INNOVATIVE APPROACHES TO IMPLEMENTING PI AT PSE&G

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PSE&G

ABSTRACT

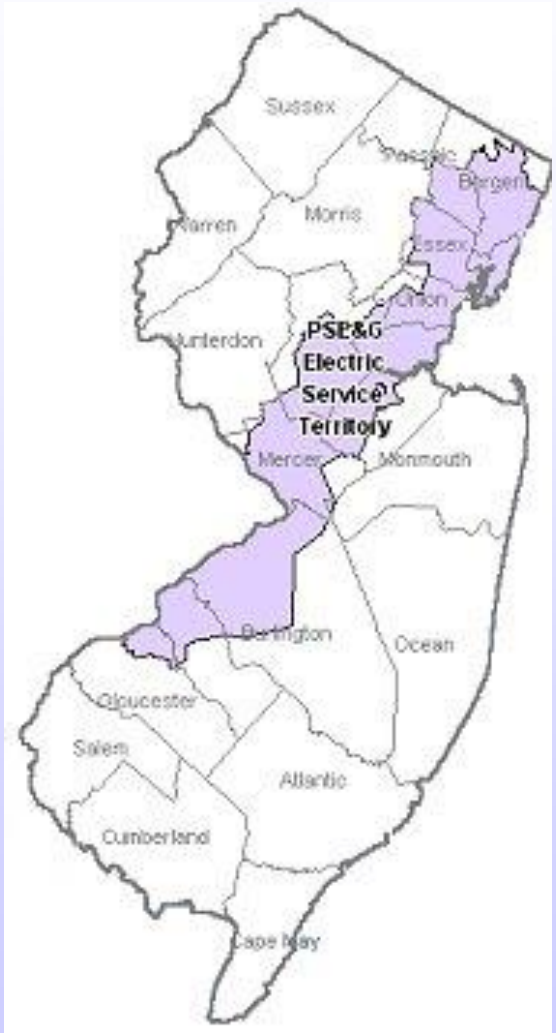
Public Service Electric & Gas Company (PSE&G) manages the electric power transmission and distribution for approximately 2600 squares miles in the heart of New Jersey. To accomplish this, the PSE&G Electric System Operations Center monitors the operation of over 150 generating, switching, and sub-stations and over 1400 miles of Transmission lines.

Over the last several years, ESOC personnel have been building a Network of PI Servers designed to provide two key functions.

1. Provide a minimum set of EMS data to the ESOC Operators completely independent of the main Energy Management System (EMS) via Video Wall Display
2. Provide a totally independent, secure means for allowing non-ESOC users to access EMS real-time and historical data.

PSE&G Electric Territory

- Electric Supply Assets and Resources:
  - 31 Generating Facilities
  - 56 Switching Stations
  - 39 Substations
  - 161 Transmission Lines
  - 2003 peak demand > 10,000MW



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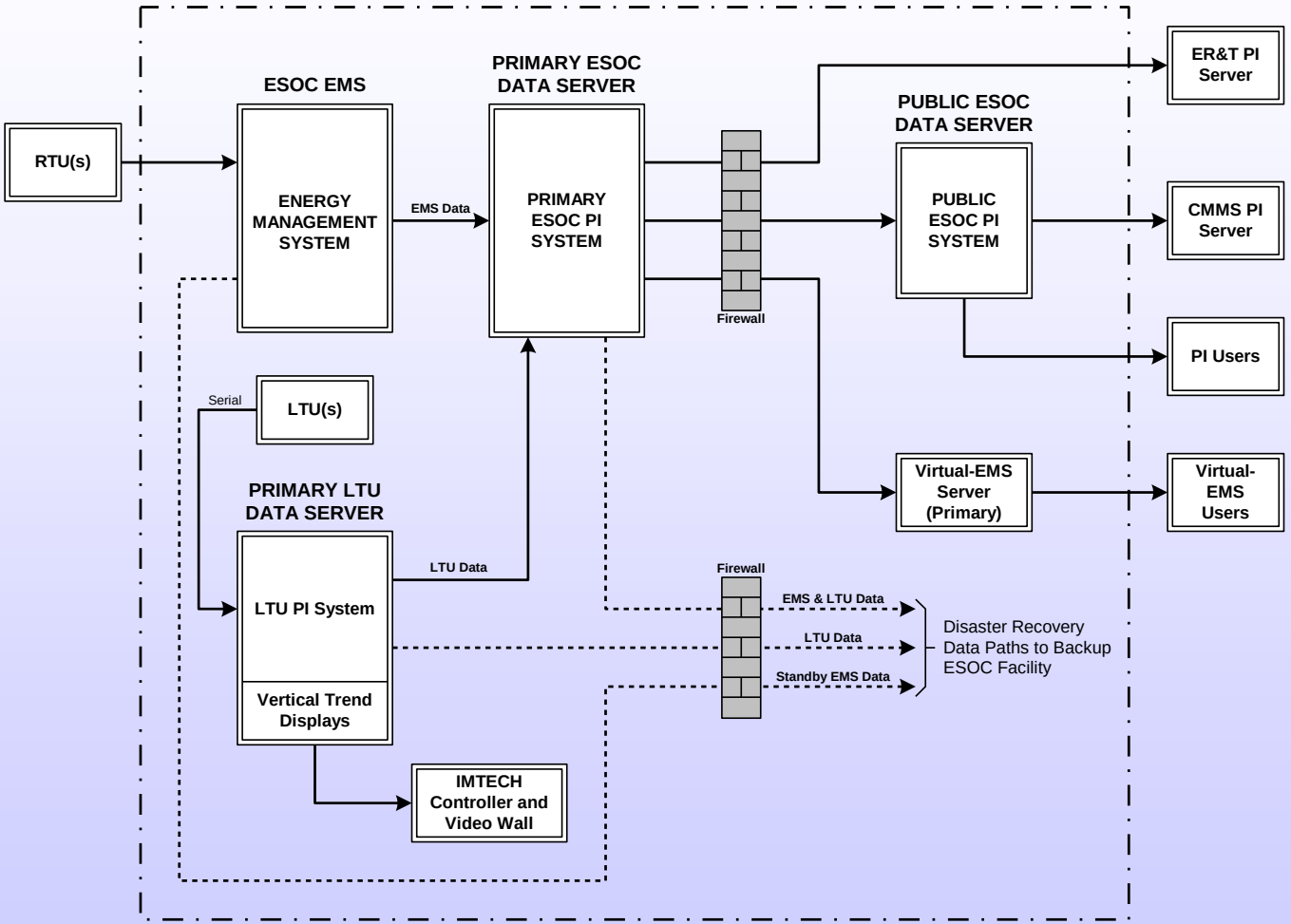
PSE&G ESOC PI Network



PRIMARY ESOC FACILITY CONFIGURATION

Data Sources

- Energy Management System (EMS)
  - Electric Delivery Operations Data
  - Power Generation Data
  - Switching/Sub-Stations Data
- Local Terminal Units (LTUs)
  - Critical System Data
- PJM (ISO) Data
  - LMP Data
  - Current and Forecast Load Data

Physical and Cyber Security

- Access Controlled, Secure Area
- PI Servers and Essential ESOC Computers on separate sub-net
- Access to ESOC Data Tightly Controlled
  - Firewall(s)
  - PI Interfaces Utilize “Trust” Relationships
  - Windows Account Authentication
  - PI User Account Authentication
  - Tags Use “Data” and “Point” Security Attributes

Video Wall Displays

- Critical Operating Data (in case of primary EMS data loss)
- Obsolete hardware replaced with modern equipment
- Custom software replaced with OSISoft ProcessBook-based displays
- Old vertical trend displays duplicated with ActiveX Control within ProcessBook Displays

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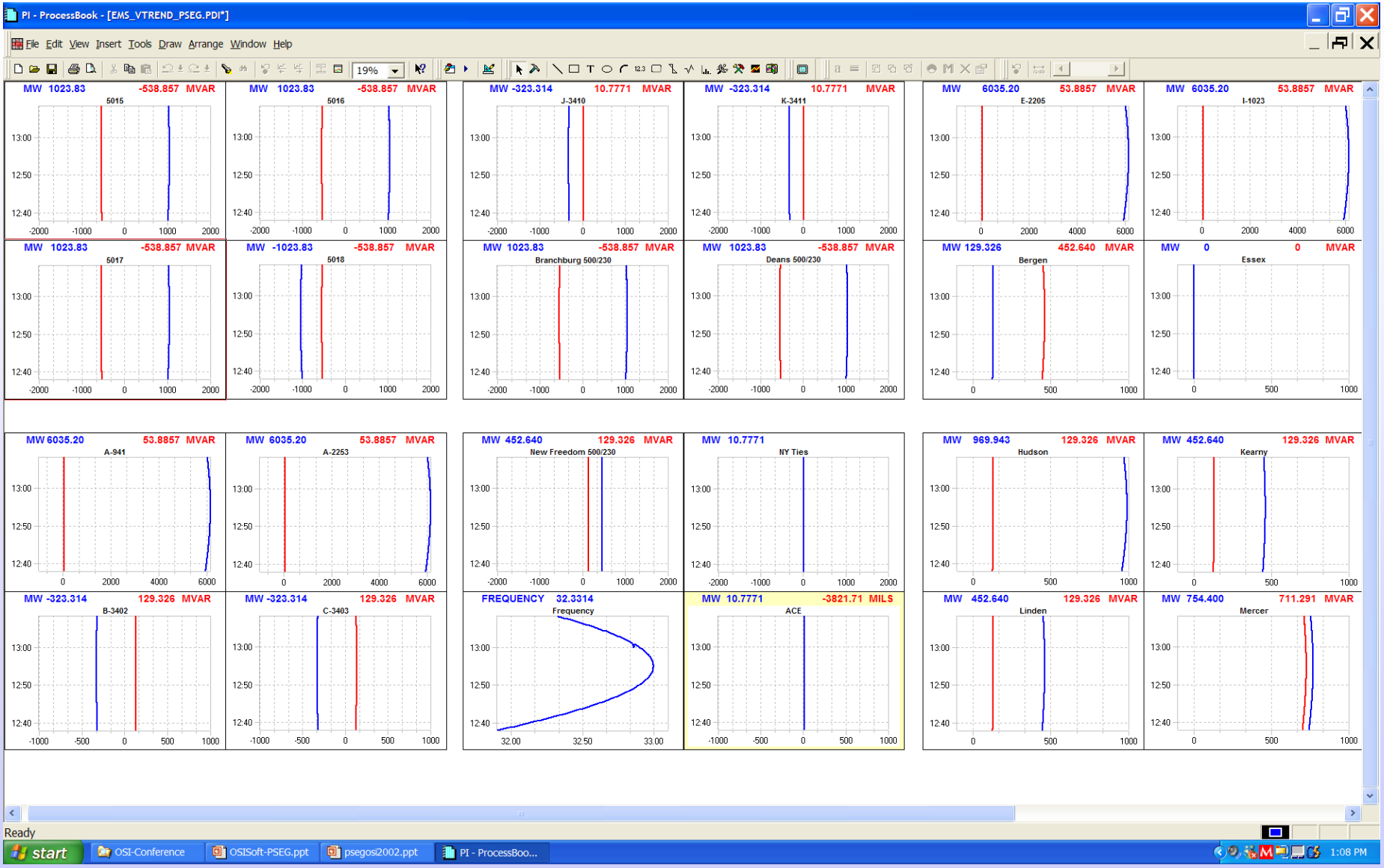
Vertical Trend Display



