CARIS – BENCHMARKING RESULTS AND SOFTWARE RECOMMENDATION

Tom Gentile

New York Independent System Operator

ESPWG Meeting
NYISO
March 24, 2009

Draft – for discussion only

Outline

- *Objectives*
- *Benchmark Recommendation*
- *Simulation Process*
- *Software Issues*
- *Benchmarking Analysis*
- *Results Peak Week 2007, Annual 2007/2013*
- *Observations from Benchmarking*
- *Selection Criteria*
- *Selection Criteria Results*

Draft – for discussion only

Objectives

- Evaluate MAPS & GridView performance
  - *Backcast Results to Probe*
  - *2007 and 2013 Results*
  - *Sample Study Results*

- Evaluate applications against Selection Criteria
  - *Meet CARIS requirements as defined in tariff*
  - *Performance across specified metrics*
  - *Review Tool's Modeling Capability, Flexibility, and Efficiency*

- Utilize two applications for the 2009 Study Phase provided each meets the above objectives

- Meet commitments made to NYISO Board, NYSPSC, and market participants

Draft – for discussion only

Benchmark Recommendations

- GridView meets all selection criteria; MAPS is currently undergoing development to meet criteria on remaining items
- NYISO Recommends:
  - *Utilize both tools for the first CARIS cycle – build confidence, shadow results, and bridge to stakeholders using MAPS*
  - *NYISO will continue to work with GE to resolve remaining MAPS items throughout the CARIS Study Phase*
  - *Immediately begin to establish input assumptions with ESPWG for the 2009 Study Phase*
  - *By mid-April, shift focus to build one common database for the CARIS Study Phase*
  - *Ultimate decision on tool selection to be used for the final CARIS results will be made towards the completion of the Study Phase (currently targeted as August 2009).*

Draft – for discussion only

Simulation Process

- Load input assumptions
  - *External transactions fixed to actual*
  - *Congestion calculation referenced to Marcy 345kV*
- Perform initial simulations and compare Zonal LBMPs
- Incorrect model of SCUC contingencies found to cause spikes in Zonal LBMPs values
- Perform diagnostics for specific hours to identify cause of spikes
- Correct SCUC contingency model
- Review results and process with program vendors

Draft – for discussion only

Simulation Process - continued

Input Assumption Alignment

- Power Flow Case
- Hourly Zonal Load (NYISO only)
- Fuel Prices (NG, FO2, FO6) – NYISO, PJM, New England
- Interface Definitions & Limits
- Constraints Definitions & Limits

Proprietary Database Items Maintained

- External Area Representations
- Generator Heat Rates

Draft – for discussion only

GridView Issues

- Reporting of NYISO congestion by binding constraint – resolved
- Dynamic Interface Limits - ABB working to resolve (anticipate within two weeks)
  - *Central East Interface varies with number of on-line units at Oswego, Independence etc…*
  - *Capability to model Winter facility Ratings*

Draft – for discussion only

MAPS Issues

- Externals hurdle rate nomogram - testing
- 6 digit bus numbers – testing
- Co-Optimization of energy and ancillary services
- Reporting of required metrics:
  - *Facility Congestion – cost and ranking*
  - *LBMPs for Energy, Congestion and Losses - testing*
  - *LBMP Generation Payments*
  - *NYISO zonal congestion payments reported by binding constraints*
  - *TCCs*
- Database management, program flexibility, and user issues (5 items)
- GE is working to resolve these remaining issues

Draft – for discussion only

Benchmark Analysis

- 2007 Peak Week Analysis – Backcast to Probe; input alignment
  - *External Transactions Scheduled*
  - *4 Pool Dispatch*

- 2007 Annual Analysis – Benchmark tools; input alignment
  - *External Transactions Scheduled*
  - *4 Pool Dispatch*
  - *Sample Studies*
    - Add new Leeds-Pleasant Valley 345 kV Circuit
    - Add 580 MW generator W. 49th Street

