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T&D USERS GROUP MEETING
September 20-22 | New Orleans, LA

Needle in a Haystack:
Using AF and Seeq to Find Operational Issues

Joel Koepke
Supervisor of Grid Applications Development

2/12/19

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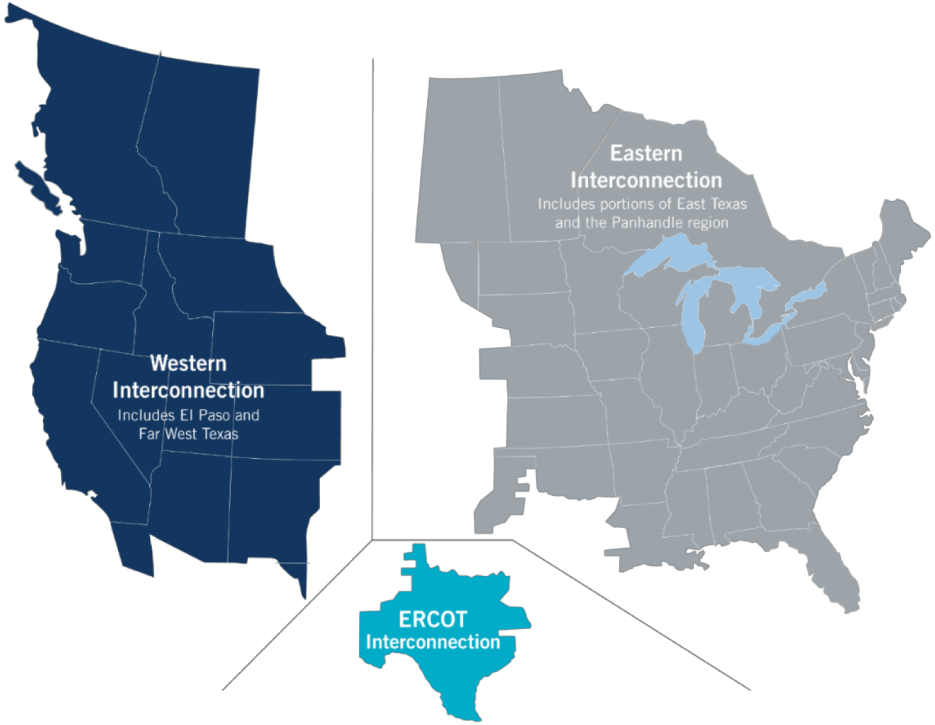
What is ERCOT?

The Texas Legislature restructured the Texas electric market in 1999 and assigned ERCOT four primary responsibilities:

- **System reliability**
- **Competitive wholesale market**
- **Open access to transmission**
- **Competitive retail market**



ERCOT is a nonprofit organization that is regulated by the Public Utility Commission of Texas, with oversight by the Texas Legislature.

ERCOT is not a market participant and does not own generation or transmission/distribution wires.

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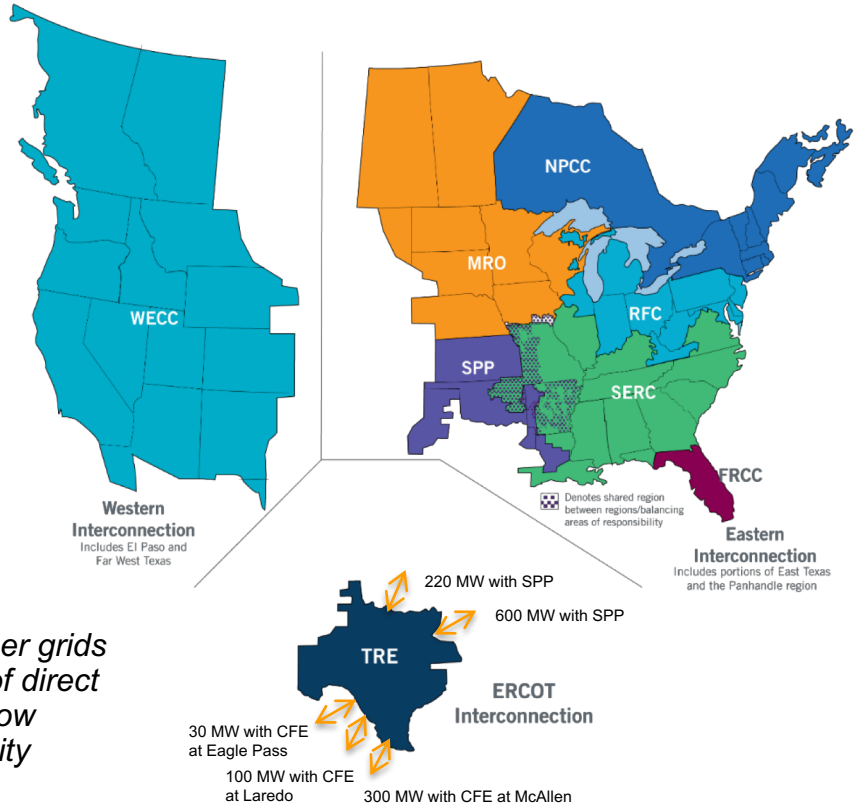
The ERCOT Region

The interconnected electrical system serving most of Texas, with limited external connections

- 90% of Texas electric load; 75% of Texas land
- 71,110 MW peak, August 11, 2016
- More than 46,500 miles of transmission lines
- 570+ generation units

ERCOT connections to other grids are limited to ~1,250 MW of direct current (DC) ties, which allow control over flow of electricity



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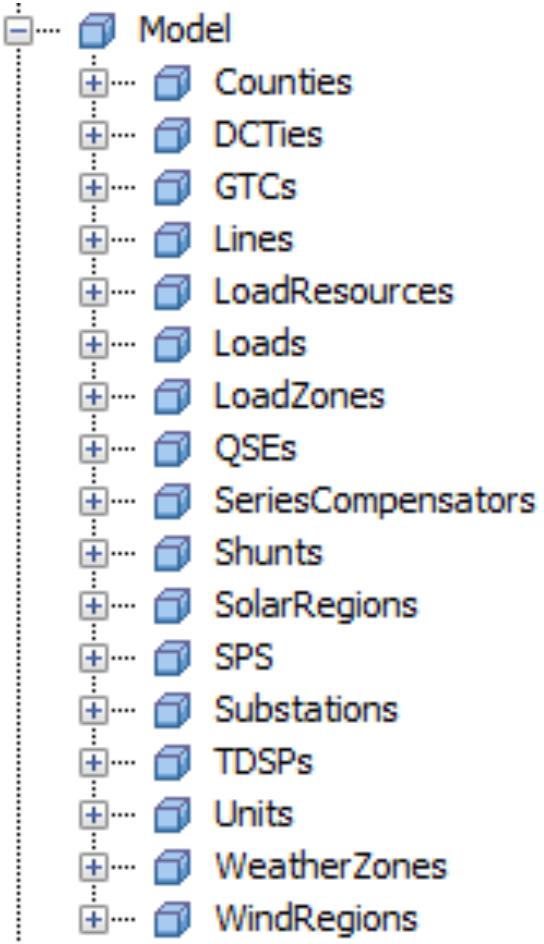
ERCOT OSIsoft Information

- ~500k tags
- ~40k assets modeled
  - Units, loads, lines, shunts
- Same assets grouped in different hierarchies
  - Substation, County, Zones, Owners
  - Allows for easier rollup analyses
- Perform database load weekly