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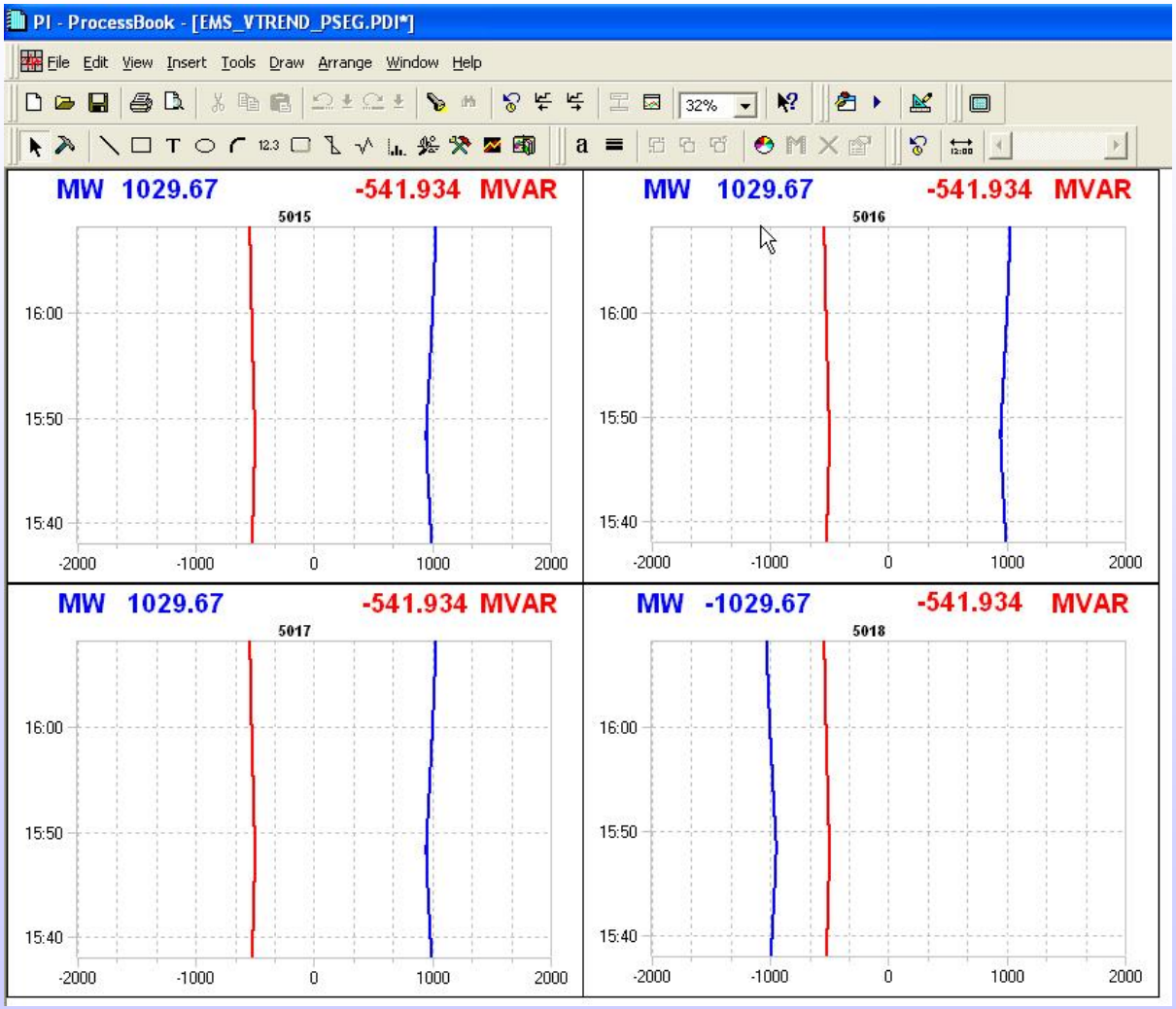
Vertical Trend Display: Details



Virtual-EMS®

Virtual Energy Management System

- Provides access to sensitive EMS Data for personnel outside ESOC
- Utilizes OSISoft client products – ProcessBook, DataLink, ActiveView
- Displays Real-Time and/or Historical (archived) Information
- Provides interactive access to Analytical Reports (On-Demand and Scheduled)

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Virtual-EMS® Functions

- Allows access to all information via an integrated set of browser-based displays (web pages), including
  - Electric Market data (e.g., ISO LMP, Load, Weather)
  - System Operations data (e.g., T&D SCADA, Generation data)
  - Information from multiple data sources, internal and external

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Virtual-EMS® Functions

- Allows users to run “on-demand” reports or access “scheduled” reports stored on a secured Virtual-EMS® server, including Excel/DataLink-based spreadsheets
- Multiple levels of security to control access to sensitive information

Virtual-EMS® Architecture

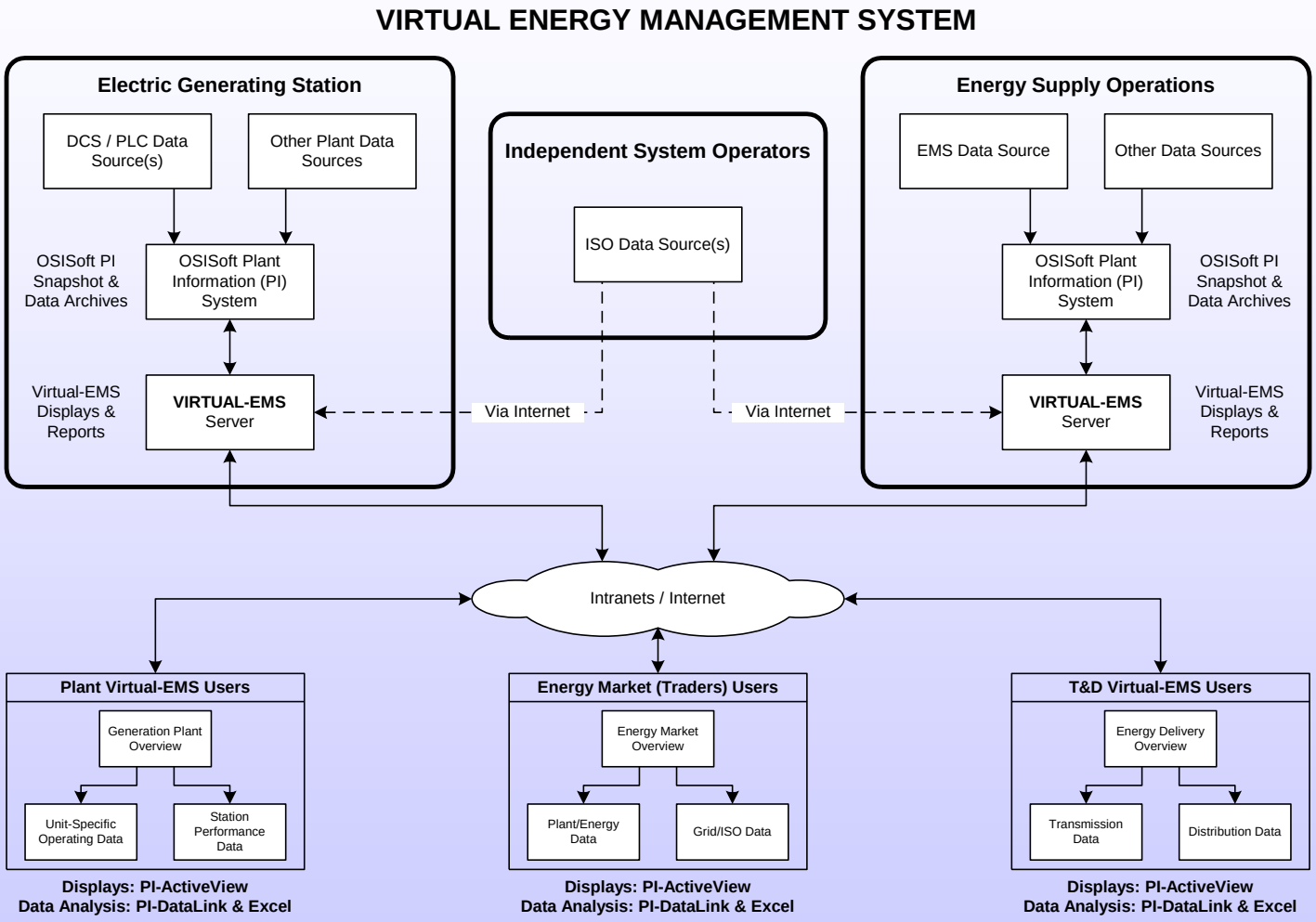
- Virtual-EMS® Server
  - Facilitates access to all data sources
  - Acts as web-site for all Virtual- EMS® displays
  - Stores and runs all Virtual- EMS® reports
  - Provides FTP site for transferring files (reports) to users
  - Regulates user access to all information