- 2013 Annual Analysis - – Benchmark tools; input alignment
  - *External Transactions Scheduled*
  - *4 Pool Dispatch*
  - *Sample Studies*
    - Add new Leeds-Pleasant Valley 345 kV Circuit
    - Add 580 MW generator W. 49th Street

Draft – for discussion only

Peak Week Backcast Results

2007 Peak Week: Externals Scheduled

Subtotal NYISO (1)	PROBE (million$)	GridView (million$)	MAPS (million$)
Production Cost (2)	215.645	148.423	128.163
Load Payment	295.731	300.043	319.127
Generator Payment	260.678	273.627	280.018
$Demand Congestion	7.069	11.65	TBD

(1) NYISO includes NYCA zones only

(2) Production Cost does not include NYCA imports cost, PROBE uses Bid-Production Cost

Draft – for discussion only

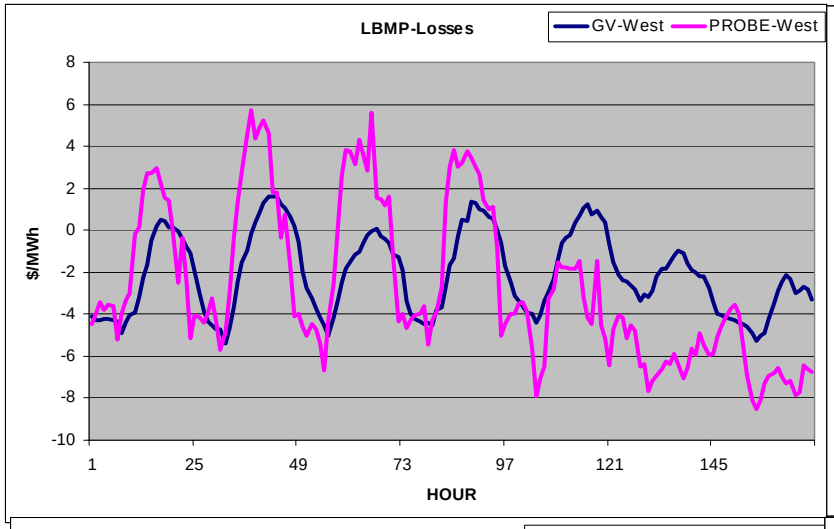
Peak Week Backcast Results
Congestion List ($Demand_Congestion)

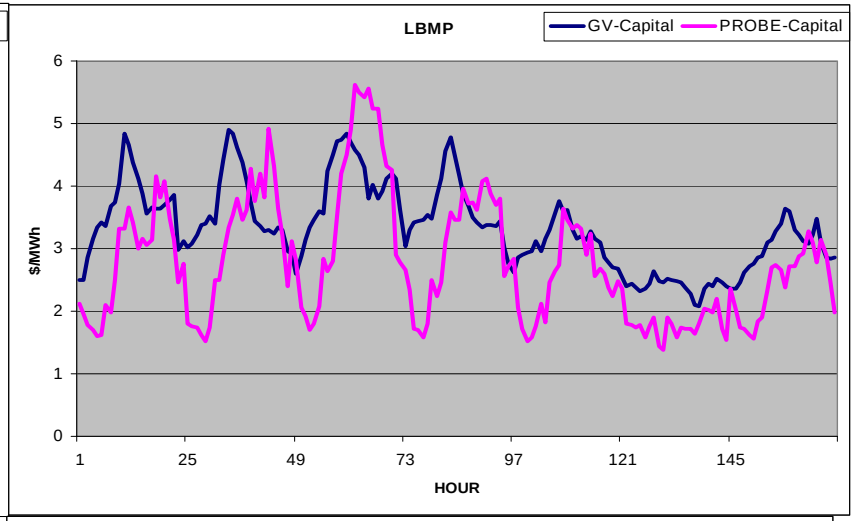
Monitored Element	Contingency	PROBE (m$)	GridView (m$)	MAPS (m$)
Leeds – Pleasant Valley 345kV	Athens – Pleasant Valley 345kV	**3.840**	**4.584**	**TBD**
Greenwood-Vernon 138kV	Base Case	**1.528**	**0.09**	**TBD**
Dunwoodie-Shore Rd 345kV Y50	Sprainbrook-East Garden 345kV Y49	**0.660**	**-**	**TBD**
Greenwood-Kent Ave 138kV	Base Case	**0.533**	**0.01**	**TBD**
Sprainbrook-East Garden 345kV	Dunwoodie-Shore Rd 345kV Y50	**0.389**	**-**	**TBD**
Rainey-Mt Haven 345kV Q11	Rainey-Mt Haven 345kV Q12	**0.209**	**1.186**	**TBD**
PJM AC	Active DNI	**0.124**	**-**	**TBD**
Gowanus S-Gowanus S 138kV	TWR: Goethals 21 & 22	**0.086**	**-**	**TBD**
HQNY	Active DNI	**0.042**	**-**	**TBD**
NYCA	Active DNI	**0.038**	**-**	**TBD**
Freshkills-Willow Brook 138kV	Base Case	**0.008**	**0.690**	**TBD**
Dunwoodie-Shore Rd 345kV Y50	Base Case	**0.001**	**0.509**	**TBD**