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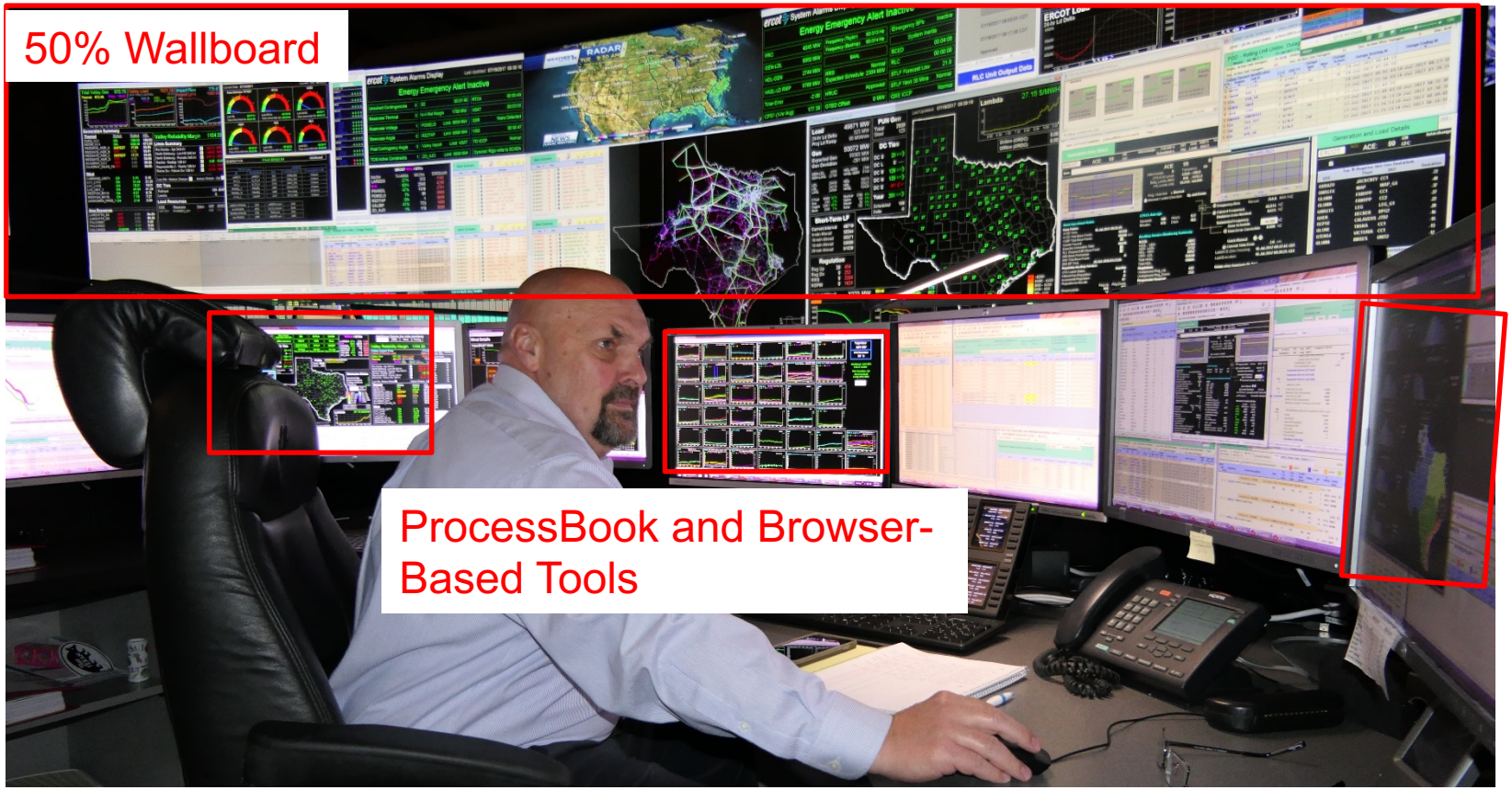
Use of PI at ERCOT – Situational Awareness



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Event Background

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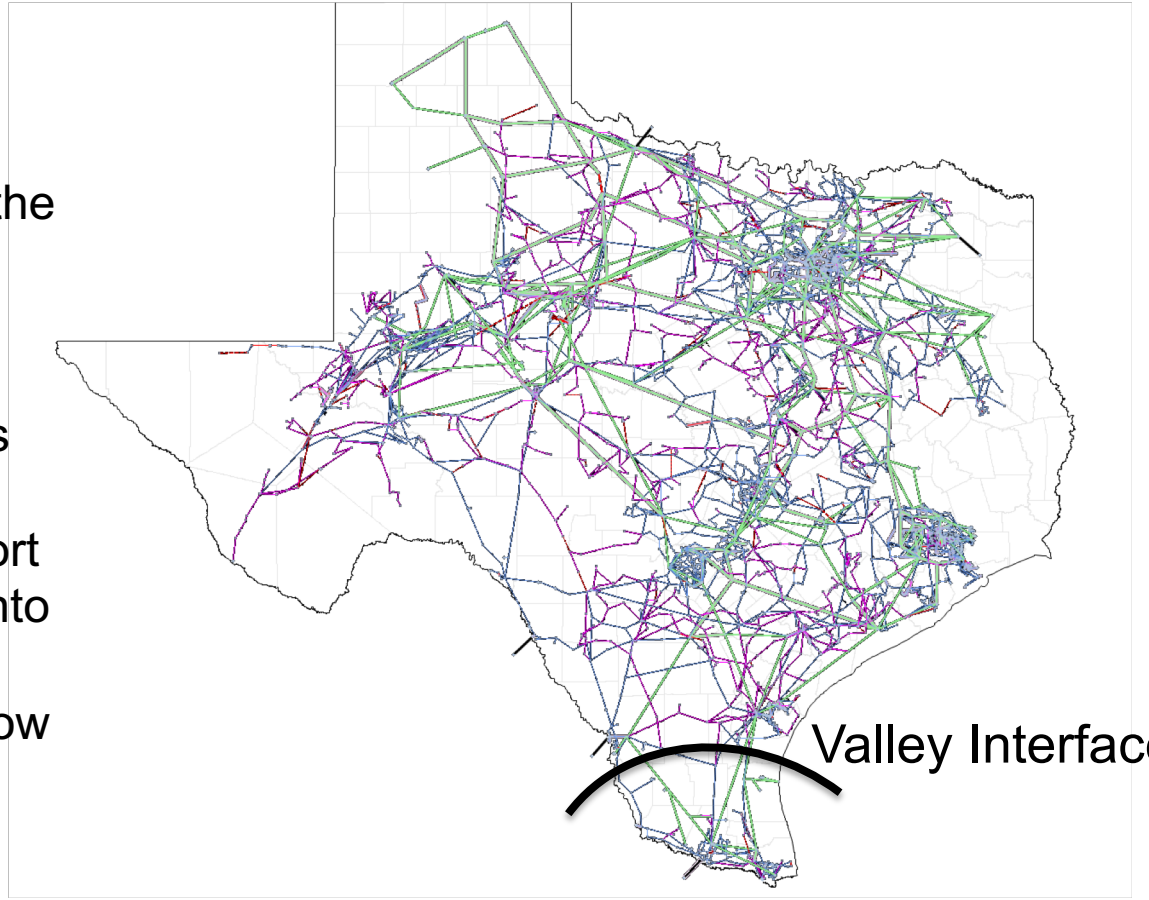
Rio Grande Valley

- Large population
- Far away from “the rest of the grid”
- Local generation does not cover the local load
- Unique transmission issues require an import limit
- Operators monitor the import using a collection of lines into the Valley
- Prices get high when the flow is close to the limit



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Starting Point of Most Investigations…

