Applying PROBE for Congestion Analysis and Grid Planning

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Topics

- Analysis Objectives
- Nature of Congestion Cost & Cost Calculation
- What is PROBE ?
- Applying PROBE

Analysis Objectives

1. Characterize Historic Congestion
   - Magnitude
     - Total Cost ???
     - Sample Periods ???
   - Physical Causes
     - Transmission Constraints ???
     - Transmission Outages ???
     - Generation Outages ???
     - Other Constraints (e.g. Voltage Support, DNI, Unit Commitment) ???

Analysis Objectives

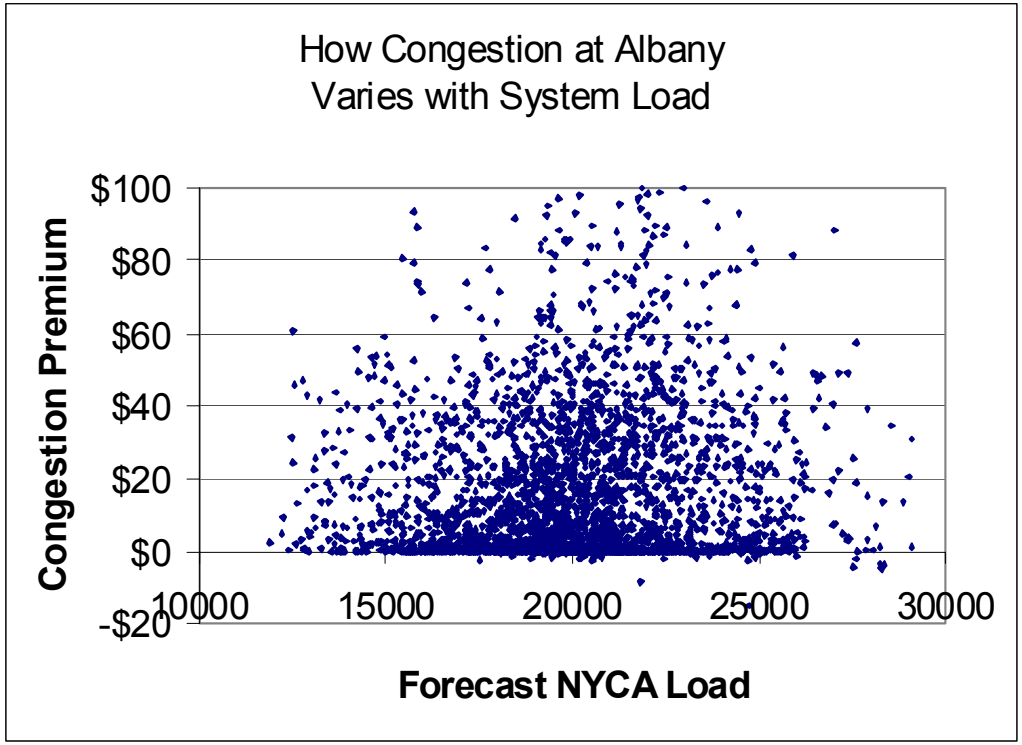
2. Perform “What if” Analysis
   - Total or Sample Congestion Cost ???
   - What Might Have Changes ???
     - Generation
     - Transmission
     - Bids
     - Business Rules