System Advantages

- Eliminates the need to provide users direct access to data sources, thereby allowing secure, selective access to information
- Eliminates the need to install, maintain, and learn multiple software packages to access information from different sources
- All displays and reports are stored and maintained in one location – the Virtual-EMS® Server, not each user's PC

Virtual-EMS®

Typical System Block Diagram



VIRTUAL-EMS®

ENERGY DELIVERY

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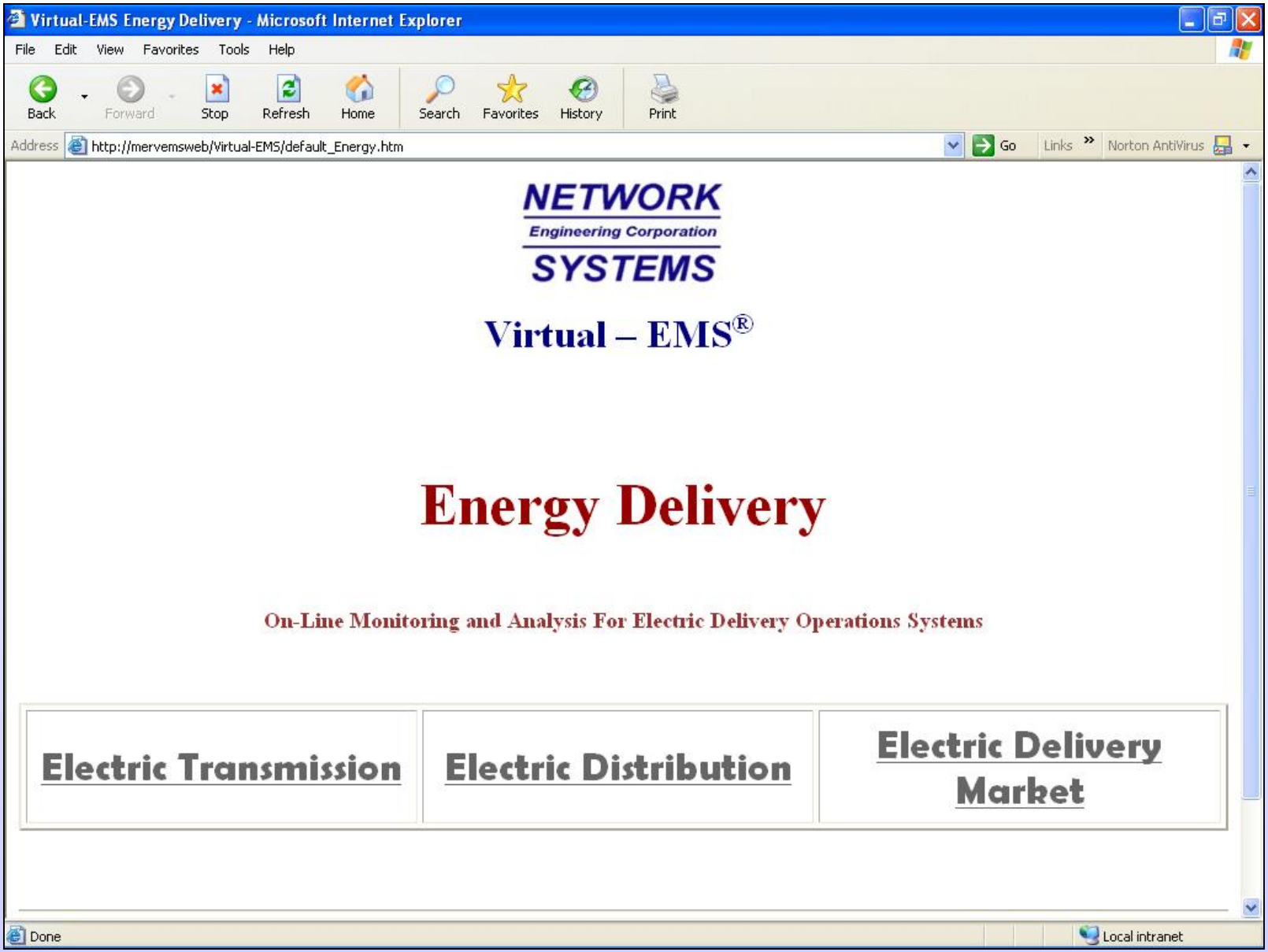
Virtual-EMS Energy Delivery - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/default_Energy.htm
Go Links Norton AntiVirus
NETWORK
Engineering Corporation
SYSTEMS
Virtual – EMS®
Energy Delivery
On-Line Monitoring and Analysis For Electric Delivery Operations Systems
Electric Transmission
Electric Distribution
Electric Delivery Market
Done
Local intranet