Operators are constantly monitor the MW **FLOW** into the Valley

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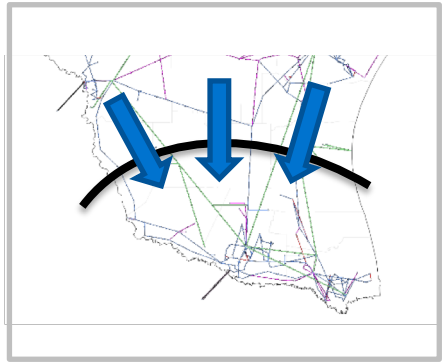
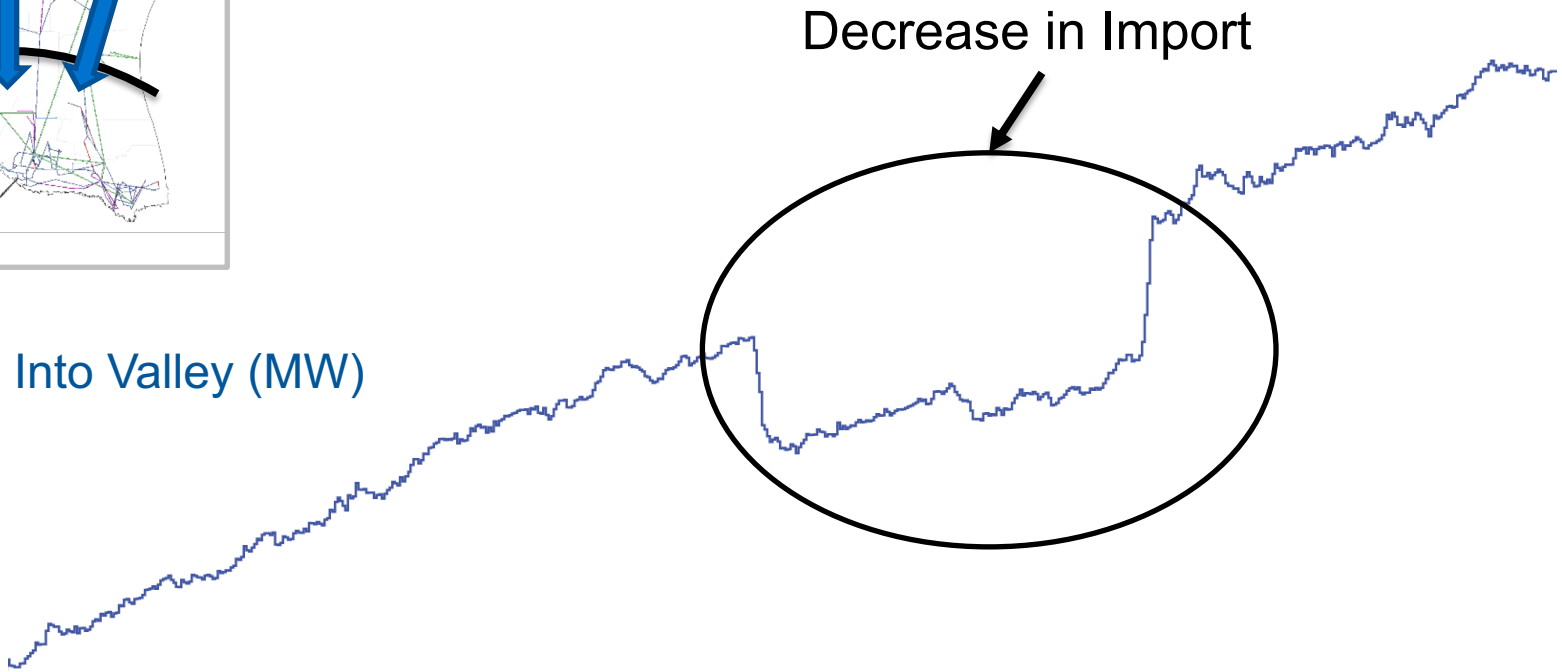
Event of Interest



Flow Into Valley (MW)



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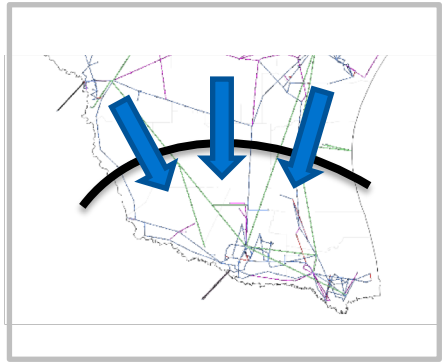
Event of Interest



Price Signal ($/MWh)

Flow Into Valley (MW)

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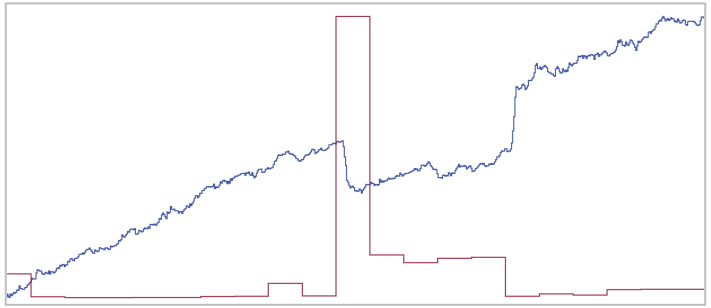
Investigative Assignment



- Of the 200+ loads within the Valley:
  1. Which loads are price-sensitive?
  2. How long has this been going on?
  3. When do they respond?
- Provide a way to give awareness of these loads to the Operators

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Old Methods For Answering These Questions

- Create a spreadsheet!
  - No thanks. There are too many spreadsheets
- Maybe write some custom code?
  - Fun, but not the best use of time
- Visually review all the loads.
  - Not fun, not the best use of time

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Instead We Used Seeq Workbench

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What Is Seeq Workbench?

- Seeq is an OSIsoft Partner Vendor
- Workbench is an interactive data analytics tool
  - Allows for ad-hoc investigation of your data
  - Interfaces with PI and AF databases
  - Browser-based application (no local installs!)
  - Designed for easy collaboration and sharing
- ERCOT recently subscribed to a two-year site license

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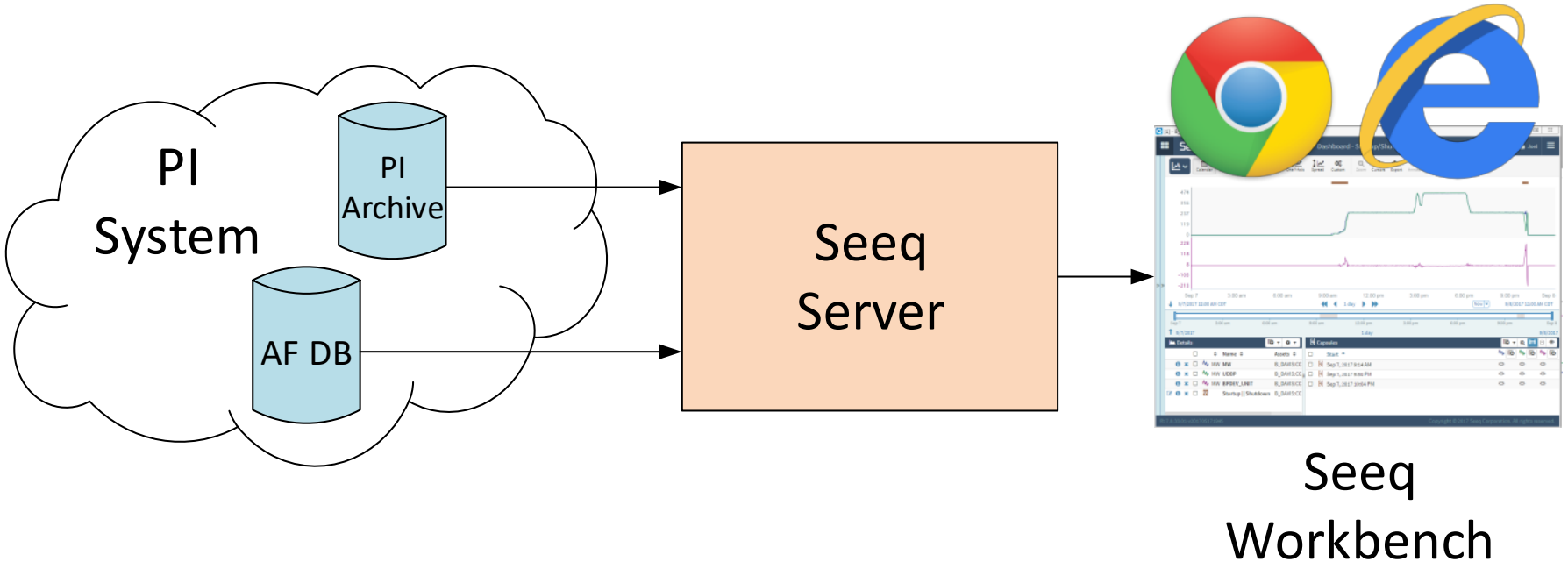
Seeq Data Flow



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Seeq Key Concept – The Capsule

- A capsule marks a range of time based on defined rules
  - Similar to an Event Frame
- Capsules can be triggered based on:
  - Time
  - Values
  - Other advanced logic
- Capsules can be combined using Boolean logic
  - AND, OR, NOT, etc.
- Main tool ERCOT uses to perform data analytics and “find” events