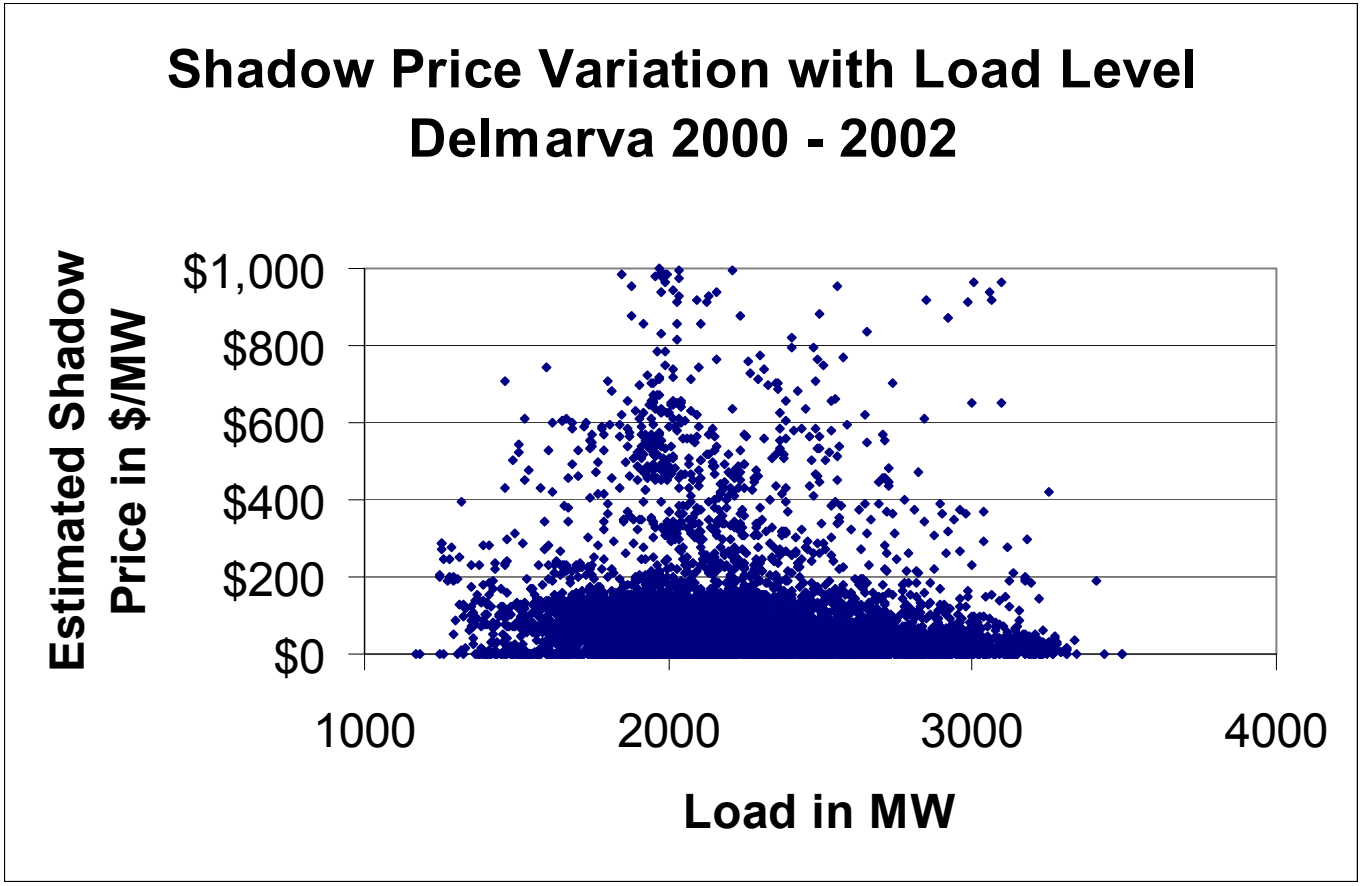
Analysis Objectives

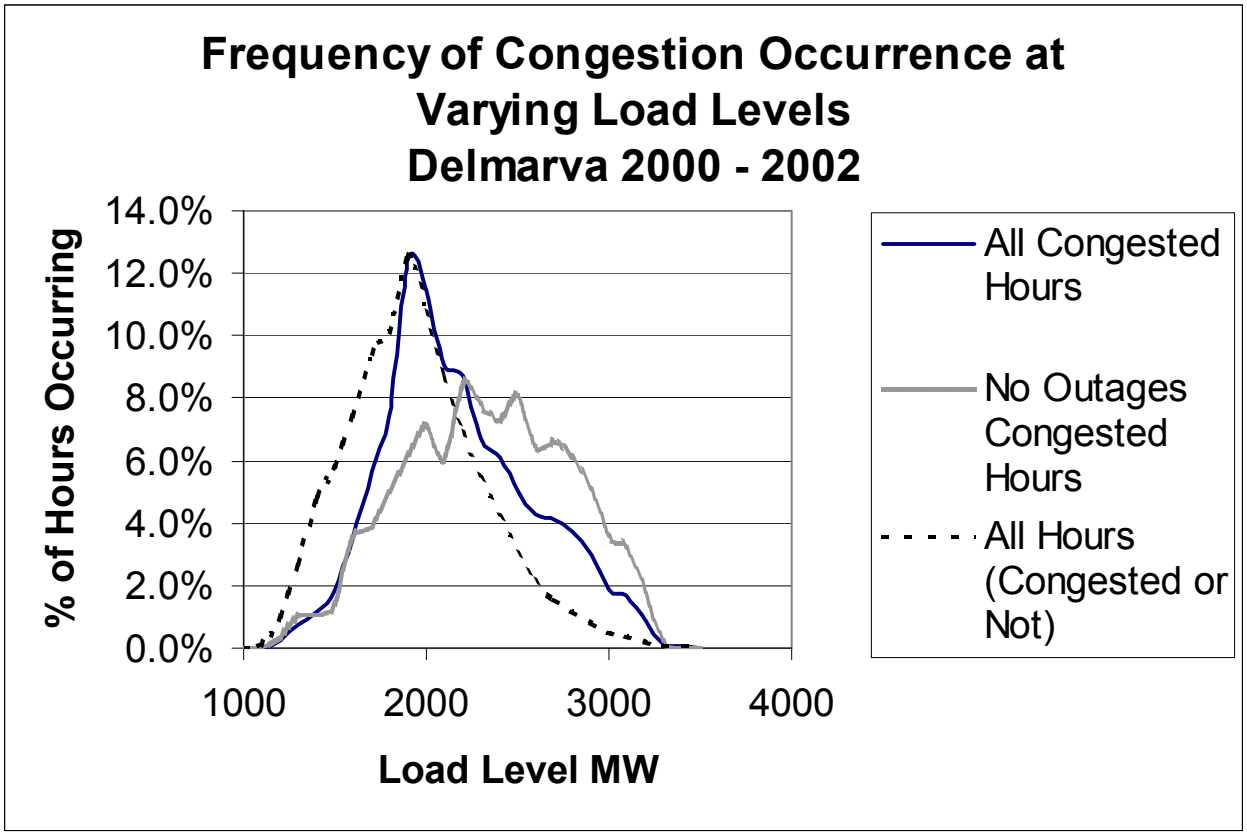
3. Doing Something About Congestion
   - Informing the Market
   - Seeking a Market Response
   - Hedgeable & Unhedgeable Congestion
   - To Address FERC Requirements