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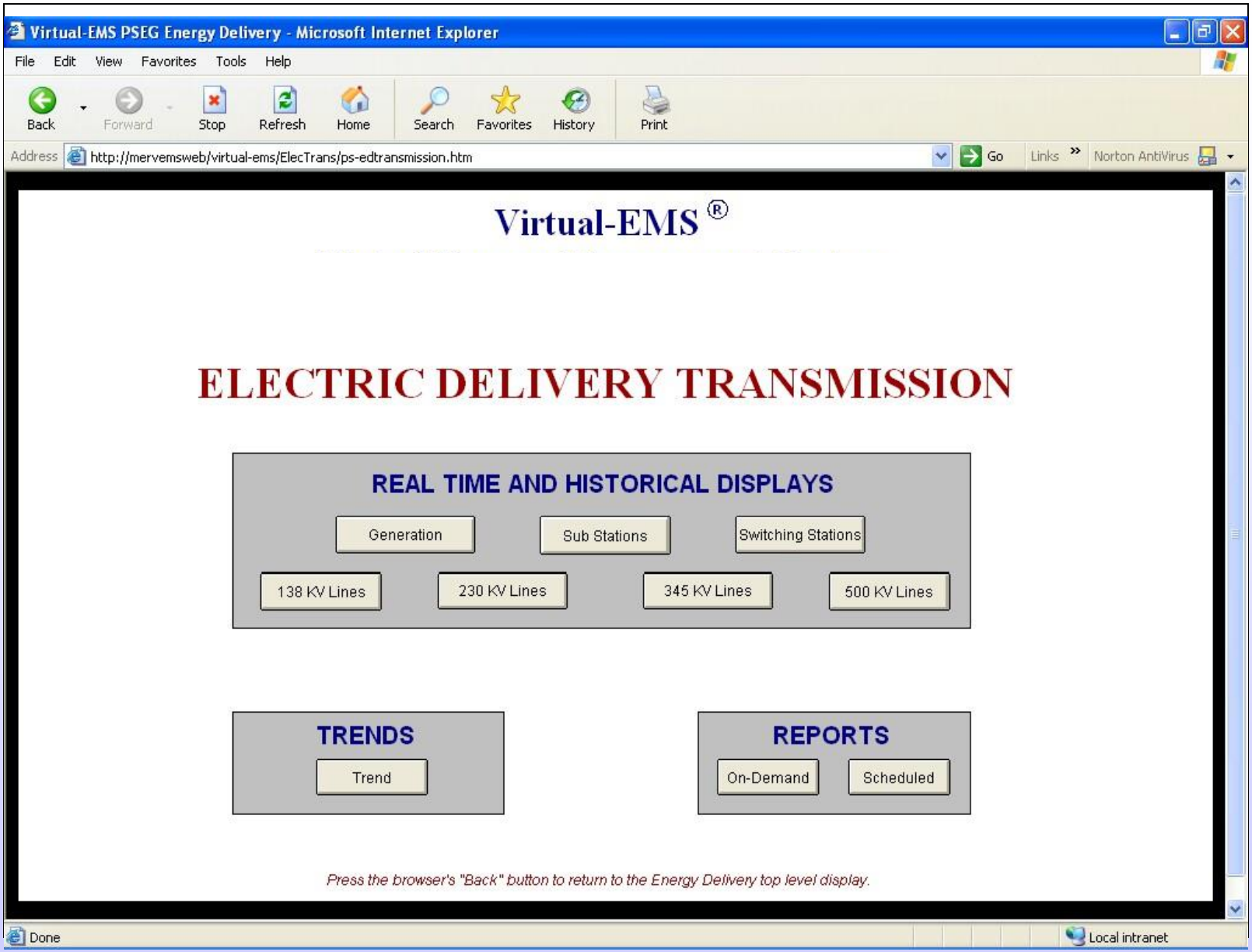
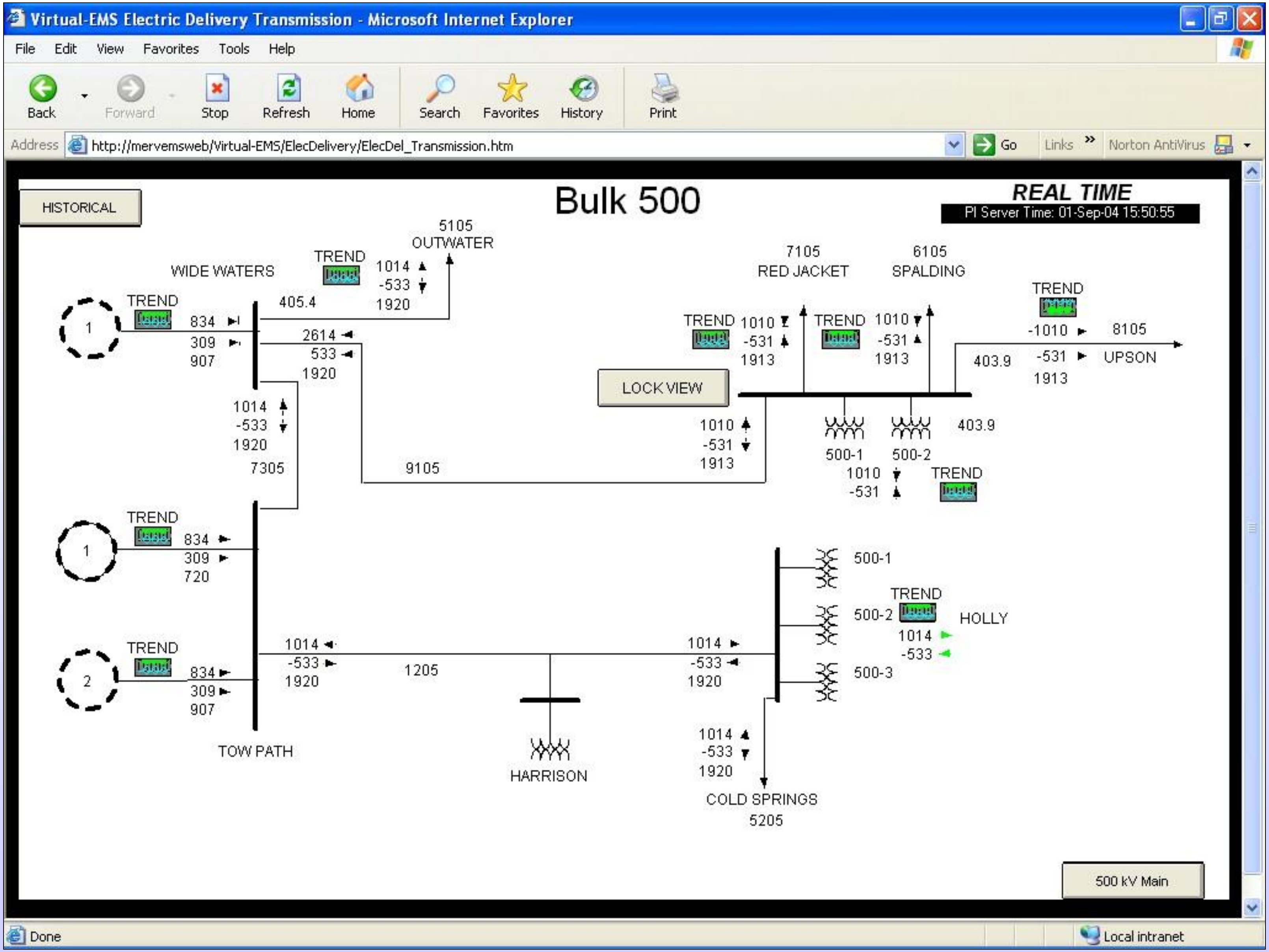
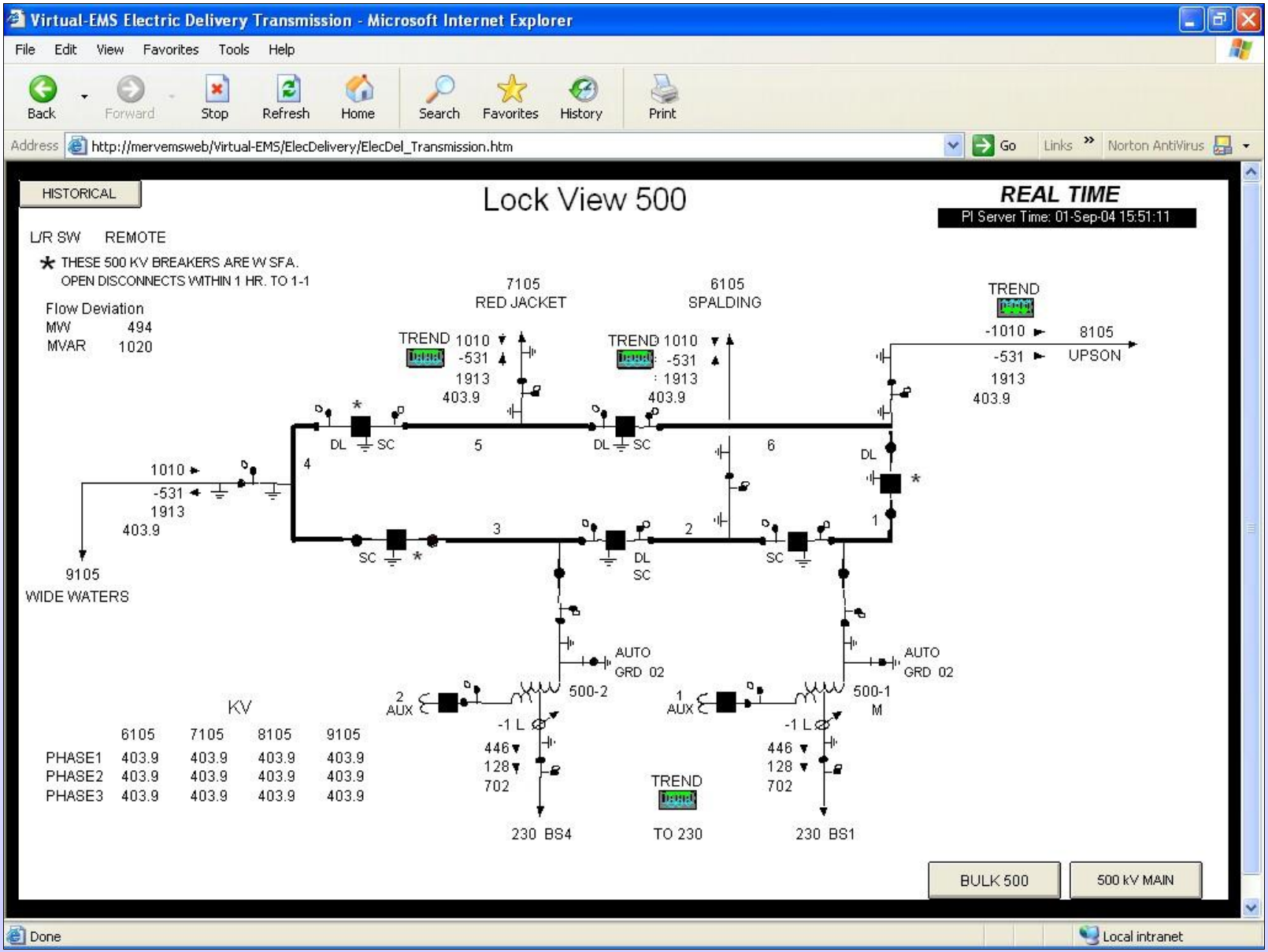
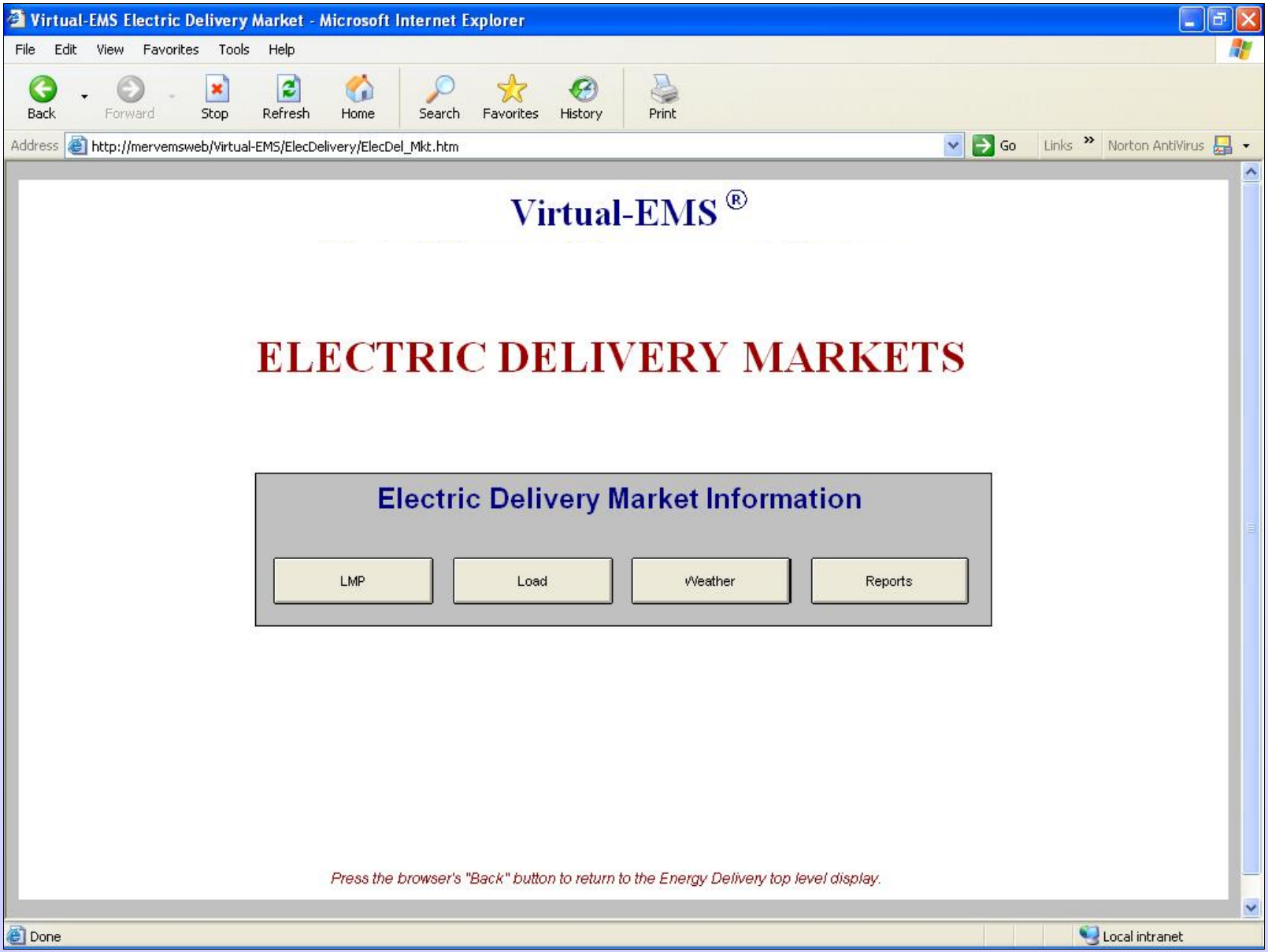

Virtual-EMS PSEG Energy Delivery - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/virtual-ems/ElecTrans/ps-edtransmission.htm
Go Links Norton AntiVirus
Virtual-EMS ®
ELECTRIC DELIVERY TRANSMISSION
REAL TIME AND HISTORICAL DISPLAYS
Generation
Sub Stations
Switching Stations
138 KV Lines
230 KV Lines
345 KV Lines
500 KV Lines
TRENDS
Trend
REPORTS
On-Demand
Scheduled
Press the browser's "Back" button to return to the Energy Delivery top level display.
Done
Local intranet