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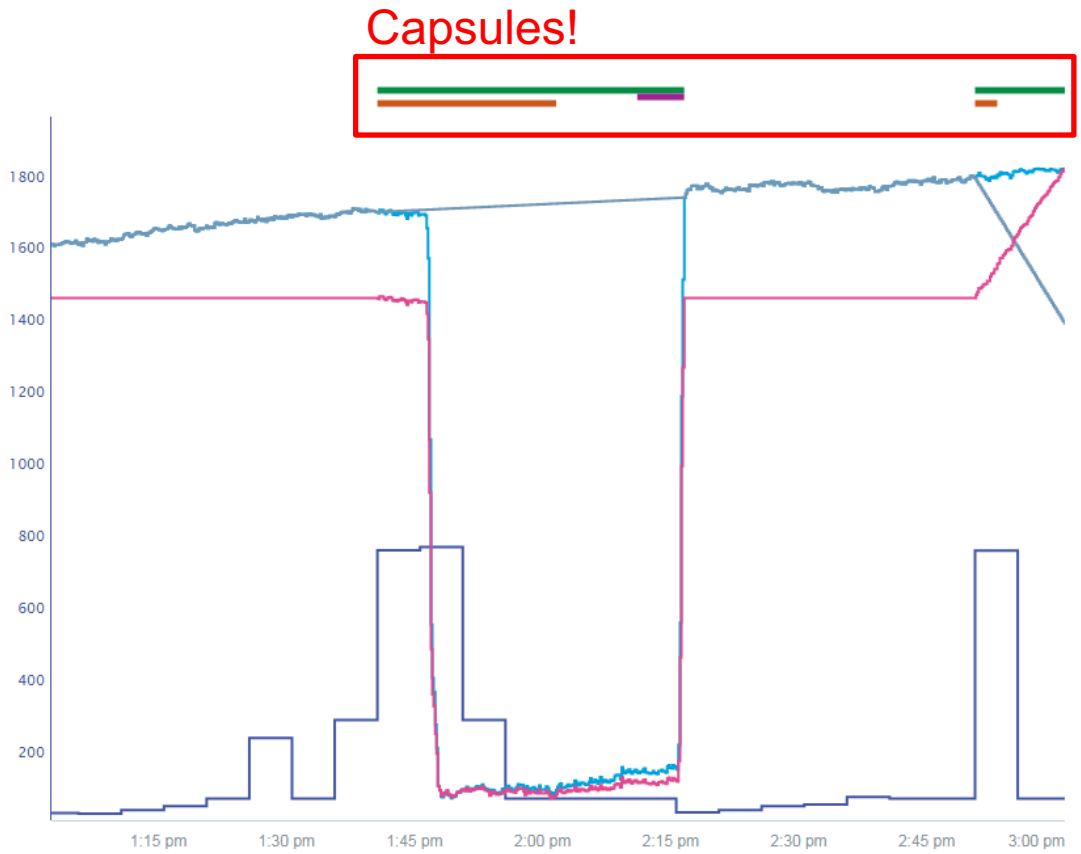
Capsules



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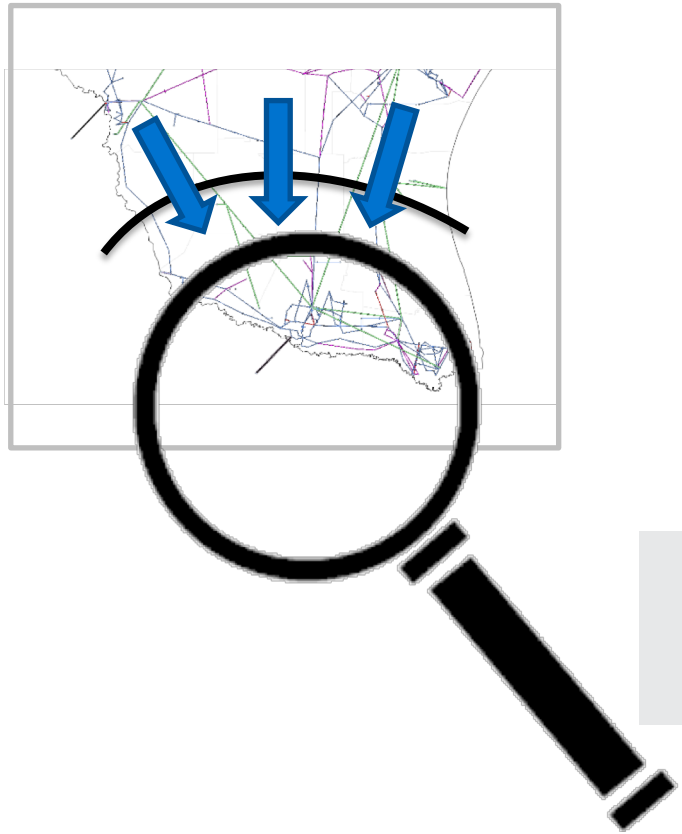

Finding The Loads

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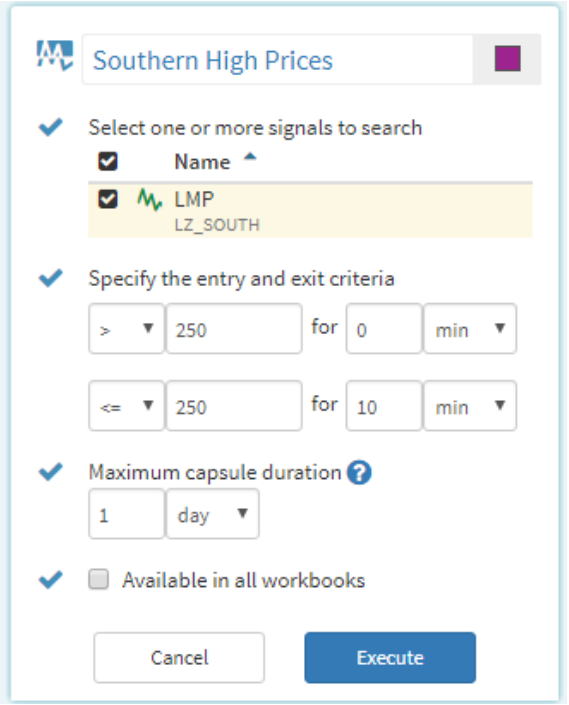
Creating Capsules in Seeq – Finding High Price Events