Nature of Congestion Cost

- Difficult to Predict Over Both Time and Location




Shadow Price Variation with Load Level
Delmarva 2000 - 2002
Estimated Shadow Price in $/MW
$1,000
$800
$600
$400
$200
$0
1000
2000
3000
4000
Load in MW

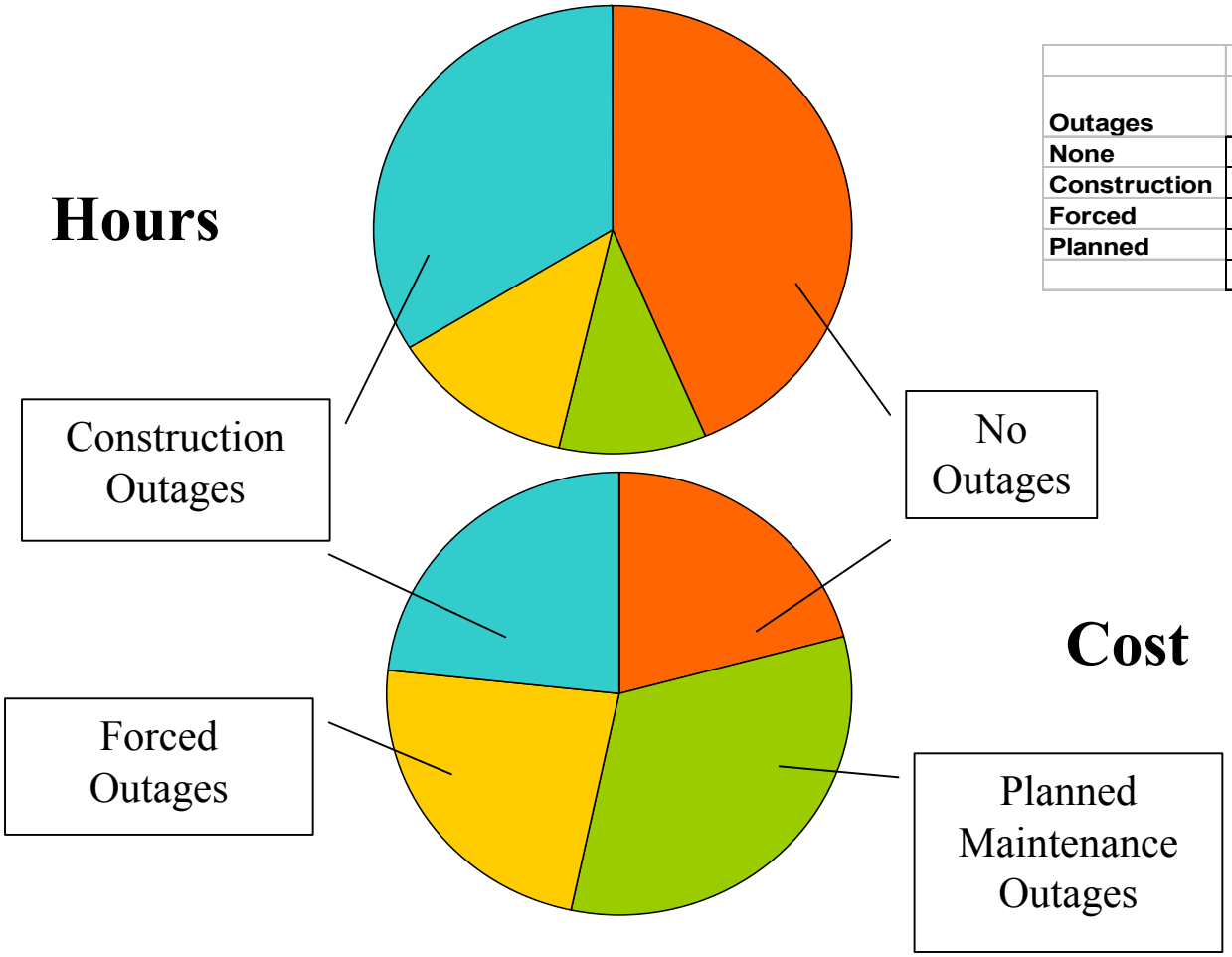


- Does Congestion Increase with Increasing Load Level ?
- Generally **No !**
