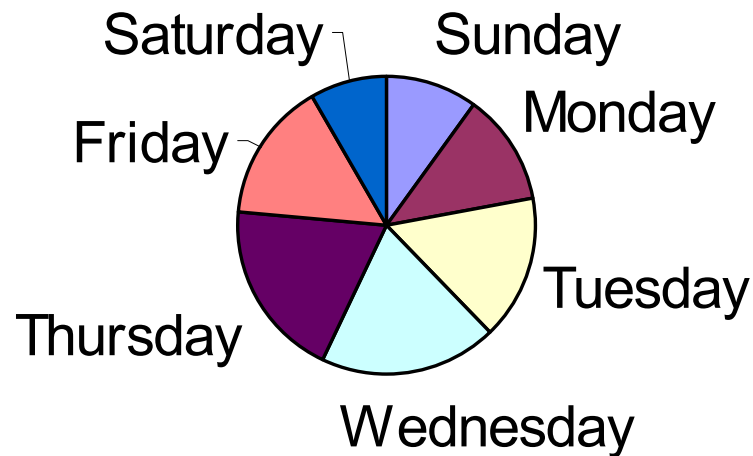
Total
\$124 million

July 2003 Congestion by Day



Total \$124 million

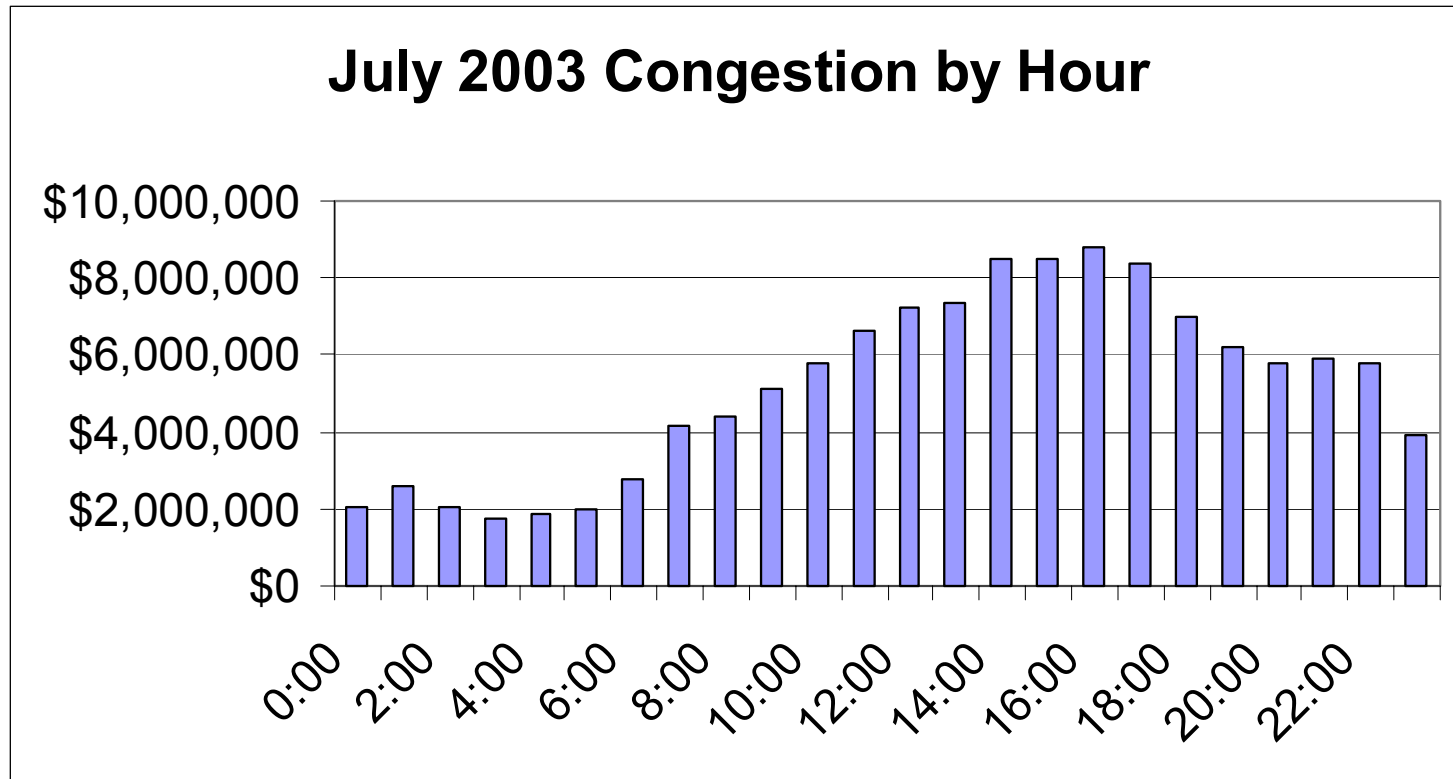
July 2003 Congestion by Day



Congestion is an Everyday Affair



Total \$124 million



Congestion is an All-Hours Affair



The Arithmetic of the Cost Calculation

One Hour, One Zone, Many Constraints

Constraints with LMP effect >\$0.01

Constraints Shadow Price

Zonal Generator (load) Dist. Factor of w.r.t. Marcy

Zone	LBMP	TotLoad	Constraint	Contingency	ShadPric	Dfact	Cong\$/M	\$TotCong
N.Y.C.	\$66.16	8776	=== Energy+Losses		\$54.34	1.132	\$61.51	\$539,785
N.Y.C.	\$66.16	8776	E179THST 138 HELLGT_E 138 1	BASE CASE	\$2.69	0.07	\$0.19	\$1,653
N.Y.C.	\$66.16	8776	HUDS_AVE 138 JAMAICA_ 138 2	BASE CASE	\$6.12	0.016	\$0.10	\$870
N.Y.C.	\$66.16	8776	RAINEY__ 138 VERNON__ 138 1	TWR: 22 21 A2253	\$3.42	0.243	\$0.83	\$7,304
N.Y.C.	\$66.16	8776	LEEDS__ 345 N.SCTLND 345 1	N.SCTLND345_LEEDS__345_94-LN_	-\$11.41	-0.31	\$3.54	\$31,042

Zonal Load (Fixed Load, Price capped load, Virtual Load and Gen)

LMP Component Sums to LMP

LMP Component * Load = Cost

Zone LMP



The Arithmetic of the Cost Calculation

One Hour, One Constraint

Zonal Load
(Fixed Load,
Price capped
load, Virtual
Load and Gen

Constraint

Zonal Generator
(load) Dist. Factor
of w.r.t. Marcy

Cong LMP *
zonal load

Zone	LBMP	TotLoad	Constraint	Contingency	ShadPric	Dfact	Cong\$/M	\$TotCong
CAPITL	\$57.13	1476	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	0.022	-\$0.25	-\$366
CENTRL	\$53.33	1826	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	-0.022	\$0.25	\$459
DUNWOD	\$64.22	915	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	-0.309	\$3.53	\$3,226
GENESE	\$51.67	1788	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	-0.021	\$0.23	\$418
HUDVL	\$63.17	1496	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	-0.275	\$3.13	\$4,688
LONGIL	\$79.25	4175	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	-0.31	\$3.54	\$14,767
MILLWD	\$63.35	388	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	-0.305	\$3.48	\$1,349
N.Y.C.	\$66.16	8776	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	-0.31	\$3.54	\$31,042
WEST	\$48.73	1629	LEEDS___345 N.SCTLND 345 1	N.SCTLND345_LEEDS___345_94-LN_	-\$11.41	-0.027	\$0.31	\$510