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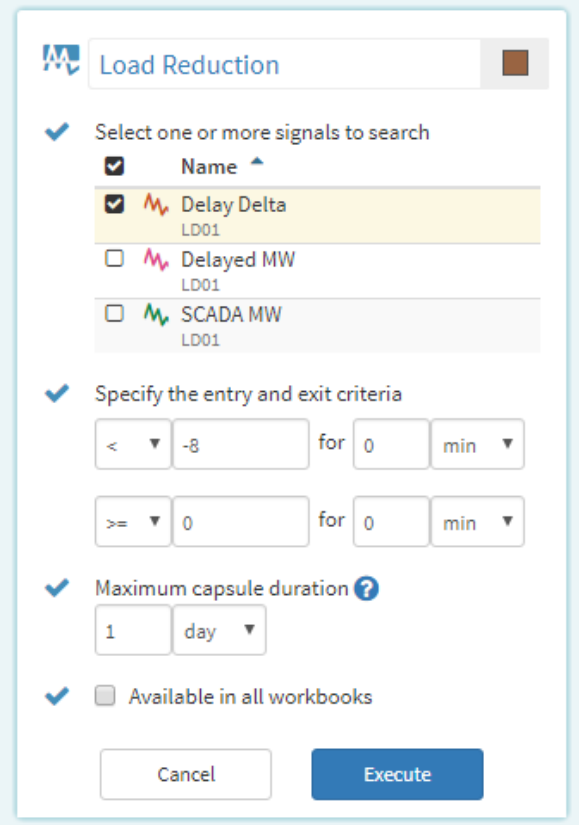
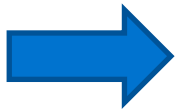
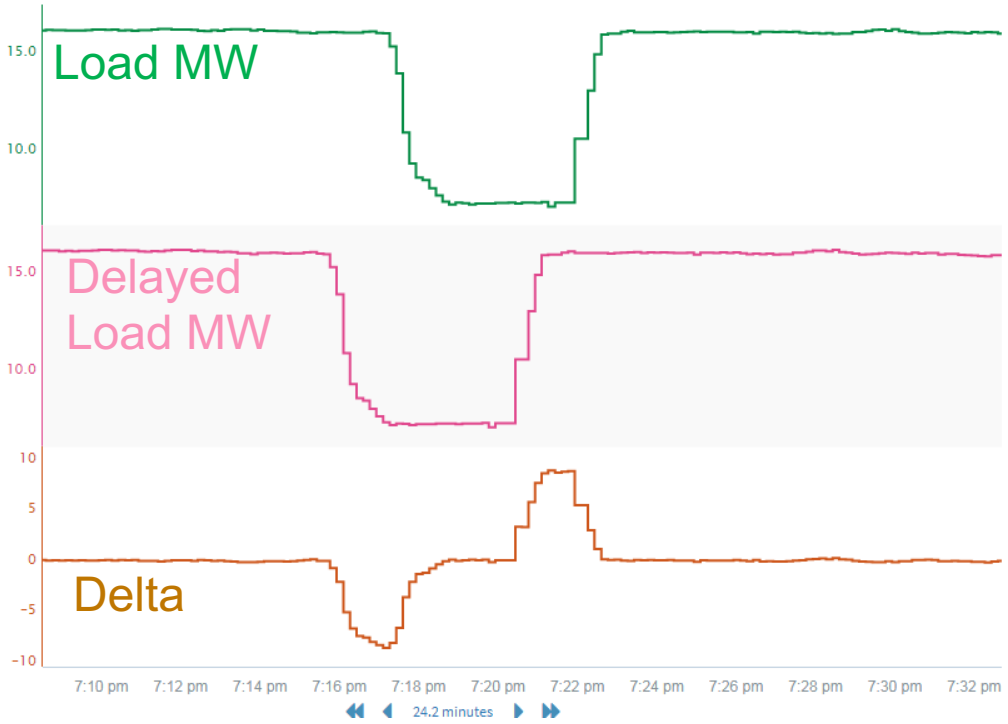
Creating Capsules in Seeq – Finding Load Reductions







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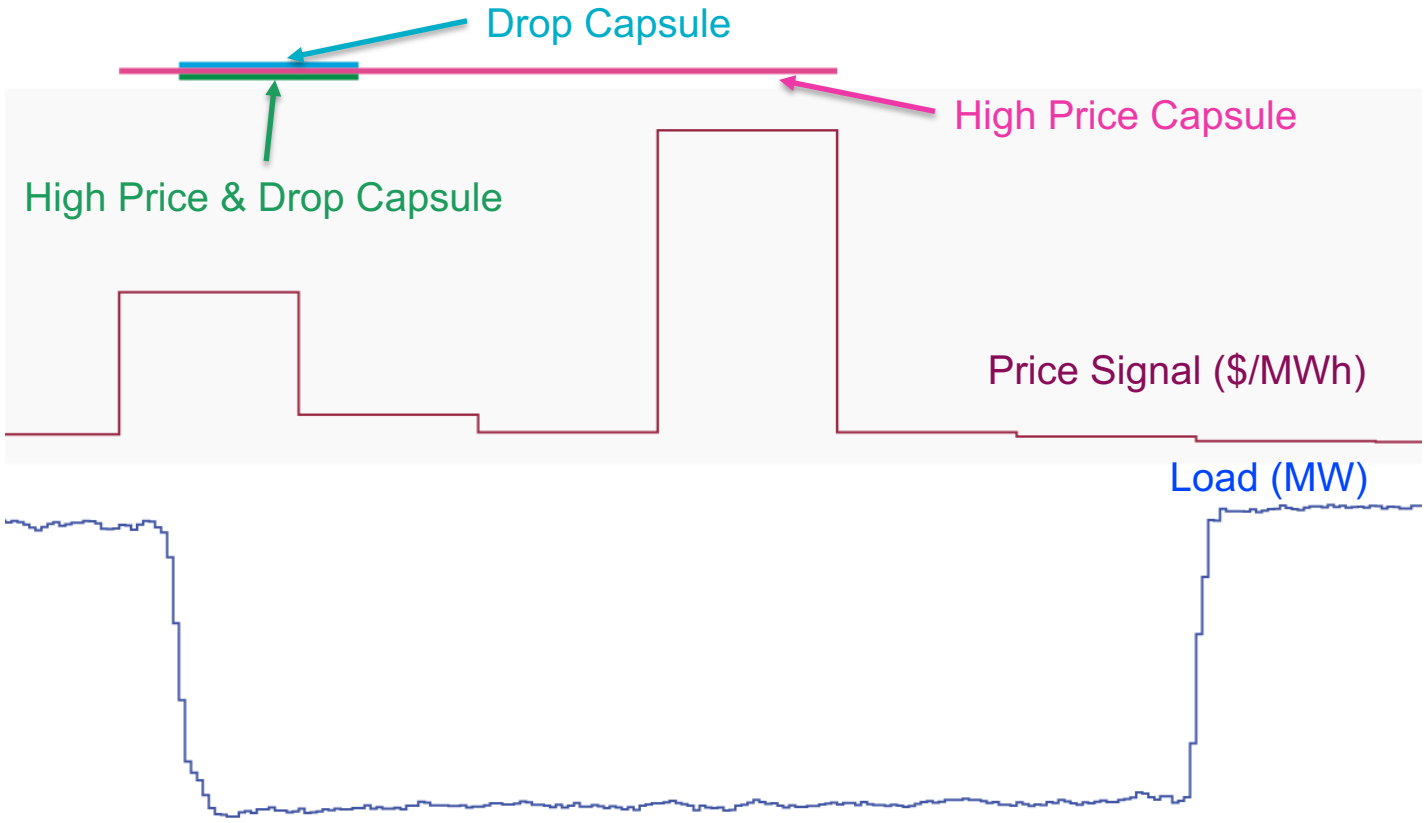
Combining Capsules – High Prices and Load Reduction



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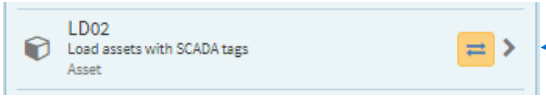
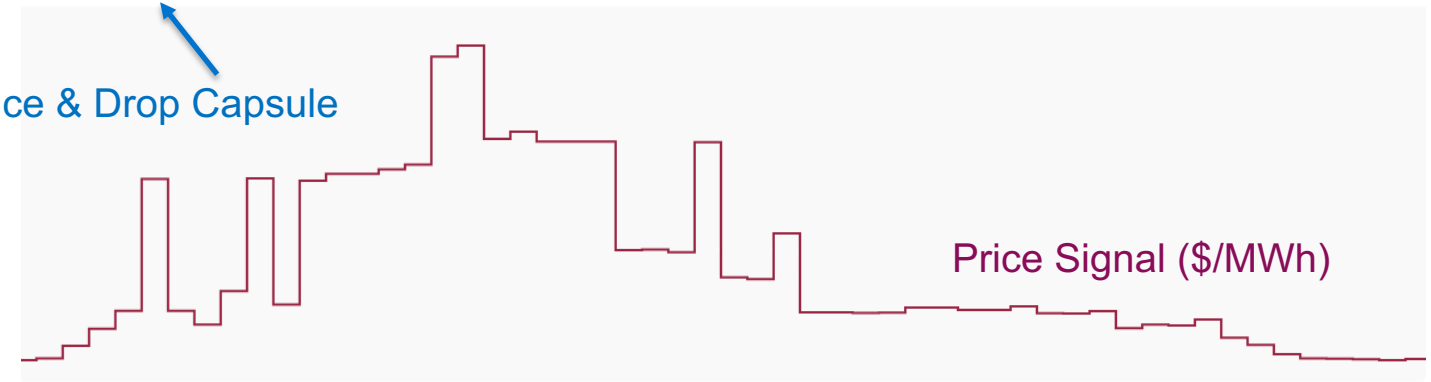
Asset Swapping