- Somewhat more frequent congestion with no outages at higher loads

What Causes Congestion At Shoulder Load ?

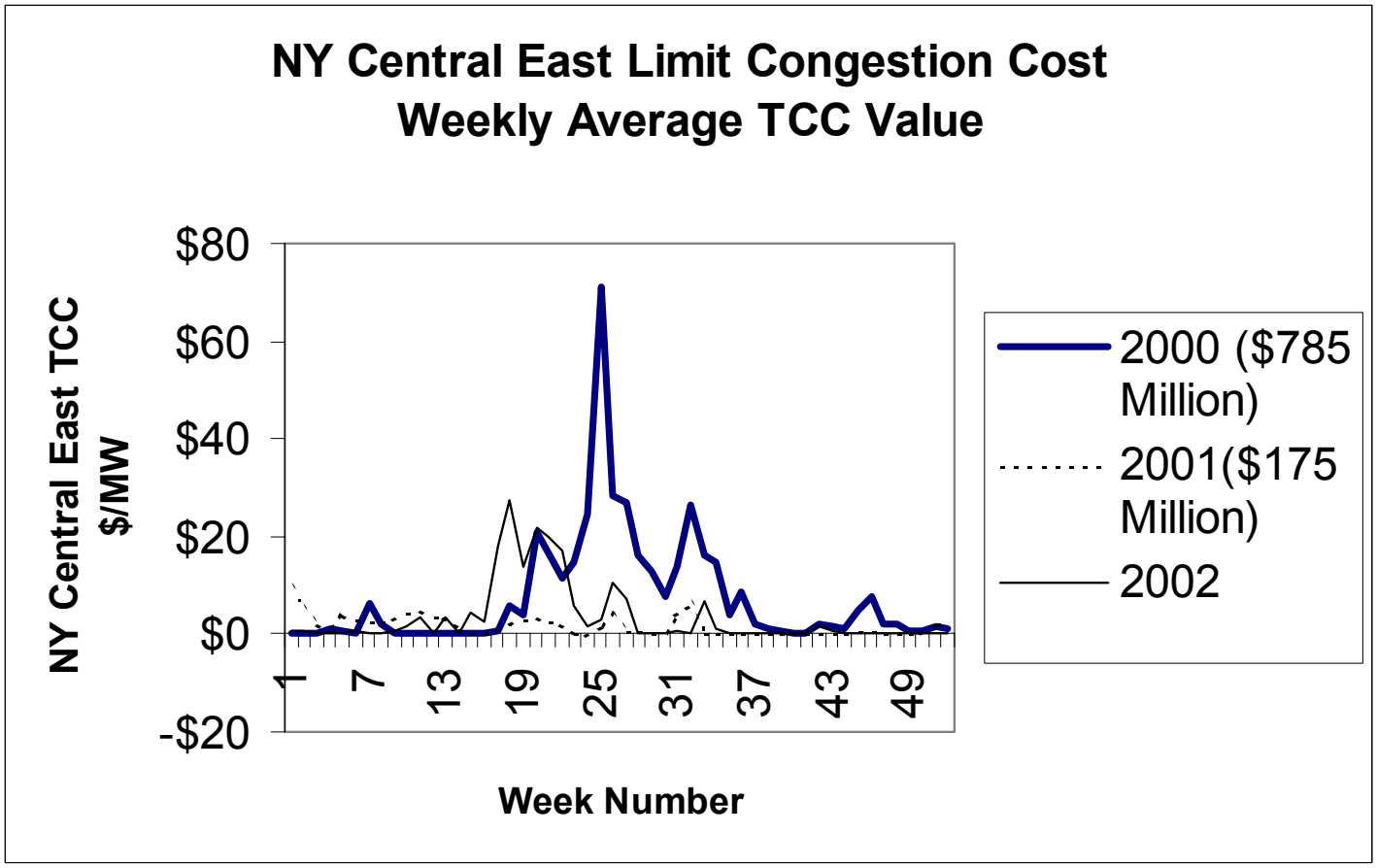
- Transmission Outages
- Generation Outages
- Unit Commitment Decisions and Restrictions
  - Unit Minimums
  - Ramp Rates
  - Minimum Run Times
- Bidding Patterns & Generation Location