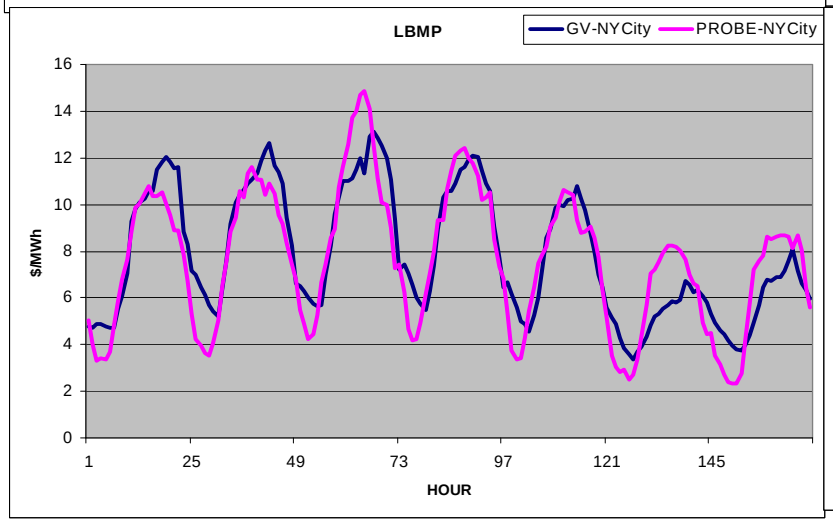
$Demand_Congestion is shadow price x load affected