Actual LMP

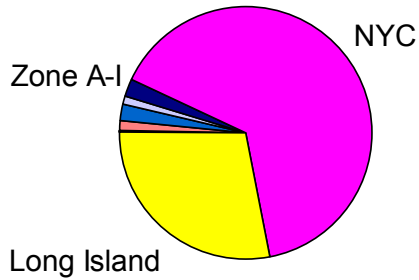
Constraint
Shadow Price

Zone With More than
Tolerance Impact \$0.01

Shadow Price* df,
The zonal
congestion
component



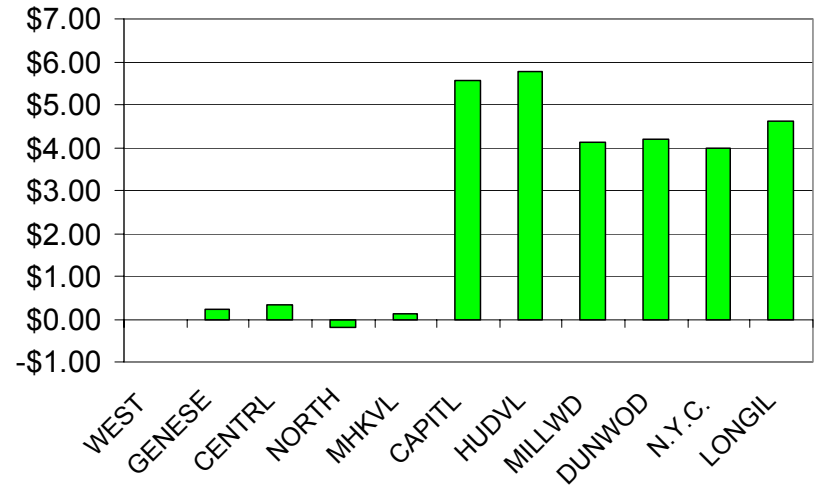
July 2003 Congestion Cost by Zone



Total \$124 million

Congestion is Determined by Load Affected and Effectiveness of Relief

July 2003 Average Zonal Congestion Cost \$/MW



July 2003 Total and Zonal Congestion by Constraint

Congestion Cost July 2003

Constraint	Total	%	Zonal Cost in \$1000												
			A	B	C	D	E	F	G	H	I	J	K		
LEEDS_ 345 N.SCTLND 345 1	\$32,897,580	26%	\$169	\$9	\$8					-\$10	\$2,000	\$875	\$2,420	\$19,151	\$8,275
RAINEY_ 138 VERNON_ 138 1	\$27,254,016	22%												\$27,254	
DUNWODIE 345 SHORE_RD 345 1	\$23,953,775	19%													\$23,954
CENTRAL EAST - VC	\$12,744,099	10%	\$240	\$138	\$150	-\$8	\$7	\$1,438	\$839	\$346	\$732	\$6,255	\$2,607		
RAINEY_ 345 DUNWODIE 345 1	\$7,270,773	6%								\$8	\$26	\$7,428	-\$191		
E179THST 138 HELLGT_E 138 1	\$5,257,064	4%										\$5,257			
VERNON_ 138 KENTAVE_ 138 1	\$5,029,517	4%										\$5,030			
RAINEY_ 345 DUNWODIE 345 2	\$3,447,207	3%								\$4	\$12	\$3,519	-\$88		
W49TH_ST 345 SPRNBRK_ 345 2	\$3,345,754	3%								-\$30	-\$37	-\$88	\$2,655	\$845	
HUDS_AVE 138 JAMAICA_ 138 2	\$2,874,916	2%										\$2,875			
W49TH_ST 345 SPRNBRK_ 345 1	\$1,842,410	1%								-\$4	-\$12	-\$37	\$1,412	\$484	
VALLYSTR 138 EGRDNCTY 138 1	\$1,583,445	1%												\$1,583	
E13THSTA 345 W49TH_ST 345 1	\$360,606	0%								-\$1	-\$2	-\$7	\$281	\$90	
ROCKTVRN 345 RAMAPO_ 345 1	\$210,818	0%							\$1	\$9	\$8	\$17	\$120	\$56	
DUNWODIE 345 PLSNTVLE 345 1	\$185,930	0%							-\$1	\$5	\$5	\$14	\$110	\$53	
BUCHAN_N 345 EASTVIEW 345 1	\$96,942	0%							\$2	-\$3	-\$5	\$10	\$65	\$28	
BUCHAN_S 345 LADENTWN 345 1	\$14,588	0%								-\$1		\$2	\$10	\$4	
E13THSTA 345 FARRAGUT 345 1	\$6,758	0%											\$7		
OAKDALE_ 345 FRASER_ 345 1	\$2,303	0%											\$2	\$1	
CARLPLCE 138 EGRDNCTY 138 1	-\$368	0%													
ROCHESTR 345 PANNELL_ 345 1	-\$1,157	0%	-\$1												
OAKDALE_ 230 WATRCURE 230 1	-\$71,410	0%	-\$59	-\$34	-\$13				\$1	\$1	\$2	\$22	\$8		
BARRETT_ 138 VALLYSTR 138 2	-\$152,296	0%												-\$152	
NRTHPORT 138 PILGRIM_ 138 2	-\$162,391	0%												-\$162	
DYSINGER EAST	-\$175,757	0%	-\$175	\$14	-\$1					-\$1		-\$1	-\$8	-\$4	
NIAGARA_ 345 ROCHESTR 345 1	-\$209,190	0%	-\$168	-\$8	-\$7					-\$2	-\$1	-\$2	-\$15	-\$6	
ELWOOD_W 138 GREENLWN 138 1	-\$482,445	0%												-\$482	
HELLGT_W 138 E179THST 138 1	-\$780,582	-1%											-\$781		
NRTHPORT 138 PILGRIM_ 138 1	-\$1,867,028	-1%												-\$1,867	
Total	\$124,475,877		\$5	\$118	\$137	-\$8	\$7	\$1,430	\$2,813	\$1,191	\$3,099	\$80,649	\$35,034		