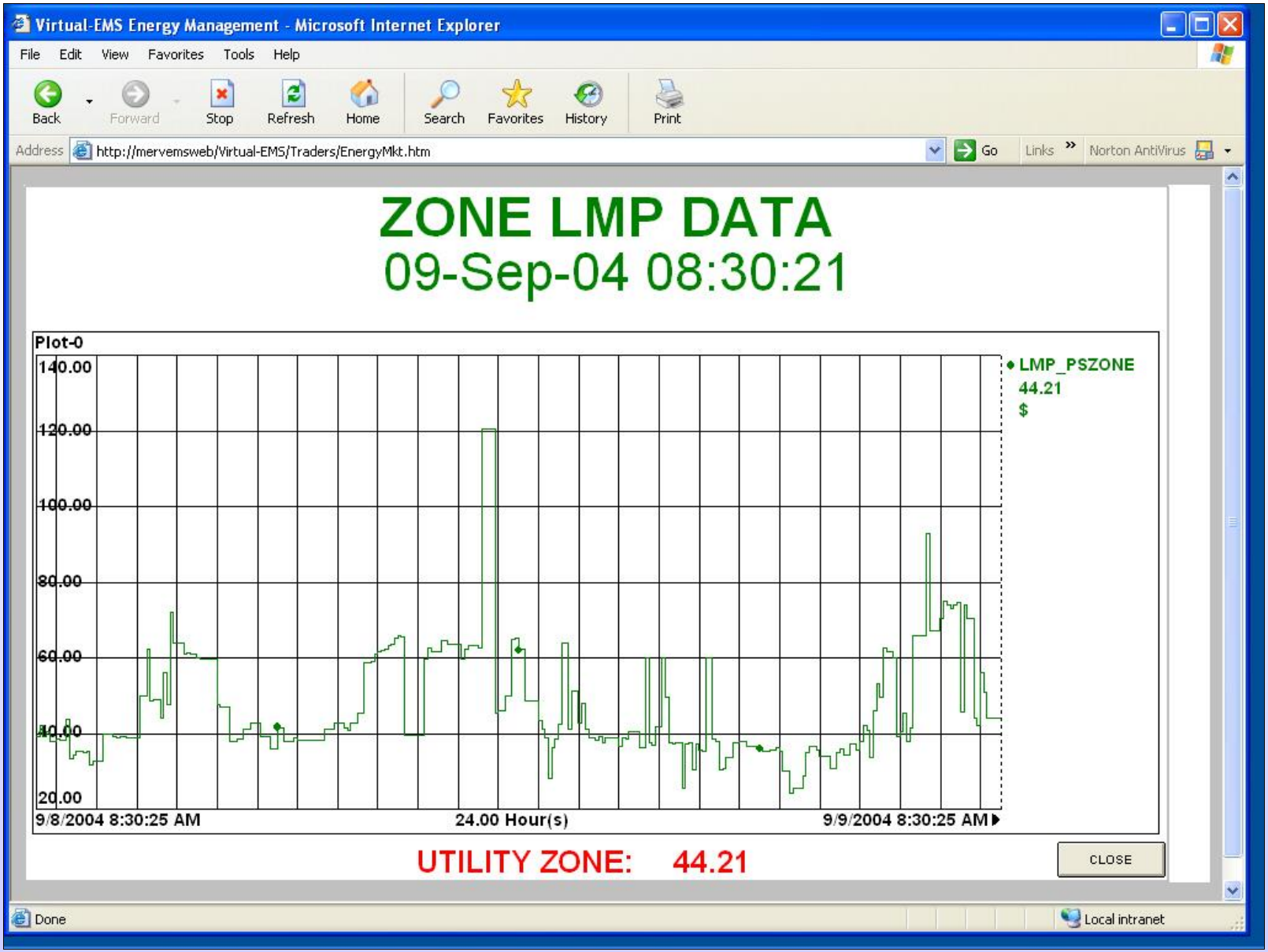
PSE&G


Virtual-EMS Electric Delivery Transmission - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/ElecDelivery/ElecDel_Transmission.htm
Go Links Norton AntiVirus
HISTORICAL
Bulk 500
REAL TIME
PI Server Time: 01-Sep-04 15:50:55
5105 OUTWATER
WIDE WATERS
TREND
1014 -533 1920
405.4
834 309 907
2614 533 1920
7105 RED JACKET
6105 SPALDING
1010 -531 1913
-1010 -531 1913
8105 UPSON
403.9
LOCK VIEW
500-1
500-2
1010 -531
7305
9105
834 309 720
500-1
500-2
500-3
HOLLY
1014 -533
834 309 907
1014 -533 1920
1205
TOW PATH
HARRISON
COLD SPRINGS 5205
500 kV Main
Done
Local intranet

PSEG


Virtual-EMS Electric Delivery Transmission - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/ElecDelivery/ElecDel_Transmission.htm
Go Links Norton AntiVirus
HISTORICAL
Lock View 500
REAL TIME
PI Server Time: 01-Sep-04 15:51:11
L/R SW REMOTE
* THESE 500 KV BREAKERS ARE W SFA.
OPEN DISCONNECTS WITHIN 1 HR. TO 1-1
Flow Deviation
MW 494
MVAR 1020
7105
RED JACKET
6105
SPALDING
TREND
1010
-531
1913
403.9
8105
UPSON
9105
WIDE WATERS
DL
SC
AUTO
GRD 02
500-2
500-1
M
2 AUX
1 AUX
-1 L
446
128
702
230 BS4
TO 230
230 BS1
KV
6105 7105 8105 9105
PHASE1 403.9 403.9 403.9 403.9
PHASE2 403.9 403.9 403.9 403.9
PHASE3 403.9 403.9 403.9 403.9
BULK 500
500 kV MAIN
Done
Local intranet


Virtual-EMS Electric Delivery Market - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/ElecDelivery/ElecDel_Mkt.htm
Go Links Norton AntiVirus
Virtual-EMS ®
ELECTRIC DELIVERY MARKETS
Electric Delivery Market Information
LMP
Load
Weather
Reports
Press the browser's "Back" button to return to the Energy Delivery top level display.
Done
Local intranet


Virtual-EMS Energy Management - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/Traders/EnergyMkt.htm
Go Links Norton AntiVirus
ZONE LMP DATA
09-Sep-04 08:30:21
Plot-0
140.00
120.00
100.00
80.00
60.00
40.00
20.00
LMP_PSZONE
44.21
$
9/8/2004 8:30:25 AM
24.00 Hour(s)
9/9/2004 8:30:25 AM
UTILITY ZONE: 44.21
CLOSE
Done
Local intranet