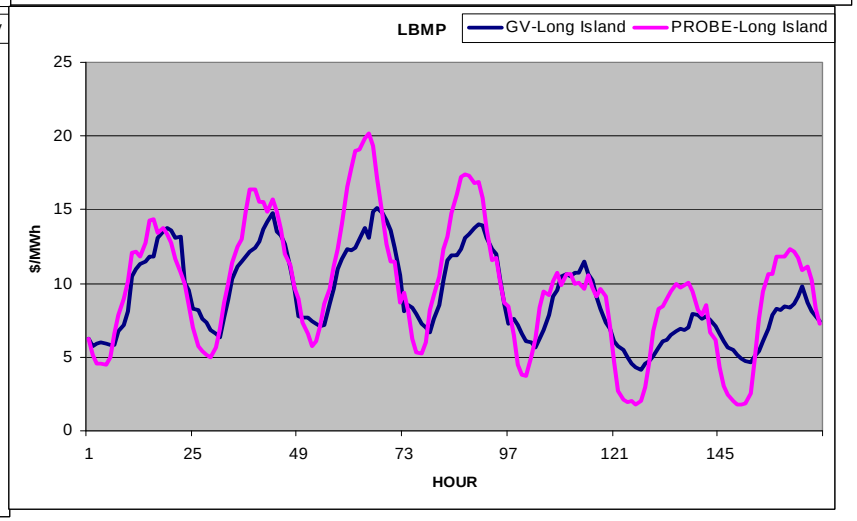
Draft – for discussion only

LBMP Losses Component – 2007 Peak Week









Draft – for discussion only

2007 Results

2007 Annual: Base & Sample Studies - Externals Scheduled

First Line GridView; Second Line MAPS

Total (million $)	Base	3rd Leeds-PV Delta	NYC CC Unit Delta
Production Cost	4,670 5,278	-7.9 1.0	-55.0 -94.0
LBMP Load Payment	11,709 14,190	-29.1 -12.0	-163.0 265.0
LBMP Generation Payment	9,904 10,727	-10.3 14.0	-108.8 -245.0
$Demand Congestion	365 TBD	-44.1 TBD	-54.0 TBD
NYISO Demand (GWh)	167,196 167,197	0 0	0 0
NYISO Generation (GWh)	148,074 TBD	-114.1 TBD	-51.7 TBD

Draft – for discussion only

2007 Results

2007 Annual: Base & Sample Studies - 4 Pool Dispatch

First Line GridView; Second Line MAPS

Total (million $)	Base	3rd Leeds-PV Delta	NYC CC Unit Delta
Production Cost	4,676 4,010	-5.5 -15.0	-58.0 -203.0
LBMP Load Payment	11,638 12,780	-11.7 -33.0	-142.2 -267.0
LBMP Generation Payment	9,884 8,697	-0.9 37.0	-112.1 -305.0
$Demand Congestion	428 TBD	-16.1 TBD	-63.2 TBD
NYISO Demand (GWh)	167,196 167,197	0 0	0 0
NYISO Generation (GWh)	149,482 TBD	-81.2 TBD	697.0 TBD

Draft – for discussion only

2007 Results – GridView Top Congested Elements $Demand Congestion – Externals Scheduled

YR2007 External Scheduled		$Demand Congestion		
Constraint Name	**Type**	**Base Case**	**Leeds-PV Ckt 3**	**NYC CC Unit**
ATHENS_PLTVLLEY_345_74344_78701_2	Contingency	157,236,115	-	143,342,068
Dunwoodie (I) to NYCity (J) and Long Island (K)	Interface	39,050,495	55,722,472	18,590,813
PLVIL345_PLVILLE_138_74349_79607_1	Contingency	36,522,400	38,730,834	41,512,579
UPNY-ConEd	Interface	22,781,400	39,142,720	11,651,694
CENTRAL EAST	Interface	22,526,686	51,036,299	24,709,853
FR-KILLS_WILOWBK2_1	Branch	16,086,511	15,544,442	14,922,750
PORTER1_VALLEY_115_75403_79581_1	Contingency	13,651,940	16,680,502	12,960,216
E.SAYRE_N.WAV115_1	Branch	11,824,663	6,951,848	10,786,207
DUNWOOD_SHORERD_345_74349_79607_1	Contingency	11,264,543	11,051,103	11,279,079
EGCPAR_EGCDUM_345_74316_75000_1	Contingency	8,441,227	1,210,545	10,202,527
RAMAPO1_SUGARLF_138_79319_79323_1	**Contingency**	**8,348,673**	**14,522,617**	**6,499,234**
DUNWDIE_SHRE-RD_345_75046_75047_1	Contingency	7,163,197	7,425,599	7,842,546
GOTHLSN_GOWANUSN_345_74335_74337_1	Contingency	6,143,272	5,601,876	4,924,478
NY MOTHVN-RAINEY Q12_74345_74691_3	Contingency	4,520,609	5,534,891	621,643
GOTHS_GOWANUSS_345_74477_74476_1	Contingency	4,206,905	4,068,760	4,768,444
EDIC_FRASR_345_75403_75405_1	Contingency	3,677,317	6,360,512	3,510,418
GOTHN345_GOWANSN_345_74479_74478_1	Contingency	3,557,832	3,506,018	4,209,102
DUNWOODIE_SHORRD_345_74316_75000_1	**Contingency**	**2,815,236**	**8,625,146**	**3,178,716**
NY MOTHVN-RAINEY Q11_74345_74691_4	Contingency	2,776,251	3,741,771	608,868
DUNSO1R_E179ST_138_74424_74435_1	Contingency	1,620,234	2,020,637	492,091
HMPHRBR_DVNPT_345_74316_75000_1	**Contingency**	**1,346,657**	**3,918,772**	**1,371,138**
GOWNUS1R_GRENWOOD_1	Branch	1,331,535	1,275,687	1,464,156
DUNNO_NUNNO2R_138_74418_74421_1	Contingency	1,199,806	1,494,468	364,571
DUNNO_DUNNO1R_138_74418_74420_1	Contingency	1,051,225	1,315,336	310,118
GRENWOOD_VERNON-E_1	Branch	1,031,432	1,065,865	1,176,320
LEEDS3_N.SCOT99_345_78701_78702_1	**Contingency**	**985,548**	**38,717,336**	**2,298,171**