July 2003 Total and Zonal Congestion by Constraint (top 95% expanded)

Congestion Cost July 2003							
Constraint	Total	%	Zonal Cost in \$1000				
			A	B	C	D	E
LEEDS__ 345 N.SCTLND 345 1	\$32,897,580	26%	\$169	\$9	\$8		
RAINEY__ 138 VERNON__ 138 1	\$27,254,016	22%					
DUNWODIE 345 SHORE_RD 345 1	\$23,953,775	19%					
CENTRAL EAST - VC	\$12,744,099	10%	\$240	\$138	\$150	-\$8	\$7
RAINEY__ 345 DUNWODIE 345 1	\$7,270,773	6%					
E179THST 138 HELLGT_E 138 1	\$5,257,064	4%					
VERNON__ 138 KENTAVE__ 138 1	\$5,029,517	4%					
RAINEY__ 345 DUNWODIE 345 2	\$3,447,207	3%					

Congestion Cost July 2003

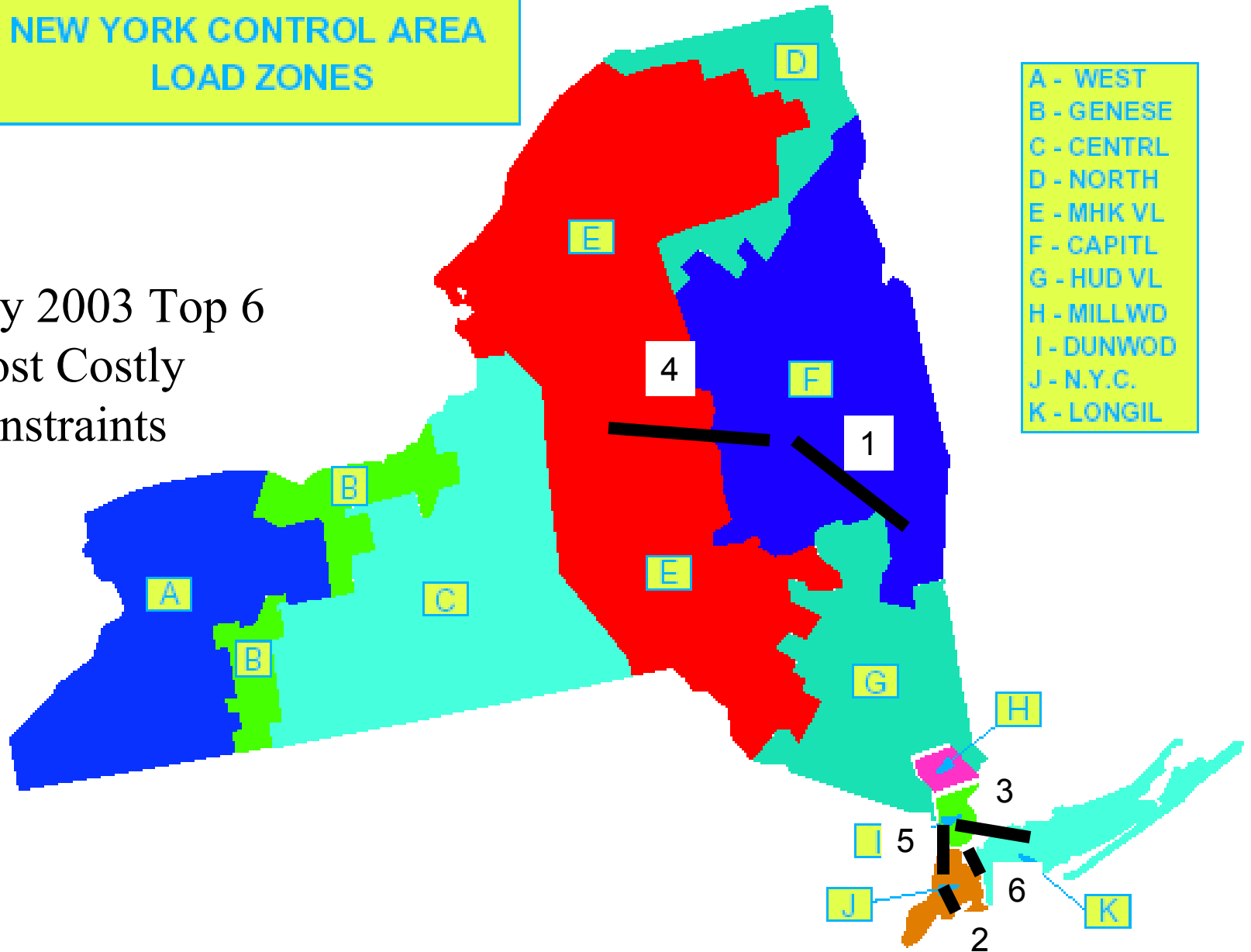
Constraint	Total	%	F	G	H	I	J	K
LEEDS__ 345 N.SCTLND 345 1	\$32,897,580	26%	-\$10	\$2,000	\$875	\$2,420	\$19,151	\$8,275
RAINEY__ 138 VERNON__ 138 1	\$27,254,016	22%					\$27,254	
DUNWODIE 345 SHORE_RD 345 1	\$23,953,775	19%						\$23,954
CENTRAL EAST - VC	\$12,744,099	10%	\$1,438	\$839	\$346	\$732	\$6,255	\$2,607
RAINEY__ 345 DUNWODIE 345 1	\$7,270,773	6%			\$8	\$26	\$7,428	-\$191
E179THST 138 HELLGT_E 138 1	\$5,257,064	4%					\$5,257	
VERNON__ 138 KENTAVE__ 138 1	\$5,029,517	4%					\$5,030	
RAINEY__ 345 DUNWODIE 345 2	\$3,447,207	3%			\$4	\$12	\$3,519	-\$88