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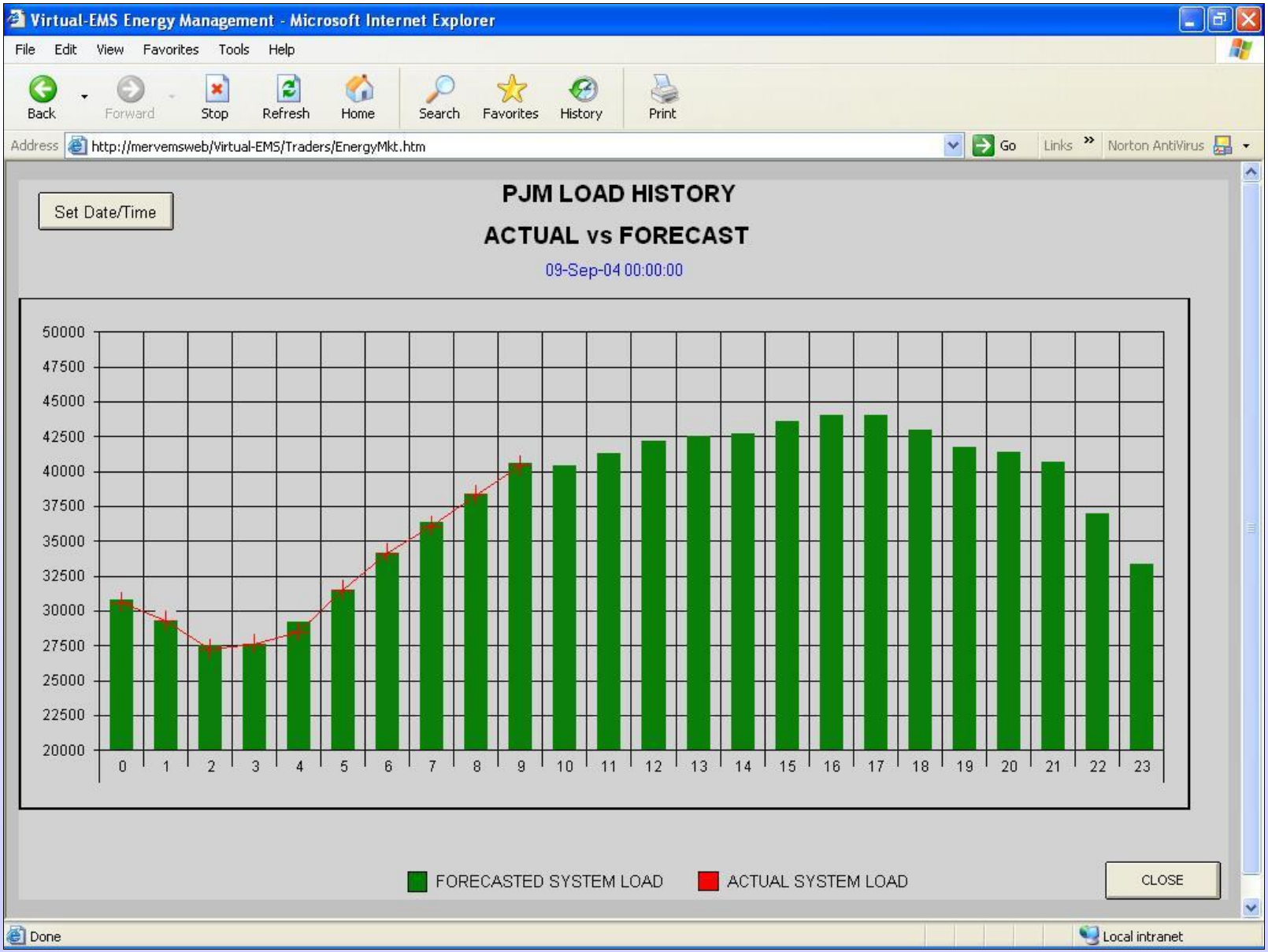
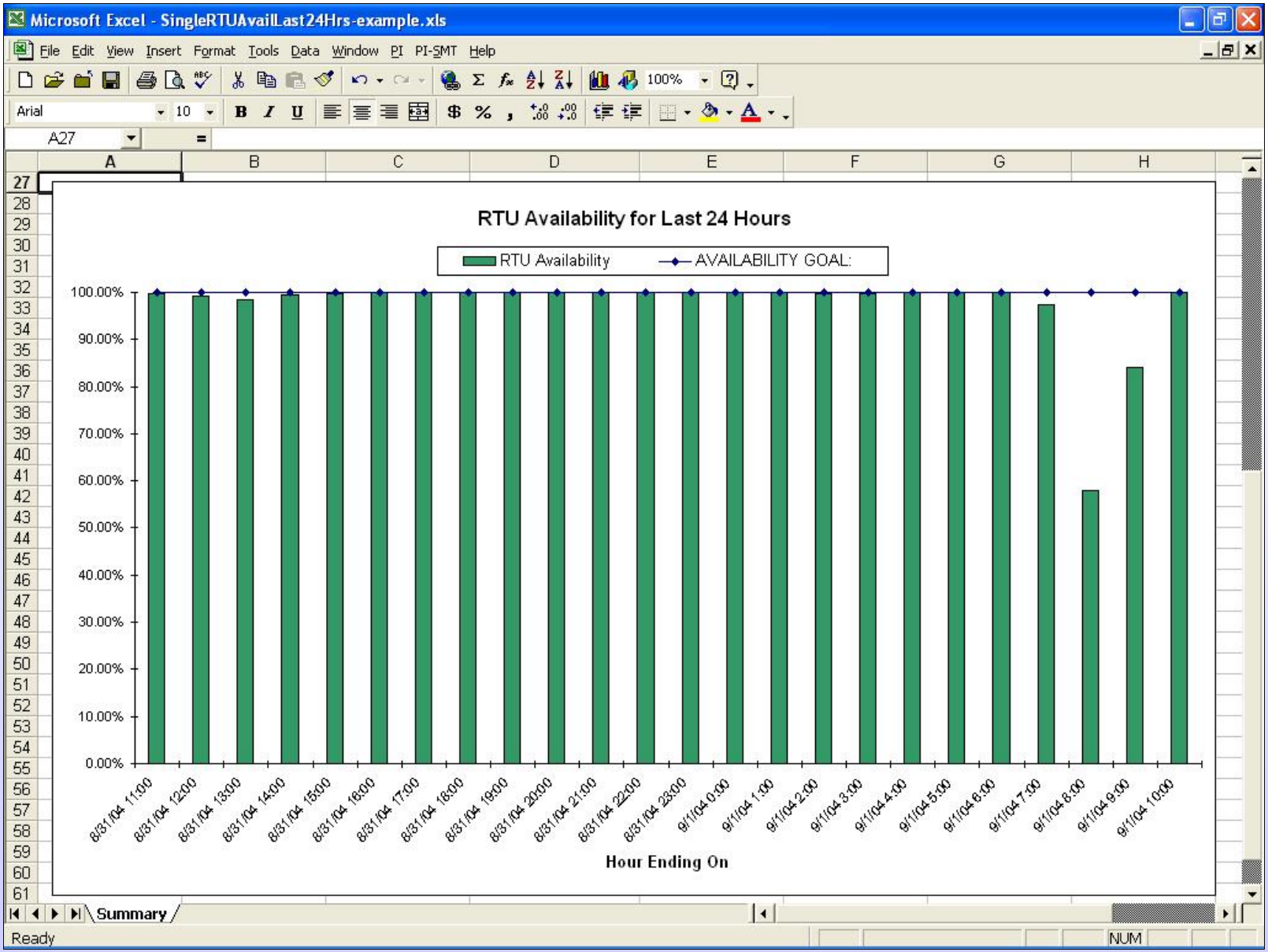
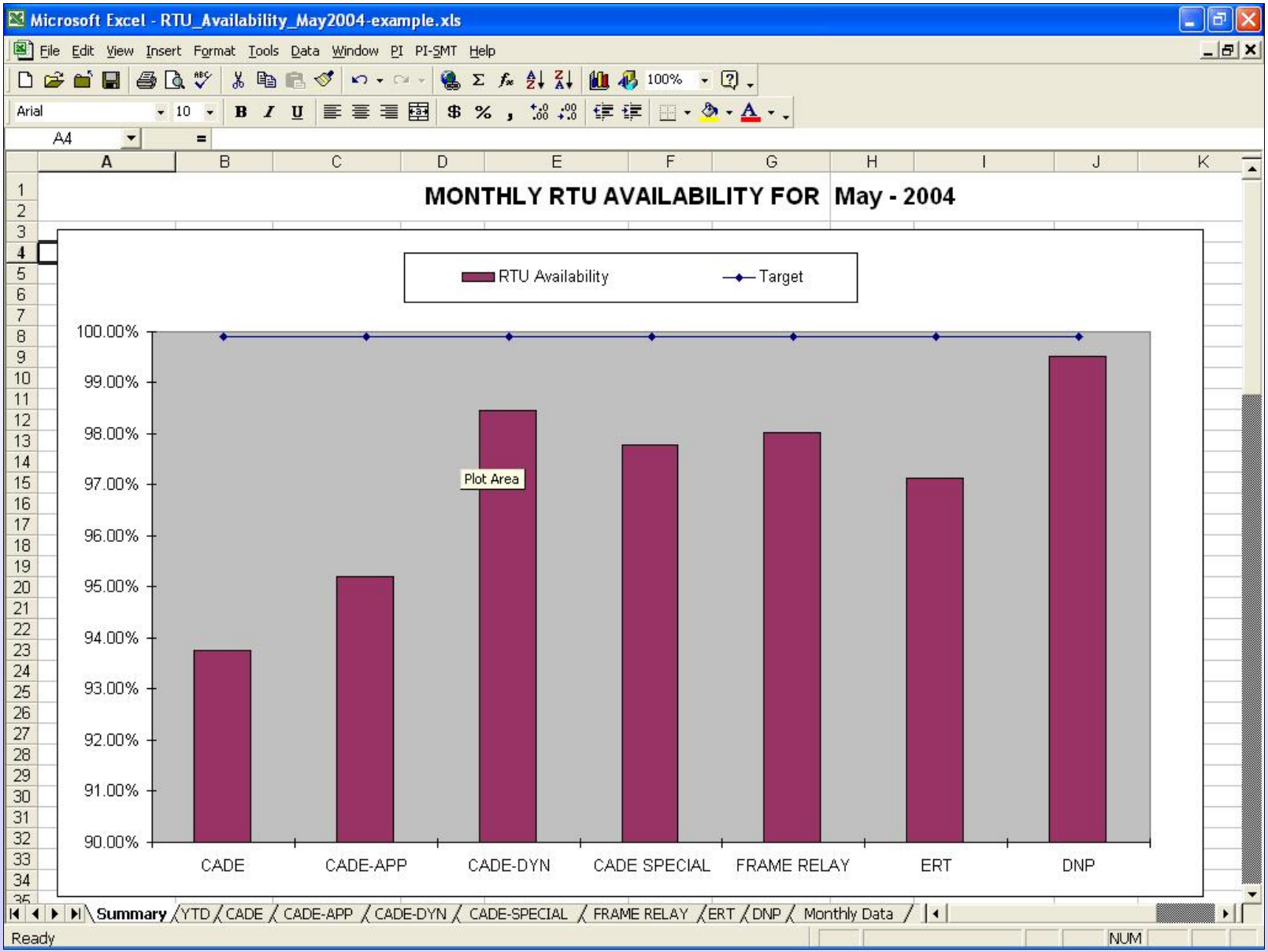

Virtual-EMS Energy Management - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/Traders/EnergyMkt.htm
Go Links Norton AntiVirus
Set Date/Time
PJM LOAD HISTORY
ACTUAL vs FORECAST
09-Sep-04 00:00:00
50000
47500
45000
42500
40000
37500
35000
32500
30000
27500
25000
22500
20000
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
FORECASTED SYSTEM LOAD
ACTUAL SYSTEM LOAD
CLOSE
Done
Local intranet

PSE&G


Microsoft Excel - SingleRTUAvailLast24Hrs-example.xls
File Edit View Insert Format Tools Data Window PI PI-SMT Help
Arial 10
A27
RTU Availability for Last 24 Hours
RTU Availability
AVAILABILITY GOAL:
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
8/31/04 11:00
8/31/04 12:00
8/31/04 13:00
8/31/04 14:00
8/31/04 15:00
8/31/04 16:00
8/31/04 17:00
8/31/04 18:00
8/31/04 19:00
8/31/04 20:00
8/31/04 21:00
8/31/04 22:00
8/31/04 23:00
9/1/04 0:00
9/1/04 1:00
9/1/04 2:00
9/1/04 3:00
9/1/04 4:00
9/1/04 5:00
9/1/04 6:00
9/1/04 7:00
9/1/04 8:00
9/1/04 9:00
9/1/04 10:00
Hour Ending On
Summary
Ready
NUM


Microsoft Excel - RTU_Availability_May2004-example.xls
File Edit View Insert Format Tools Data Window PI PI-SMT Help
Arial 10
A4
MONTHLY RTU AVAILABILITY FOR May - 2004
RTU Availability
Target
100.00%
99.00%
98.00%
97.00%
96.00%
95.00%
94.00%
93.00%
92.00%
91.00%
90.00%
Plot Area
CADE
CADE-APP
CADE-DYN
CADE SPECIAL
FRAME RELAY
ERT
DNP
Summary YTD CADE CADE-APP CADE-DYN CADE-SPECIAL FRAME RELAY ERT DNP Monthly Data
Ready
NUM