Delmarva Peninsula
Summary of Congestion by Cause
August 1999 - August 2002



Outages	Average $/hour
None	$6,774
Construction	$10,000
Forced	$26,667
Planned	$47,143

Congestion Can be Greatly Affected by Network Incidents



Calculating Historic Congestion Cost

- Use Shadow Prices
  - The Shadow Price is the Value of Constraint Relief at the Constraint
  - One Shadow Price for Each Constraint that Reflects All Constraints
  - Cost per Constraint is Shadow Price x Load Affected
  - Total Hourly Cost is Sum of All Constraints Cost
  - Total Cost is the Sum of All Hours
  - Reference Bus not an Issue Since LMP Differences are Used, not Absolutes

Calculating Historic Congestion Cost

- Difficulties Using Historic LMP Data
  - LOTS of data to manipulate
  - Shadow Prices are Not Available
  - Shadow Prices Can Be Estimated from LMP's and Distribution Factors
  - LMP's are Not Available at the Constraint Points
  - Multiple Simultaneous Constraints

- What is the True Cause ?
  - Transmission Maintenance
  - Generation Outages
  - Bidding
  - Generator Characteristics (e.g. ramp rates, min run times)

- What is the True Cost
  - Another Constraint is Likely Limiting if One is Relieved
  - Compare One Constraint at a Time
  - Compare to No Constraints Scenario (?)

Planning from Historic Data

- Will the Future Be Like Yesterday ?
- Day Ahead or Real Time ?
  - The 2 are Very Different
  - DAM Can be Artificial, but that's Where the Money Is !

Opinion – Use Day Ahead

- Simulations Need to Reflect the Realities
  - Outages
  - Bids
  - Multiple Products
  - Business Rules

Opinion – Use Historic Data if Available

- SCUC is not Set-up or Efficient for Simulation and Sensitivity Studies

PROBE is

What is PROBE ?

- PoRtfolio Ownership Bid Evaluation
- Development Begun April 2001
- Market Monitoring Unit (MMU) Application
  - Study Day Ahead Market Congestion Before Accepting Daily Bids
  - Some Application for Testing Market Rule Changes
- Used Since January 2002
- NYISO MMU Uses Routinely Today
- PJM Congestion Planning Application Now in Development

What is PROBE ?

- A “Study Mode” for the NYISO SCUC
- Driven by Same Data as the SCUC
  - Bids (real and virtual, load and generation), Hourly Network Models, Business Rules, TCC Ownership
- Produces Same Hourly Results as SCUC (LMP’s, dispatch, flows, etc.)
- MANY More Reports than SCUC