NEW YORK CONTROL AREA LOAD ZONES

- A - WEST
- B - GENESE
- C - CENTRL
- D - NORTH
- E - MHK VL
- F - CAPITL
- G - HUD VL
- H - MILLWD
- I - DUNWOD
- J - N.Y.C.
- K - LONGIL

July 2003 Top 6
Most Costly
Constraints



July 2003 Average and Zonal Congestion \$/MW by Constraint (top 9)

Constraint	Average	A West	B Gense	C Cntrl	D North	E MhkVal
LEEDS__ 345 N.SCTLND 345 1	\$12.82	\$0.59	\$0.36	\$0.38		
ROCKTVRN 345 RAMAPO__ 345 1	\$11.84					
DUNWODIE 345 SHORE_RD 345 1	\$10.35					
DUNWODIE 345 PLSNTVLE 345 1	\$9.32					
E13THSTA 345 W49TH_ST 345 1	\$5.91					
RAINEY__ 138 VERNON__ 138 1	\$5.64					
VERNON__ 138 KENTAVE_ 138 1	\$4.48					
CENTRAL EAST - VC	\$3.47	\$0.87	\$0.74	\$0.75	-\$0.20	\$0.14
RAINEY__ 345 DUNWODIE 345 1	\$2.21					

Constraint	Average	F Captl	G HudVal	H Milwd	I Dunwd	J NYC	K LI
LEEDS__ 345 N.SCTLND 345 1	\$12.82	-\$0.32	\$14.68	\$16.17	\$16.48	\$16.52	\$16.53
ROCKTVRN 345 RAMAPO__ 345 1	\$11.84	\$0.77	\$7.60	\$17.34	\$15.59	\$14.89	\$14.84
DUNWODIE 345 SHORE_RD 345 1	\$10.35						\$10.35
DUNWODIE 345 PLSNTVLE 345 1	\$9.32	-\$0.67	\$4.05	\$11.39	\$13.10	\$13.97	\$14.05
E13THSTA 345 W49TH_ST 345 1	\$5.91		-\$1.37	-\$4.06	-\$5.06	\$21.96	\$18.09
RAINEY__ 138 VERNON__ 138 1	\$5.64					\$5.64	
VERNON__ 138 KENTAVE_ 138 1	\$4.48					\$4.48	
CENTRAL EAST - VC	\$3.47	\$6.65	\$5.06	\$5.06	\$5.12	\$5.13	\$5.13
RAINEY__ 345 DUNWODIE 345 1	\$2.21			\$0.25	\$0.30	\$8.67	-\$0.56