VIRTUAL-EMS®

SYSTEM PRODUCTION

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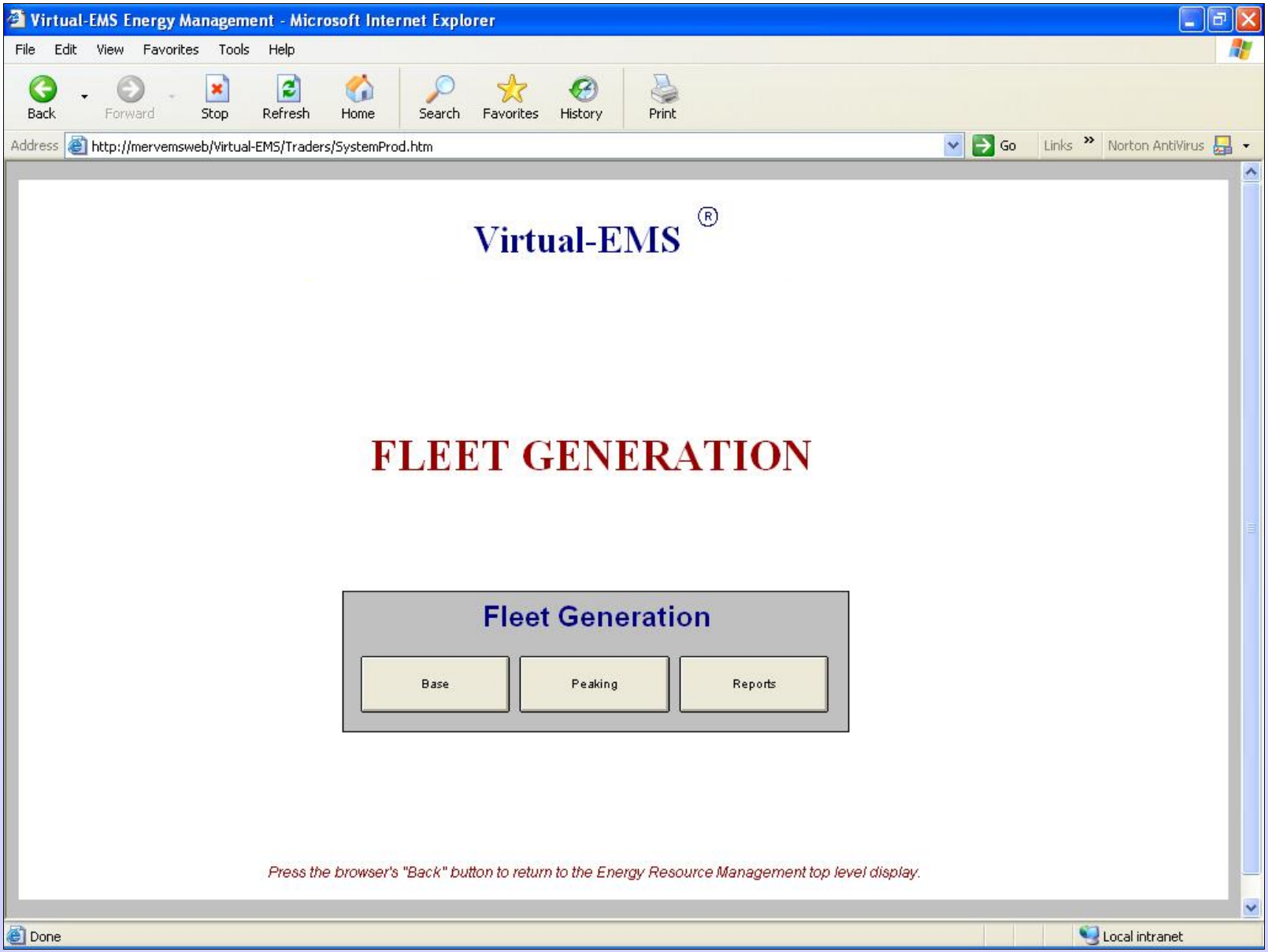
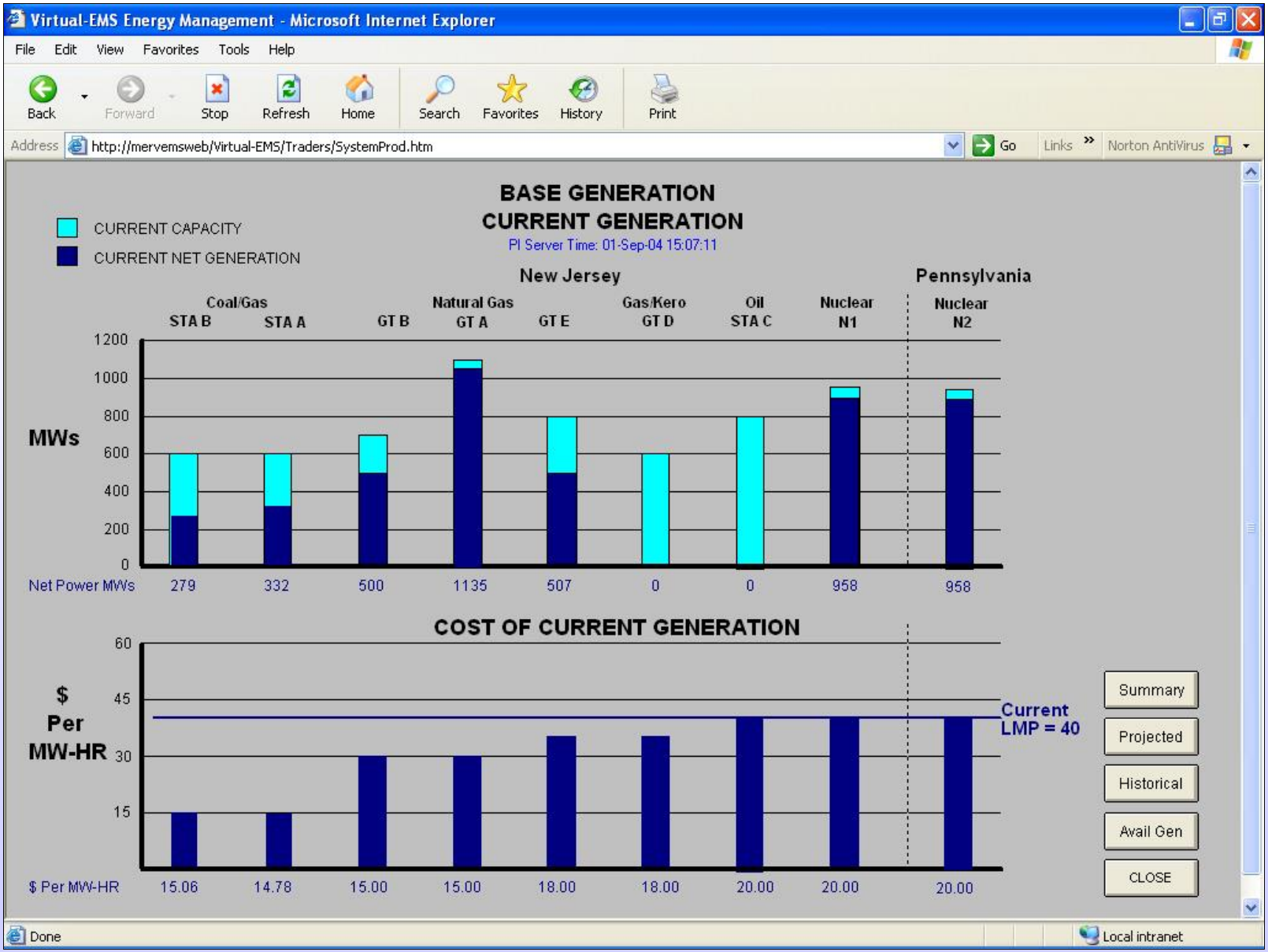
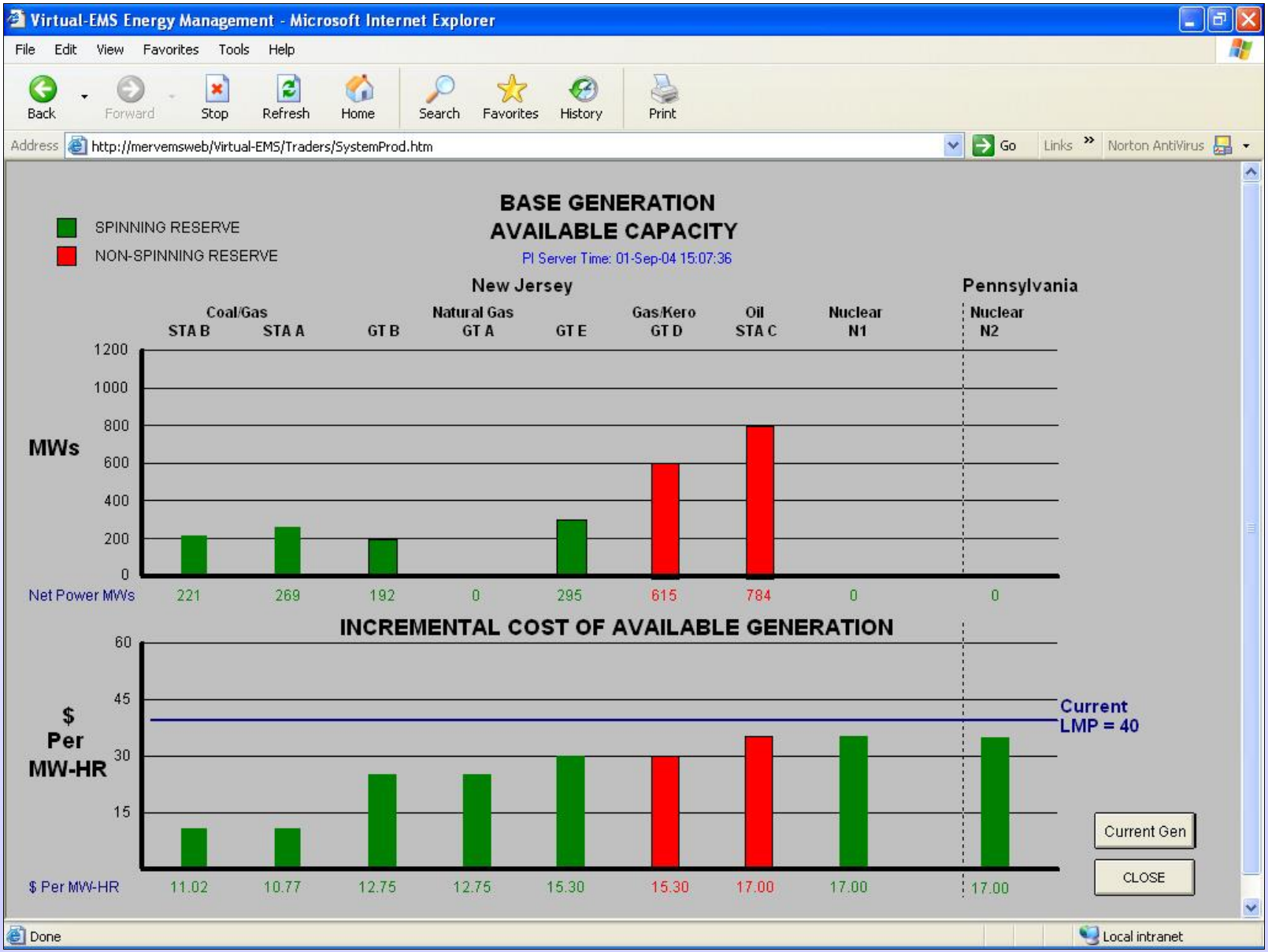
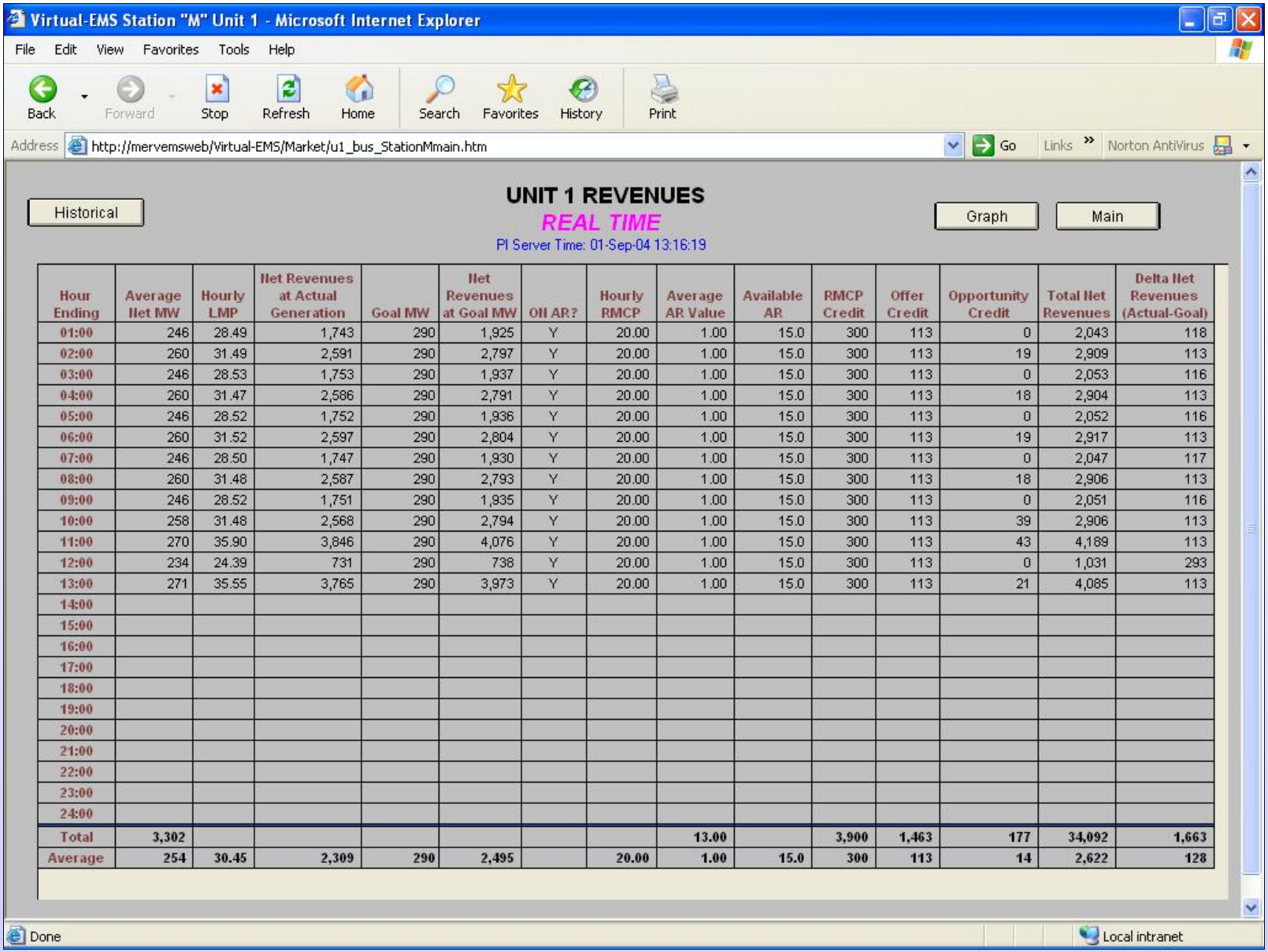