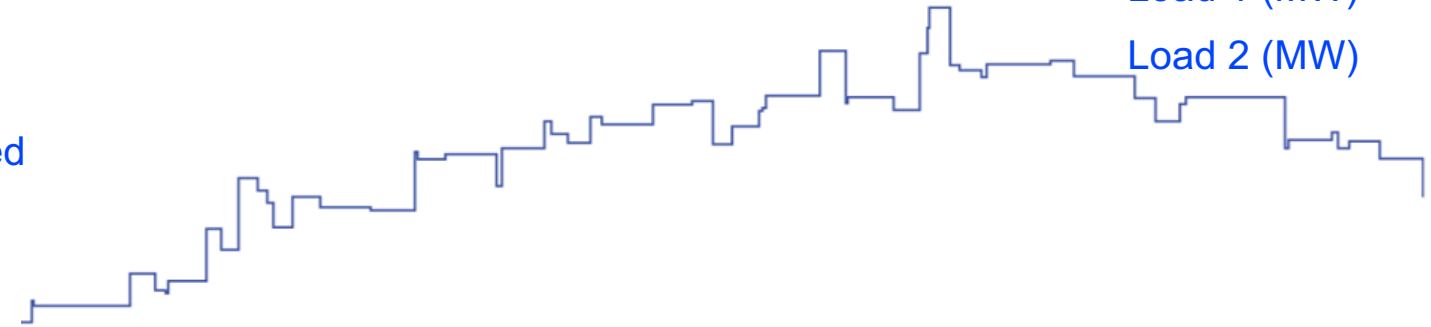
Click the swap button

High Price & Drop Capsule



Load 1 (MW)

Load 2 (MW)



Here we see Load 1 and Load 2 have an obvious load reductions tied to high prices

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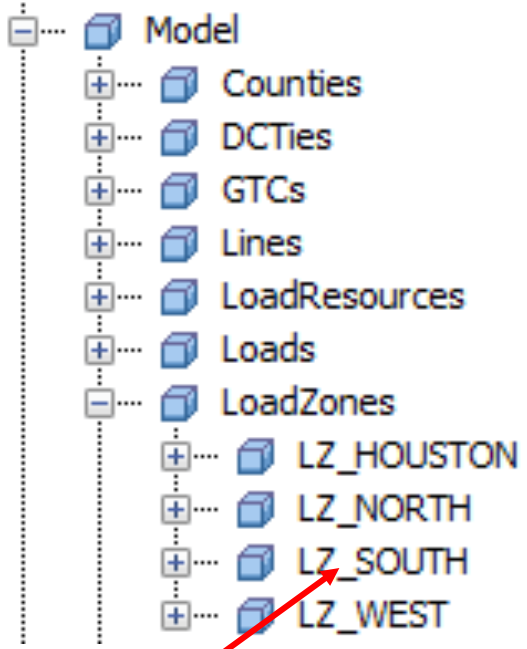
Automating the Process – Outer Loop

- Using the Seeq SDK we automated:
  1. Copying the high-price/load-reduction template worksheet
  2. Adjusting the investigative time range
  3. Swapping the AF-modeled Load asset
  4. Looping through all Loads in the Southern zone.



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Automating the Process – Inner Loop

- After each Asset swap the code:
  - Determines if the combination of required capsules existed.
    - If yes, then keep the Seeq Worksheet
    - If no, delete the Seeq Worksheet

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Results

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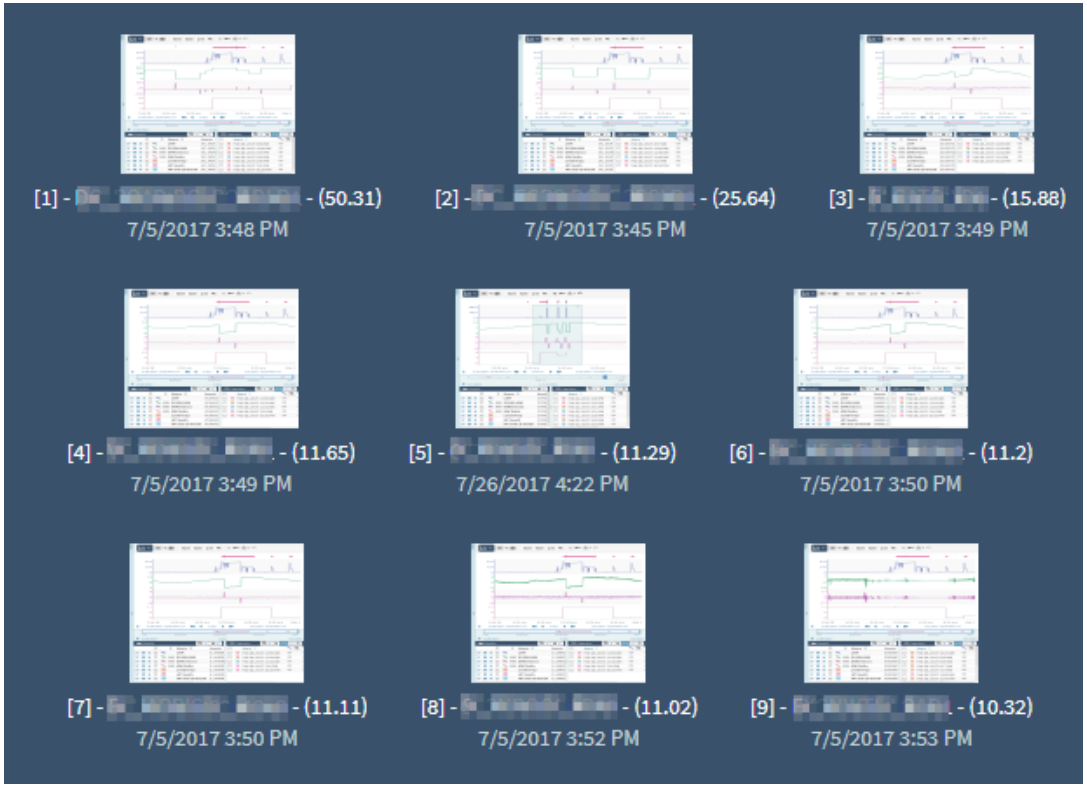
Results – All The Price-Responsive Load



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Programmatically Created Worksheet

A worksheet is created for all loads having the required capsules during a given time range.

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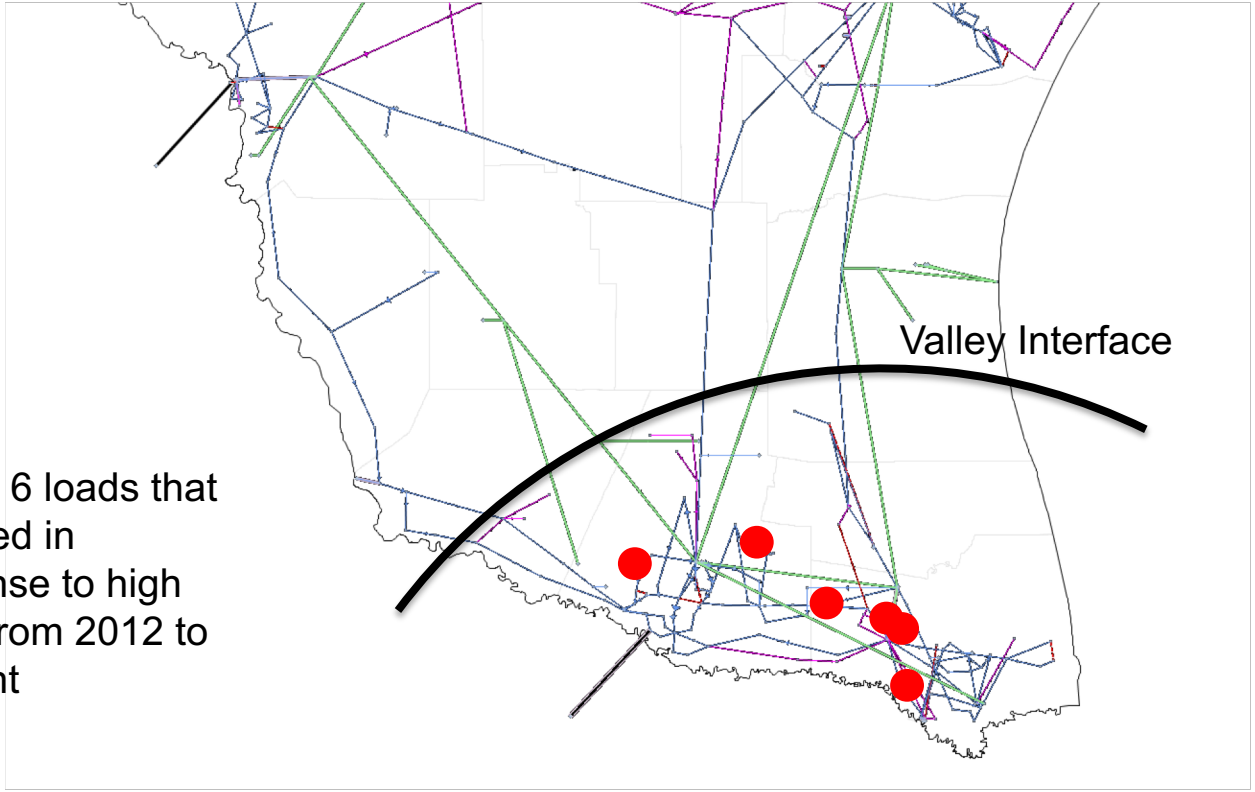
Needles Found - Price Sensitive Loads