July 2003 Total and Zonal Congestion by Contingency

Congestion Cost July 2003

Contingency	Total	%	Cost in \$1000 Zone										
			A	B	C	D	E	F	G	H	I	J	K
BASE CASE	\$36,311,340	29%	\$64	\$151	\$150	-\$8	\$7	\$1,438	\$838	\$346	\$731	\$27,063	\$5,531
MTN:SCB1 R391OR R94301 O/S LE	\$31,858,035	26%	\$156					-\$4	\$1,929	\$844	\$2,344	\$18,572	\$8,017
SPRNBK_345_EGRDNCTY345CY49	\$21,026,380	17%											\$21,026
TWR: 22 21 A2253	\$14,049,639	11%										\$14,050	
DUNWODIE345_RAINEY_345_71	\$7,270,773	6%								\$8	\$26	\$7,428	-\$191
SCB: GOETH(8): 42 26 21 GOW	\$4,776,447	4%										\$4,776	
DUNWODIE345_RAINEY_345_72	\$3,357,368	3%								\$4	\$12	\$3,439	-\$97
SCB: SPBK (RS-4): M52 99941	\$3,089,636	2%							-\$29	-\$35	-\$83	\$2,457	\$779
SCB: SPBK (RS3): W75 99941	\$2,459,134	2%							-\$6	-\$16	-\$49	\$1,890	\$639
BUS: E F BARRET 292 459 BA	\$1,583,445	1%											\$1,583
N.SCTLND345_LEEDS_345_94-LN	\$1,039,545	1%	\$13	\$9	\$8			-\$6	\$71	\$31	\$76	\$580	\$258
TWR: F30 F31 W80 W81 WD#	\$396,748	0%						\$0	\$14	\$13	\$31	\$230	\$109
BUCHAN_S345_MILLWOOD345_W97	\$96,942	0%						\$2	-\$3	-\$5	\$10	\$65	\$28
MTN:SCB2 4 OR 7 O/S DUNWOD Y50	\$89,839	0%										\$81	\$9
SIN:REL W93 W79 EV#2N: #TA5	\$14,588	0%						\$0	-\$1	\$0	\$2	\$10	\$4
TWR: UCC2-41 EF24-40	\$2,303	0%	\$0	\$0	\$0		\$0	\$0	\$0	\$0	\$0	\$2	\$1
SCB: OCB1330 262 362	-\$368	0%											\$0
SCB: ROCH(3414): RP-2 ROCH#2	-\$1,157	0%	-\$1	\$0	\$0				\$0	\$0	\$0	\$0	\$0
BUS: ELWOOD 674 681 BK3	-\$60,326	0%											-\$60
WATRCURE345_OAKDALE_345_31	-\$71,410	0%	-\$59	-\$34	-\$13				\$1	\$1	\$2	\$22	\$8
BUS: VALLYST 292 262	-\$152,296	0%											-\$152
NRTHPORT138EPILGRIM_138A679	-\$162,391	0%											-\$162
KINTIGH_345_ROCHESTR345_SR-1	-\$209,190	0%	-\$168	-\$8	-\$7				-\$2	-\$1	-\$2	-\$15	-\$6
NRTHPORT138WELWOOD_E138_681	-\$482,445	0%											-\$482
NRTHPORT138EPILGRIM_138A677	-\$1,806,702	-1%											-\$1,807
Total	\$124,475,877		\$5	\$118	\$137	-\$8	\$7	\$1,430	\$2,813	\$1,191	\$3,099	\$80,649	\$35,034



Issues

- What Weighting?
 - Load to Include
 - Load of Generator Weighting by Zone
- What Reference?
 - Marcy
 - Marginal Generator
 - Unconstrained Cost
- “What If” Analysis
 - Analysis Objective ?
 - What is an Unusual Event ?
 - How Many Days to Analyze?



PROBE Enhancements

- Automate Multiple Days Viewing and Data Collection
- Add Report by Constraints
- “What If” Analysis
 - Smooth Data Extraction at NYISO
 - Improve Data Checking and Actual vs. Simulated Comparison and Debugging
 - Simplify Set-up of What if Events
 - Transmission Outages
 - Transmission Ratings
 - Network Topology or Ratings
 - Decide on Approach for Changing Unit Commitment