Draft – for discussion only

2007 Results – GridView Top Congested Elements
$Demand Congestion – 4 Pool Dispatch

YR2007 4 Pool Dispatch		$Demand Congestion		
Constraint Name	**Type**	**Base Case**	**Leeds-PV Ckt 3**	**NYC CC Unit**
ATHENS_PLTVLLEY_345_74344_78701_2	Contingency	95,707,230	-	80,644,270
CENTRAL EAST	Interface	89,459,658	124,044,048	89,926,146
Dunwoodie (I) to NYCity (J) and Long Island (K)	Interface	58,231,117	73,211,217	28,882,855
PLVIL345_PLVILLE_138_74349_79607_1	Contingency	55,081,609	55,503,600	62,534,058
UPNY-ConEd	Interface	20,678,872	27,479,415	8,049,714
FR-KILLS_WILOWBK2_1	Branch	16,584,756	16,263,789	15,340,134
PORTER1_VALLEY_115_75403_79581_1	Contingency	15,551,853	18,479,281	14,922,006
EGCPAR_EGCDUM_345_74316_75000_1	Contingency	10,297,930	1,405,818	12,639,543
DUNWDIE_SHRE-RD_345_75046_75047_1	Contingency	9,142,735	9,190,544	10,121,962
GOTHLSN_GOWANUSN_345_74335_74337_1	Contingency	6,559,854	5,895,043	5,581,643
DUNWOOD_SHORERD_345_74349_79607_1	Contingency	6,240,890	6,488,890	6,466,074
EDIC_FRASR_345_75403_75405_1	Contingency	5,017,627	8,117,909	4,699,807
DUNWOODIE_SHORRD_345_74316_75000_1	Contingency	4,153,334	10,012,963	4,404,932
GOTHS_GOWANUSS_345_74477_74476_1	Contingency	3,853,534	3,695,150	4,024,136
GOTHN_GOWANN_345_74333_74336_1	Contingency	3,237,973	3,180,145	2,326,176
GOTHN345_GOWANSN_345_74479_74478_1	Contingency	2,995,614	3,228,842	3,391,948
NY MOTHVN-RAINEY Q12_74345_74691_3	Contingency	2,883,331	2,556,897	569,356
WARREN_FALCONER_1	Branch	2,063,992	2,441,192	2,192,955
NY MOTHVN-RAINEY Q11_74345_74691_4	Contingency	1,727,599	2,577,252	378,232
HMPHRBR_DVNPT_345_74316_75000_1	Contingency	1,669,844	4,966,503	2,047,296
LEEDS3_N.SCOT99_345_78701_78702_1	Contingency	-	13,232,814	40,574

Draft – for discussion only

2013 Results

2013 Annual: Base & Sample Studies – Externals Scheduled

First Line GridView; Second Line MAPS

Total (million $)	Base	3rd Leeds-PV Delta	NYC CC Unit Delta
Production Cost	5,492 6,105	-9.3 -13.0	-46.4 -115.0
LBMP Load Payment	12,785 15,838	-22.8 -6.0	-113.0 -237.0
LBMP Generation Payment	11,066 11,696	5.4 21.0	-82.7 -301.0
$Demand Congestion	294 TBD	-86.5 TBD	-35.4 TBD
NYISO Demand (GWh)	176,848 178,760	0 0	0 0
NYISO Generation (GWh)	161,952 TBD	96.4 TBD	-63.7 TBD