Found 6 loads that dropped in response to high price from 2012 to present



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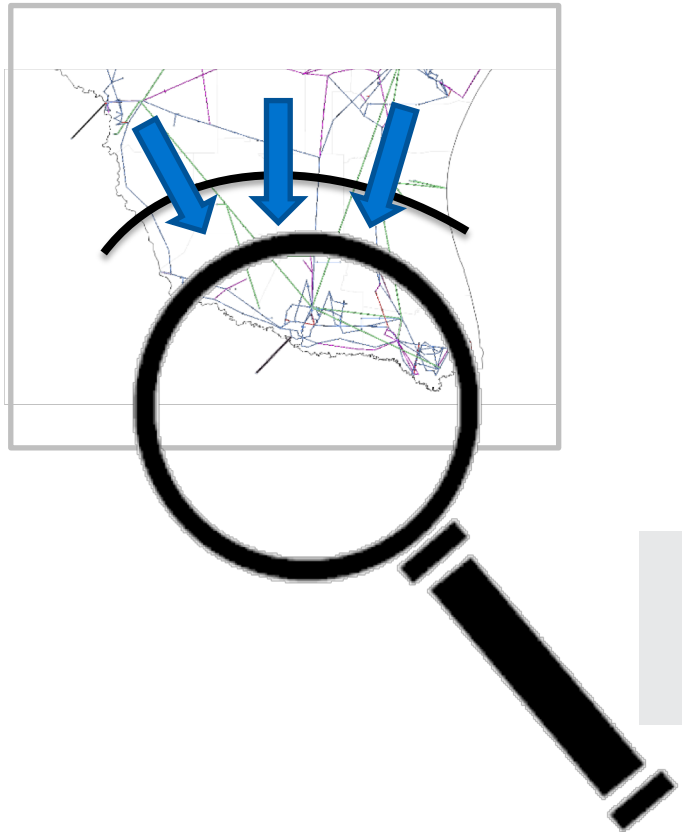

Finding The Loads

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Characterizing the Loads

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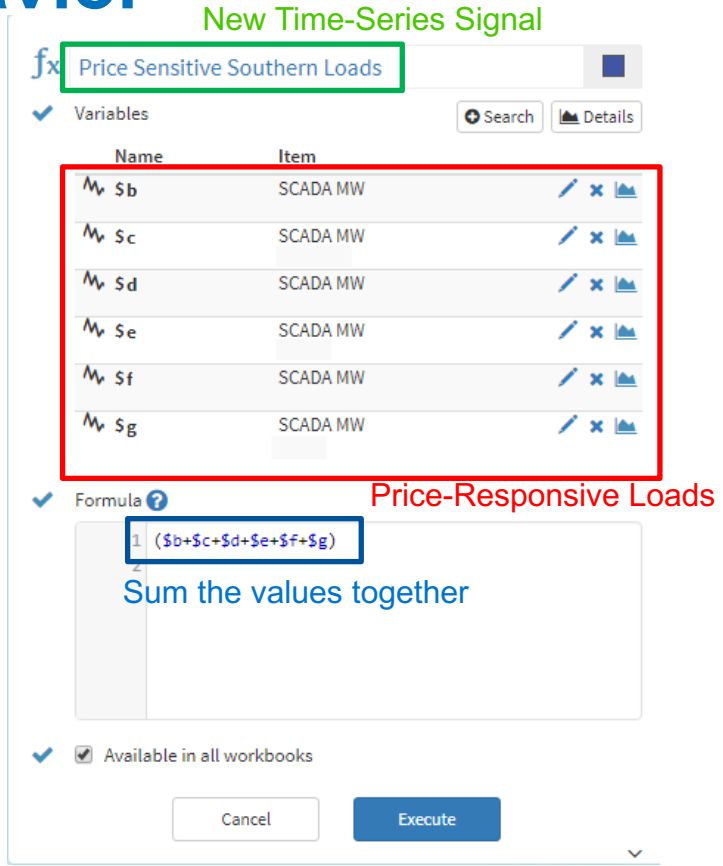
Characterizing The Loads Behavior

- Easier to aggregate the loads first
- Performing analysis on aggregated loads reduces “noise”
- Can look through “all of time”



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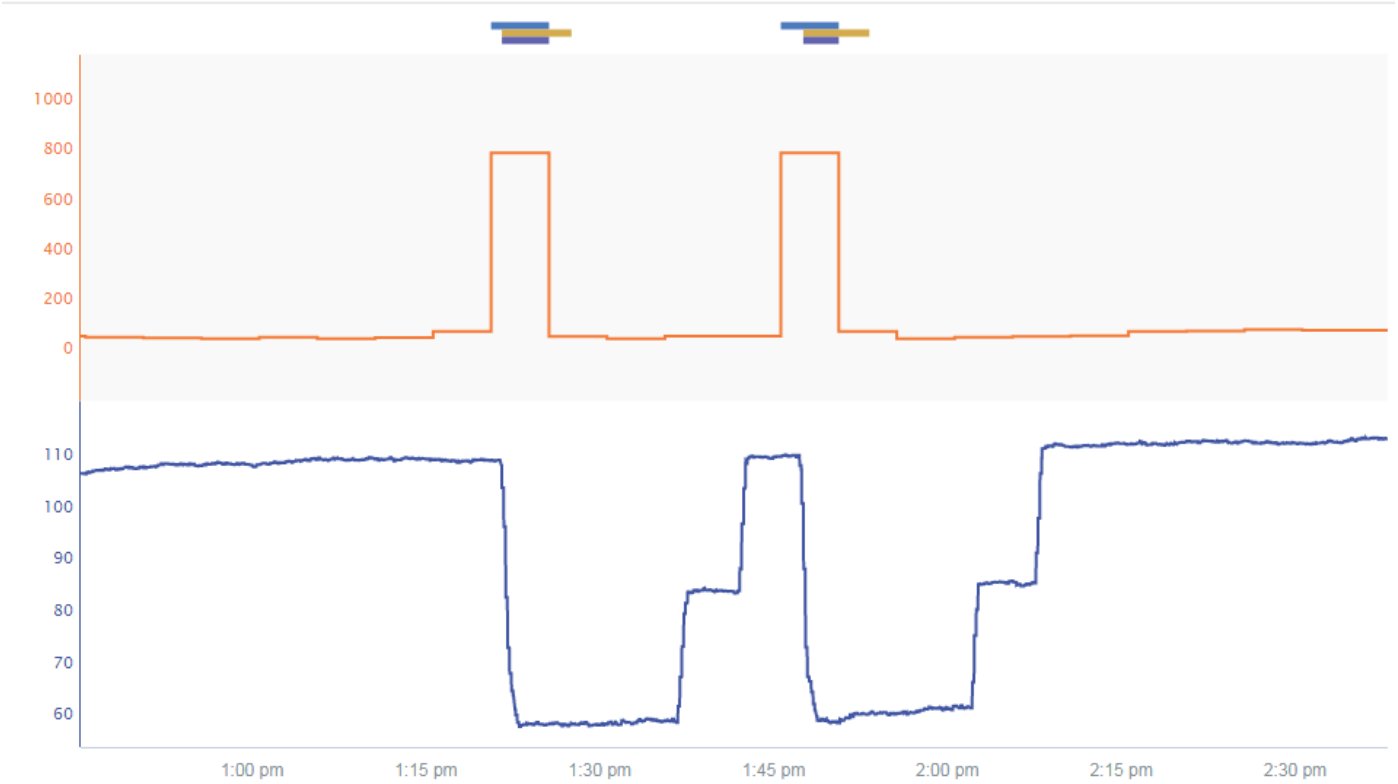
Can Perform Same Capsule Logic on Aggregated Signal