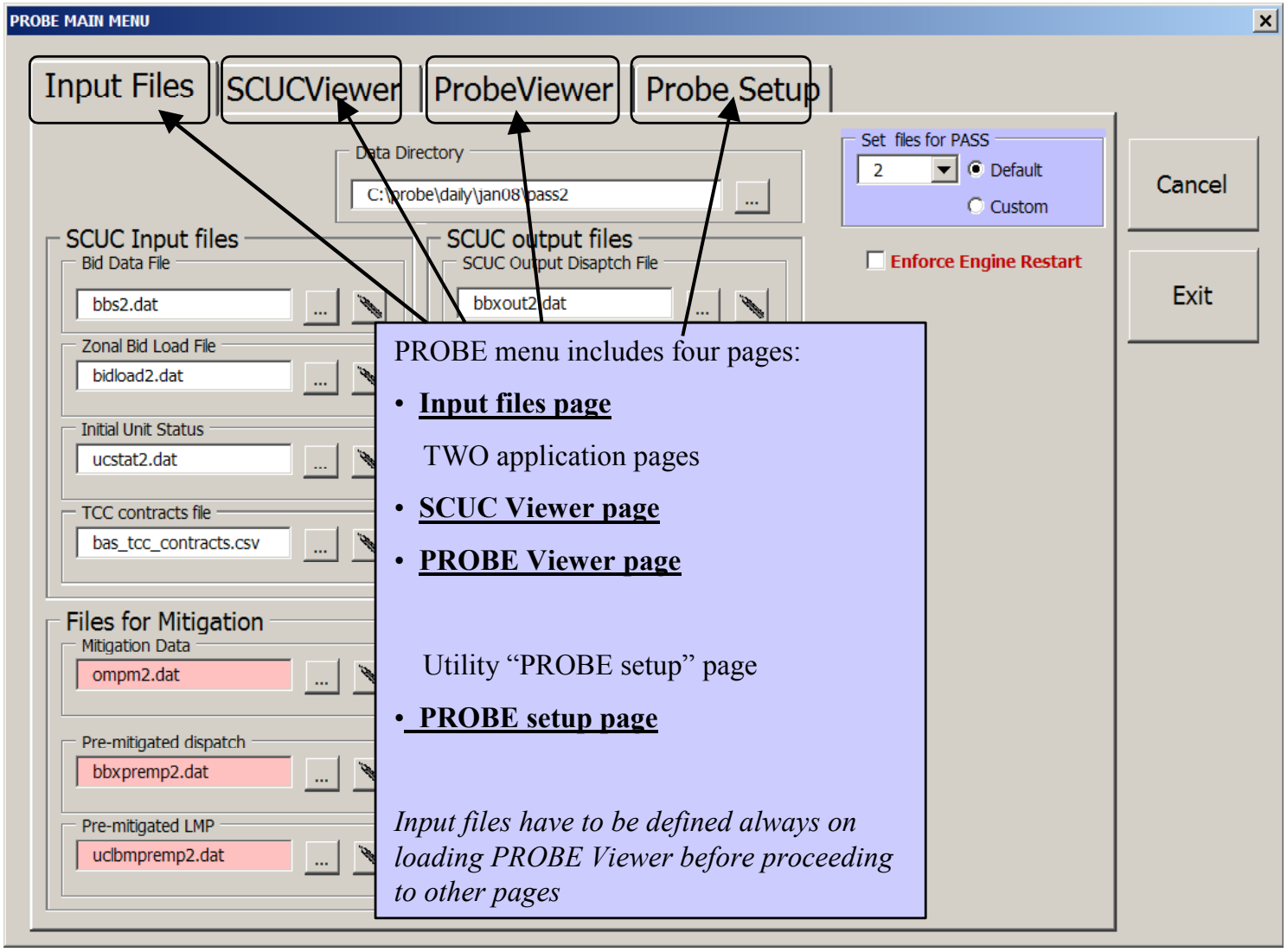
2 Modes

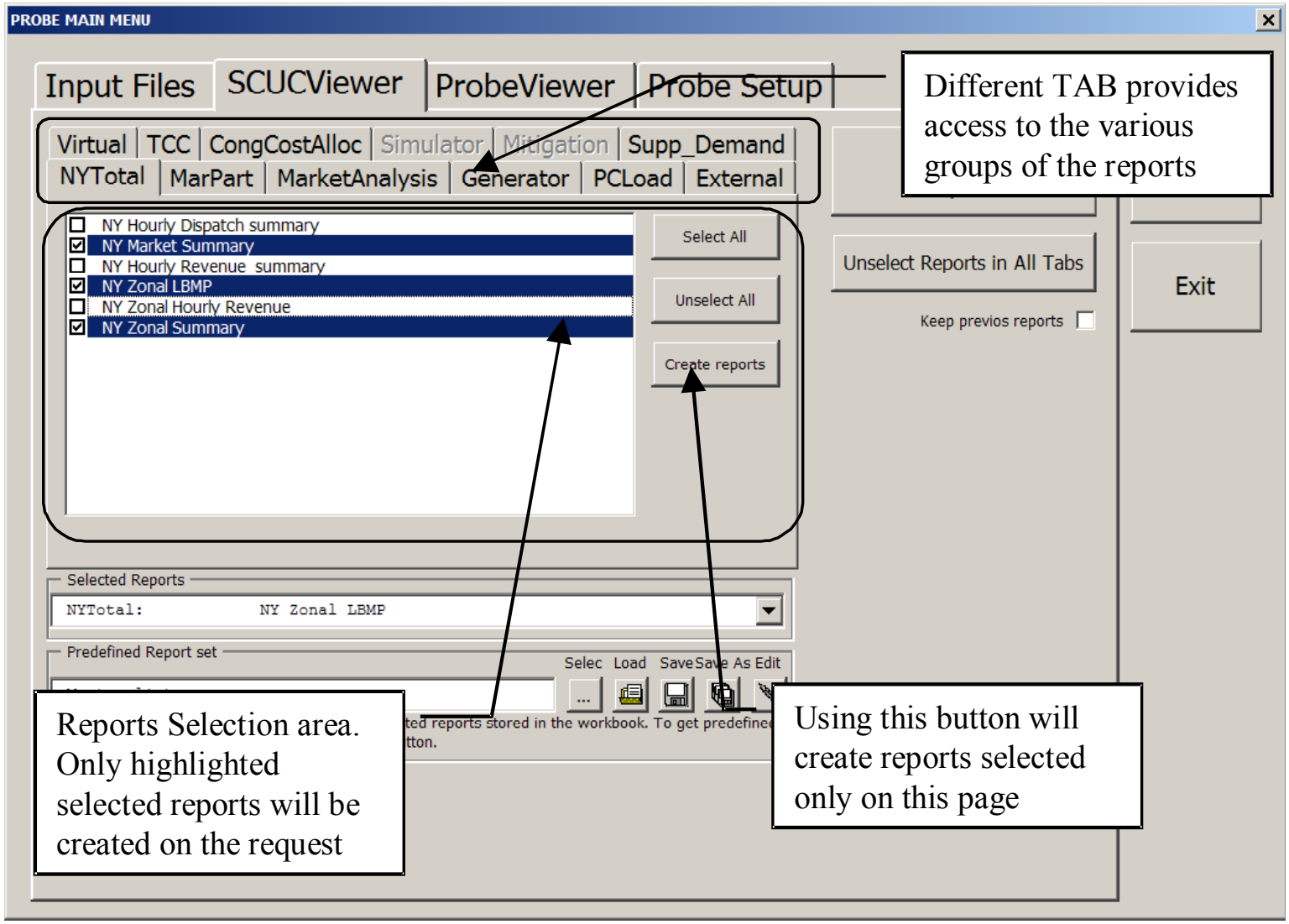
- SCUC Viewer
- Simulation

Same Reports are Available for Both, Plus Comparisons

PROBE Approach

- Read in SCUC Data (Bids, Unit Commitment, Initial Dispatch & More, All Automated)
- Define Portfolios by Bid and Owner (automated)
- Define TCC Ownership (automated)
- Map LMP points to Power Flow Model (automated)
- Perform LP with Given Unit Commitment
- Enforce Ramp Rate Limitations (24 hour simultaneous optimization)
- Transmission Constraints are Either Pre-set Monitored Element/Contingency Combinations or n-1 on a Voltage Level Basis
- Report in EXCEL


PROBE MAIN MENU
Input Files
SCUCViewer
ProbeViewer
Probe Setup
Data Directory
C:\probe\daily\jan08\pass2
Set files for PASS
2
Default
Custom
Cancel
Exit
Enforce Engine Restart
SCUC Input files
Bid Data File
bbs2.dat
Zonal Bid Load File
bidload2.dat
Initial Unit Status
ucstat2.dat
TCC contracts file
bas_tcc_contracts.csv
SCUC output files
SCUC Output Disaptch File
bbxout2.dat
Files for Mitigation
Mitigation Data
ompm2.dat
Pre-mitigated dispatch
bbxpremp2.dat
Pre-mitigated LMP
uclbmpremp2.dat
PROBE menu includes four pages:
• Input files page
TWO application pages
• SCUC Viewer page
• PROBE Viewer page
Utility "PROBE setup" page
• PROBE setup page
Input files have to be defined always on loading PROBE Viewer before proceeding to other pages


PROBE MAIN MENU
Input Files
SCUCViewer
ProbeViewer
Probe Setup
Virtual
TCC
CongCostAlloc
Simulator
Mitigation
Supp_Demand
NYTotal
MarPart
MarketAnalysis
Generator
PCLoad
External
NY Hourly Dispatch summary
NY Market Summary
NY Hourly Revenue summary
NY Zonal LBMP
NY Zonal Hourly Revenue
NY Zonal Summary
Select All
Unselect All
Create reports
Unselect Reports in All Tabs
Keep previos reports
Exit
Selected Reports
NYTotal: NY Zonal LBMP
Predefined Report set
Selec
Load
Save
Save As
Edit
Different TAB provides access to the various groups of the reports
Reports Selection area. Only highlighted selected reports will be created on the request
Using this button will create reports selected only on this page