Draft – for discussion only

2013 Results

2013 Annual: Base & Sample Studies – 4 Pool Dispatch

First Line GridView; Second Line MAPS

Total (million $)	Base	3rd Leeds-PV Delta	NYC CC Unit Delta
Production Cost	4,675 5,324	-9.4 -4.0	-35.0 -172.0
LBMP Load Payment	12,731 15,162	-25.8 -7.9	-90.2 -213
LBMP Generation Payment	10,905 10,868	6.5 113.0	-28.0 -274.0
$Demand Congestion	770 TBD	-2.8 TBD	-58.2 TBD
NYISO Demand (GWh)	176,848 178,760	0 0	0 0
NYISO Generation (GWh)	149,653 TBD	90.0 TBD	260.0 TBD

Draft – for discussion only

2013 Results – GridView Top Congested Elements $Demand Congestion – Externals Scheduled

YR 2013 External Scheduled		$Demand Congestion		
Constraint Name	**Type**	**Base Case**	**Leeds-PV Ckt 3**	**NYC CC Unit**
ATHENS_PLTVLLEY_345_74344_78701_2	Contingency	145,762,506	-	117,662,503
DUNWODIE_SHORE_345_75002_75001_1	Contingency	39,910,595	41,793,765	43,147,504
DUNWODE_SHORE_345_75003_75001_1	Contingency	39,654,703	41,550,647	42,919,136
E.SAYRE_N.WAV115_1	Branch	12,191,213	8,781,625	10,687,961
DUNWDIE_SHRE-RD_345_75046_75047_1	Contingency	10,518,491	10,761,476	11,555,350
DUNWODIE_SHORE RD_1	Branch	7,587,685	8,355,753	7,805,496
FR-KILLS_WILOWBK2_1	Branch	4,928,819	4,031,254	3,352,485
CENTRAL EAST	Interface	4,060,684	12,586,885	3,994,398
OAKDL_OAK3M115_345_75407_75418_1	Contingency	3,021,440	3,498,810	2,782,658
NY MOTHVN-RAINEY Q12_74345_74691_3	Contingency	3,003,407	3,633,685	1,482,721
UPNY-ConEd	Interface	2,892,980	5,180,294	-
NY MOTHVN-RAINEY Q11_74345_74691_4	Contingency	2,560,898	3,775,992	1,458,467
RAMAPO1_SUGARLF_138_79319_79323_1	Contingency	2,443,087	10,227,377	2,163,148
GOTHN_GOWANN_345_74333_74336_1	Contingency	2,415,919	1,889,484	1,593,761
GOTHLSN_GOWANUSN_345_74335_74337_1	Contingency	2,274,400	1,809,887	1,555,184
EDIC_FRASR_345_75403_75405_1	Contingency	2,218,008	5,856,972	2,089,339
MARCY-T1_COOPC_345_75400_75403_1	Contingency	1,450,763	5,628,045	1,522,029
DUNSO1R_E179ST_138_74424_74435_1	Contingency	1,306,241	1,693,935	791,484
LAUREL L_GOUDY115_1	Branch	1,035,921	830,229	862,392
DUNNO_NUNNO2R_138_74418_74421_1	Contingency	959,161	1,246,609	568,225
DUNNO_DUNNO1R_138_74418_74420_1	Contingency	831,128	1,095,235	484,656
SPRBROOK_TREMONT_1	Branch	533,521	688,883	300,660
LEEDS3_N.SCOT99_345_78701_78702_1	Contingency	469,083	43,647,620	397,530
HUDAVEAST_JAMAIC_138_74502_74505_1	Contingency	395,842	432,863	670,018