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Get All “High Price Load Drop” Capsules For Past 7 Years

- Export event meta data
  - High-price duration
  - Maximum aggregated load value
  - Minimum aggregated load value
  - Delta aggregated load value
  - System load

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Load-Response Percentage of High Price Events

	Event Date				
	2013	2014	2015	2016	2017
January	0.0 (0/13)	85.7 (6/7)	57.1 (12/21)	84.6 (11/13)	42.5 (17/40)
February	0.0 (0/9)	20.0 (5/25)	60.0 (6/10)	40.0 (2/5)	77.8 (14/18)
March	0.0 (0/17)	14.3 (4/28)	66.7 (10/15)	70.0 (21/30)	41.2 (7/17)
April	0.0 (0/19)	14.3 (3/21)	37.5 (3/8)	36.4 (4/11)	77.5 (31/40)
May	0.0 (0/10)	20.0 (3/15)	68.8 (11/16)	76.9 (10/13)	78.9 (30/38)
June	0.0 (0/4)	14.3 (1/7)	0.0 (0/1)	38.5 (5/13)	56.5 (13/23)
July	0.0 (0/9)	33.3 (1/3)	100.0 (1/1)	88.9 (8/9)	62.5 (5/8)
August	60.0 (3/5)	25.0 (2/8)	50.0 (1/2)	77.8 (14/18)	
September	54.5 (6/11)	50.0 (3/6)	100.0 (3/3)	75.0 (12/16)	
October	10.5 (2/19)	13.0 (3/23)	85.7 (12/14)	72.0 (18/25)	
November	5.6 (1/18)	58.3 (7/12)	75.0 (6/8)	55.6 (15/27)	
December	18.8 (3/16)	46.2 (6/13)	71.4 (5/7)	50.0 (10/20)	

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Control Room Awareness

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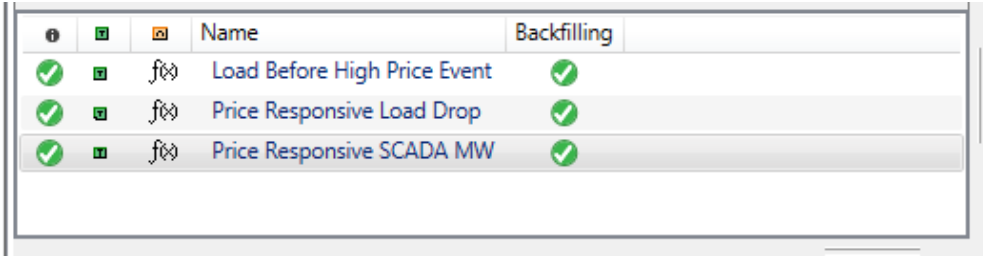
AF Analyses to Calculate Load Reduction in Real Time

- Perform a system level rollup of all price-responsive loads



- During high-price events, write the Reduced MWs value to a tag

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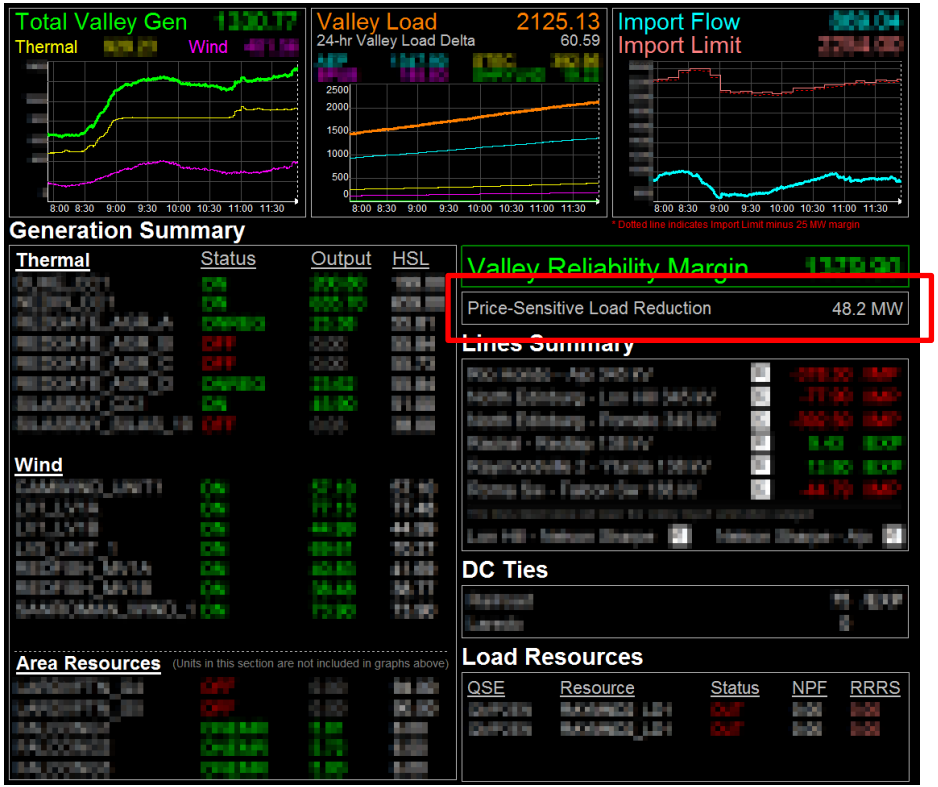
(Possible) Wallboard ProcessBook Display



Operators can see the reduction of load during high price events.

Price-Sensitive Load Reduction	48.2 MW

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Daily Reports

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Automated Daily Reports

- Every morning reports are generated for the previous day
  - Renewable curtailments
  - Unit Startup/Shutdowns
  - Ancillary Service Deployments
  - Incorrect Ramp Rate Telemetry

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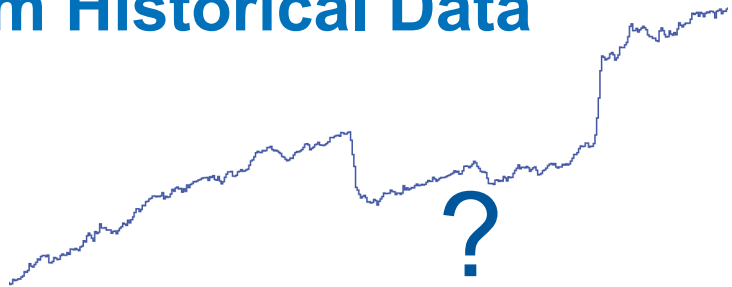
Creating Real-Time Awareness From Historical Data

Electric Reliability Council of Texas

"The patterns, trends, and answers have always been hiding in the data. Using Asset Framework to bring order to years' worth of PI data has enabled ERCOT to quickly find those answers and characterize key events. The effort and careful consideration put into creating the AF model continues to pay off."

Joel Koepke, Grid Applications Development



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CHALLENGES

There are hundreds of loads in the Valley which could be responding to price.

Characterizing the loads' behavior as a whole.

Operators cannot easily "see" the real-time load reductions affecting the Valley import.

SOLUTION

Developed logic in Seeq Workbench and leveraged AF to iterate through all loads for a given time.

Used Seeq Workbench to aggregate the loads and perform analysis over time.

Developed PI AF analysis rules to monitor and calculate the load reduction.

RESULTS

Discovered the specific loads responding to price.

Determine when distribution generation was installed and at what prices they respond.

Control Room ProcessBook displays will soon display the reduced load value.

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Thank You

"Make everything model-driven"