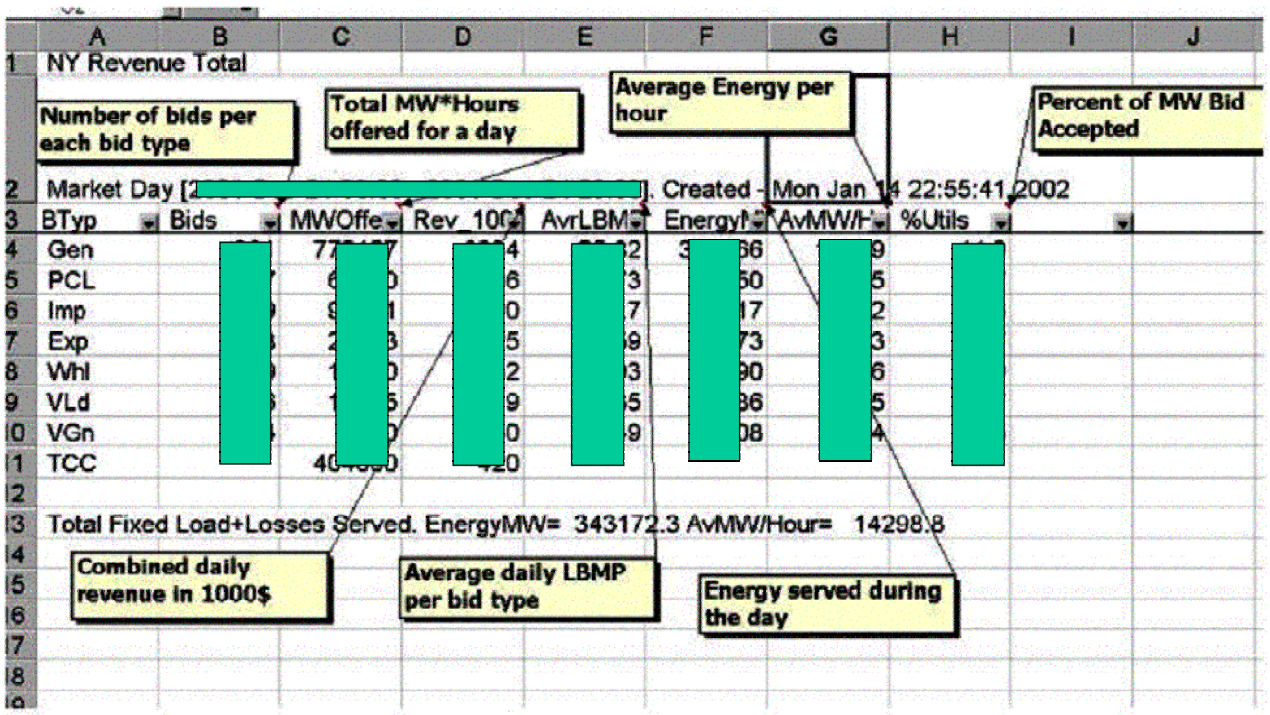
PROBE Advantages

- Much Faster then SCUC (2 Minutes vs. 2 Hours)
- Network Data is Available for Sensitivity Testing
- Many More Reports then SCUC
- Reports Out to EXCEL
- Real Shadow Prices are Calculated and Loads are Known
- Software Changes Can be Done Without Affecting Production SCUC Tool

PROBE Reports

- Market Summaries by State, Zone
- Revenue by Type (Generation, Load, TCC, Imports, Wheels, etc.)
- Revenue by Market Participant and Portfolio
- Supply and Demand Curves
- Bid Details
- Congestion Cost by Constraint by State, Zone, or Market Participant

Sample Summary Report



Congestion Cost Summary Example

Report on zonal congestion cost by constraints (Load=Fixed+PCL+VL-VS). Generator weighted
Market Day [1941-Dec-07 00:00 - 1941-Dec-07 23:00]. Created - Wed Sep 18 10:40:21 1943. Version
Total Day Load= 570310 MW. Hour Average= 23763 MW/H

Constraint	Contingency	TotCong$	Cong$/MW
=== Energy+Losses		$26,191,286	45.925
Jim 138 Boris 138 1	BASE CASE	$2,608	0.005
Jim 138 Boris 138 2	BASE CASE	$26,576	0.047
John__ 138 Steve 138 1	BASE CASE	$89,318	0.157
Bill 138 Steve 138 1	BASE CASE	$2,012	0.004
Interface	BASE CASE	$16,513,594	28.955
John 138 Steve 138 1	TWR: 22 21 A2253	$292,402	0.513

Total and per constraint cost is also available by hour, zone, market participant

PROBE Limitations
(Can Mostly be Removed as Needed)

- No Unit Commitment
  - Incremental Unit Commitment Being Added this Year
- No Ancillary Services Consideration
  - Being Added Today
- Day Ahead Market Only
- Single Day Only
- Not Configured for Multiple Periods
- Network Sensitivity Studies Capability Clumsy Today
- Previous Day's Unit Status is a Given
- Losses Handled with SCUC Loss Penalty Factors
- Somewhat Limited Contingency Specification

Congestion Cost Calculation Application

- Idea
  - Modify Software to Automate Multiple Days and Collect Data from NYISO Archives
  - Get all Data from 1/1/03 and run through PROBE
  - Summarize Results
  - Produce Monthly Summaries Going Forward

  - Questions
    - All days needed ?
      - SCUC data format changes complicate going backwards too far
    - What about successively releasing constraints?
    - Get down to no constraints ?
    - What Results are Desired ?
      - By branch, Base case & contingency, By Zone

Congestion Analysis Application

- Idea
  - Modify Software to Plan/Evaluate Transmission Plans on Market Prices
    - Some of the needed changes are being done for PJM and will be available to NYISO
  - Use Actual Day Ahead Market Information (Bids, Generator Characteristics) as the Cost Basis
  - Make Network Changes and Test Effect

- Questions & Notes
  - Base Congestion Planning Evaluation on Selected Sample Days ?
  - Automating Network Changes My be Tricky Using IDEVs
  - What About “Unusual” Events