Virtual-EMS Energy Management - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/Traders/SystemProd.htm
Go Links Norton AntiVirus
Virtual-EMS ®
FLEET GENERATION
Fleet Generation
Base
Peaking
Reports
Press the browser's "Back" button to return to the Energy Resource Management top level display.
Done
Local intranet


Virtual-EMS Energy Management - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/Traders/SystemProd.htm
Go Links Norton AntiVirus
BASE GENERATION
CURRENT GENERATION
PI Server Time: 01-Sep-04 15:07:11
CURRENT CAPACITY
CURRENT NET GENERATION
New Jersey
Pennsylvania
Coal/Gas
STA B
STA A
GT B
Natural Gas
GT A
GT E
Gas/Kero
GT D
Oil
STA C
Nuclear
N1
Nuclear
N2
MWs
1200
1000
800
600
400
200
0
Net Power MWs 279 332 500 1135 507 0 0 958 958
COST OF CURRENT GENERATION
$ Per MW-HR
60
45
30
15
Current LMP = 40
$ Per MW-HR 15.06 14.78 15.00 15.00 18.00 18.00 20.00 20.00 20.00
Summary
Projected
Historical
Avail Gen
CLOSE
Done
Local intranet


Virtual-EMS Energy Management - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Print
Address http://mervemsweb/Virtual-EMS/Traders/SystemProd.htm
Go Links Norton AntiVirus
BASE GENERATION
AVAILABLE CAPACITY
SPINNING RESERVE
NON-SPINNING RESERVE
PI Server Time: 01-Sep-04 15:07:36
New Jersey
Pennsylvania
Coal/Gas
Natural Gas
Gas/Kero
Oil
Nuclear
Nuclear
STA B
STA A
GT B
GT A
GT E
GT D
STA C
N1
N2
MWs
1200
1000
800
600
400
200
0
Net Power MWs
221
269
192
0
295
615
784
0
0
INCREMENTAL COST OF AVAILABLE GENERATION
$ Per MW-HR
60
45
30
15
Current LMP = 40
$ Per MW-HR
11.02
10.77
12.75
12.75
15.30
15.30
17.00
17.00
17.00
Current Gen
CLOSE
Done
Local intranet



Hour Ending	Average Net MW	Hourly LMP	Net Revenues at Actual Generation	Goal MW	Net Revenues at Goal MW	OII AR?	Hourly RMCP	Average AR Value	Available AR	RMCP Credit	Offer Credit	Opportunity Credit	Total Net Revenues	Delta Net Revenues (Actual-Goal)
01:00	246	28.49	1,743	290	1,925	Y	20.00	1.00	15.0	300	113	0	2,043	118
02:00	260	31.49	2,591	290	2,797	Y	20.00	1.00	15.0	300	113	19	2,909	113
03:00	246	28.53	1,753	290	1,937	Y	20.00	1.00	15.0	300	113	0	2,053	116
04:00	260	31.47	2,586	290	2,791	Y	20.00	1.00	15.0	300	113	18	2,904	113
05:00	246	28.52	1,752	290	1,936	Y	20.00	1.00	15.0	300	113	0	2,052	116
06:00	260	31.52	2,597	290	2,804	Y	20.00	1.00	15.0	300	113	19	2,917	113
07:00	246	28.50	1,747	290	1,930	Y	20.00	1.00	15.0	300	113	0	2,047	117
08:00	260	31.48	2,587	290	2,793	Y	20.00	1.00	15.0	300	113	18	2,906	113
09:00	246	28.52	1,751	290	1,935	Y	20.00	1.00	15.0	300	113	0	2,051	116
10:00	258	31.48	2,568	290	2,794	Y	20.00	1.00	15.0	300	113	39	2,906	113
11:00	270	35.90	3,846	290	4,076	Y	20.00	1.00	15.0	300	113	43	4,189	113
12:00	234	24.39	731	290	738	Y	20.00	1.00	15.0	300	113	0	1,031	293
13:00	271	35.55	3,765	290	3,973	Y	20.00	1.00	15.0	300	113	21	4,085	113
14:00														
15:00														
16:00														
17:00														
18:00														
19:00														
20:00														
21:00														
22:00														
23:00														
24:00														
Total	**3,302**							**13.00**		**3,900**	**1,463**	**177**	**34,092**	**1,663**
Average	**254**	**30.45**	**2,309**	**290**	**2,495**		**20.00**	**1.00**	**15.0**	**300**	**113**	**14**	**2,622**	**128**

Lessons Learned

- Helps to have good vision
- Concepts are difficult for many users
- Data, data, data – start early with knowledgeable, dedicated resources
- It's going to change, start with a flexible foundation – don't fixate on initial equations, displays or reports
- Train on Displays, not ProcessBook – Use ActiveView or ICE
- Many spin-offs from initial deployment,
- The software is not the issue, culture and data are

Q&A