Draft – for discussion only

2013 Results – GridView Top Congested Elements
$Demand Congestion – 4 Pool Dispatch

YR2013 - 4 Pool Dispatch		$Demand Congestion		
Constraint Name	Type	Base Case	Leeds-PV Ckt 3	NYC CC Unit
CENTRAL EAST	Interface	261,670,464	310,529,096	262,765,286
ATHENS_PLTVLLEY_345_74344_78701_2	Contingency	110,236,875	-	92,291,005
DUNWODIE_SHORE_345_75002_75001_1	Contingency	81,779,853	87,097,882	82,977,910
DUNWODE_SHORE_345_75003_75001_1	Contingency	81,231,143	86,544,256	82,453,332
PORTER1_VALLEY_115_75403_79581_1	Contingency	48,265,472	55,550,638	48,268,789
NY MOTHVN-RAINEY Q11_74345_74691_4	Contingency	24,650,520	29,125,259	16,407,090
DUNWODIE_SHORE RD_1	Branch	22,575,760	25,698,627	19,731,322
NY MOTHVN-RAINEY Q12_74345_74691_3	Contingency	22,252,074	28,063,795	16,030,942
DUNWDIE_SHRE-RD_345_75046_75047_1	Contingency	17,335,843	17,456,058	19,376,417
DUNSO1R_E179ST_138_74424_74435_1	Contingency	10,090,086	12,159,770	7,056,596
DUNNO_NUNNO2R_138_74418_74421_1	Contingency	7,479,989	9,019,535	5,220,181
DUNNO_DUNNO1R_138_74418_74420_1	Contingency	6,568,427	7,944,855	4,627,242
EDIC_FRASR_345_75403_75405_1	Contingency	4,466,586	6,615,389	4,627,487
UPNY-ConEd	Interface	4,184,224	12,521,770	731,996
SPRBROOK_TREMONT_1	Branch	4,101,222	4,940,836	2,866,559
FR-KILLS_WILOWBK2_1	Branch	3,416,163	3,136,248	2,780,060
LEEDS3_N.SCOT99_345_78701_78702_1	Contingency	73,513	14,585,043	167,000

Draft – for discussion only

Observations from Benchmarking

- PROBE uses a different congestion formula compared to MAPS and GridView
- Critical factors affecting the results
    - External transactions
    - Phase Angle Regulator Settings and Control
    - Analysis of Historic Market Performance on Congestion
- Results from simulation tools are different from Actuals given operational configuration conditions (transmission, outages, etc…)
- Results do not correlate with absolute magnitudes of Actuals due to intrinsic modeling differences (market bids vs. cost based bids, network operational configuration influence, virtual bidding, external proxy bus vs. actual external system representation, etc.)
- Benchmarking exercise was extremely beneficial in building the experience and skills that will be necessary to perform the CARIS studies

Draft – for discussion only

Selection Criteria

Criteria	MAPS	GridView
Peak Week, Annual 2007 & 2013 Results		
NYISO Tariff Requirements TCC Revenues Co-Optimization Energy & Reserves		
Powerflow: handle CRP 6-digit bus number models		
User Friendly		
Flexible Database Management		
Efficient Results Reporting		
Hourly Transmission Maintenance		
Parallel Computing Capability		
Documentation – User & Application Manuals		

Ratings: '-' Not Met '0' Meets '+' Exceeds

Draft – for discussion only

Selection Criteria Results

Criteria	MAPS	GridView
Peak Week, Annual 2007 & 2013 Results	0	0
NYISO Tariff Requirements	-	+
TCC Revenues	-	+
Co-Optimization Energy & Reserves	-	+
Powerflow: handle CRP 6-digit bus number models	testing	+
User Friendly	0	+
Flexible Database Management	0	+
Efficient Results Reporting	0	+
Hourly Transmission Maintenance	-	+
Parallel Computing Capability	+	-
Documentation – User & Application Manuals	+	-

Ratings: '-' Not Met '0' Meets '+' Exceeds

Draft – for discussion only

The New York Independent System Operator (NYISO) is a not-for-profit corporation that began operations in 1999. The NYISO operates New York's bulk electricity grid, administers the state's wholesale electricity markets, and provides comprehensive reliability planning for state's bulk electricity system.

www.nyiso.com