Implementing V&R Voltage Security Analysis (VSA) Tool for near Real-Time IROLs Monitor in Peak Control Room

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assuring the wide area view

Agenda

- Introduction-V&R Peak ROSE-online VSA tool implementation
- Tool validation: findings and resolutions
- Success and lessons learned

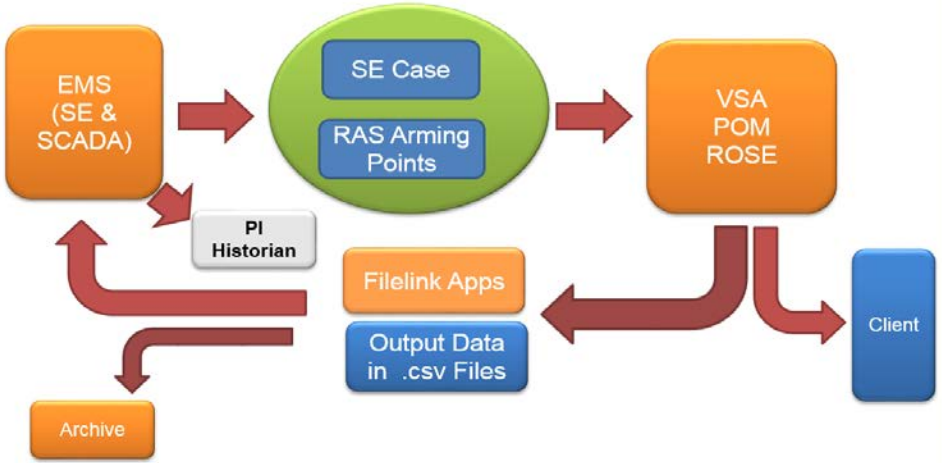
Introduction

- New SOL Methodology created in the wake of 9/8/2011 blackout
- The ultimate task of TOPs and the RC is to *continually assess and evaluate* projected system conditions as Real-time approaches with the objective of ensuring acceptable system performance in Real-time against SOL/IROL exceedance
- ***NW Washington Net Load*** and ***SDGE Summer Import*** are two known IROLs limited by voltage stability
- Peak has implemented V&R Peak ROSE-online Voltage Security Analysis (VSA) tool to calculate/monitor two IROLs in near real-time (R-T) operations

Peak ROSE Architecture & Capabilities

- Runs for every 5 minutes and imports real-time WSM SE case for near R-T VSA limit assessment

  - Calculates the VSA upon basecase and contingency conditions
  - Provides P-V & Q-V analysis curves
  - Enables modeling of shunt capacitors switching & RAS/SPS
  - Models unit D-curves for stressing
  - Gives multiple options for stressing negative reactive load points
  - Supports unit economic Pmax modeling



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Calculating VSA Limit: Real-time vs Offline

- There are different assumptions for calculating VSA limits between R-T assessment and offline study

R-T VSA Assessment Mode

- Network (unit, load & transmission etc.) condition is current and true
- No new generation is placed online
- Reactive reserves can be depleted
- Shunt Cap switching is locked for both pre and post-contingency
- Informs operators how far the system is away from a break point

Offline VSA Study Mode

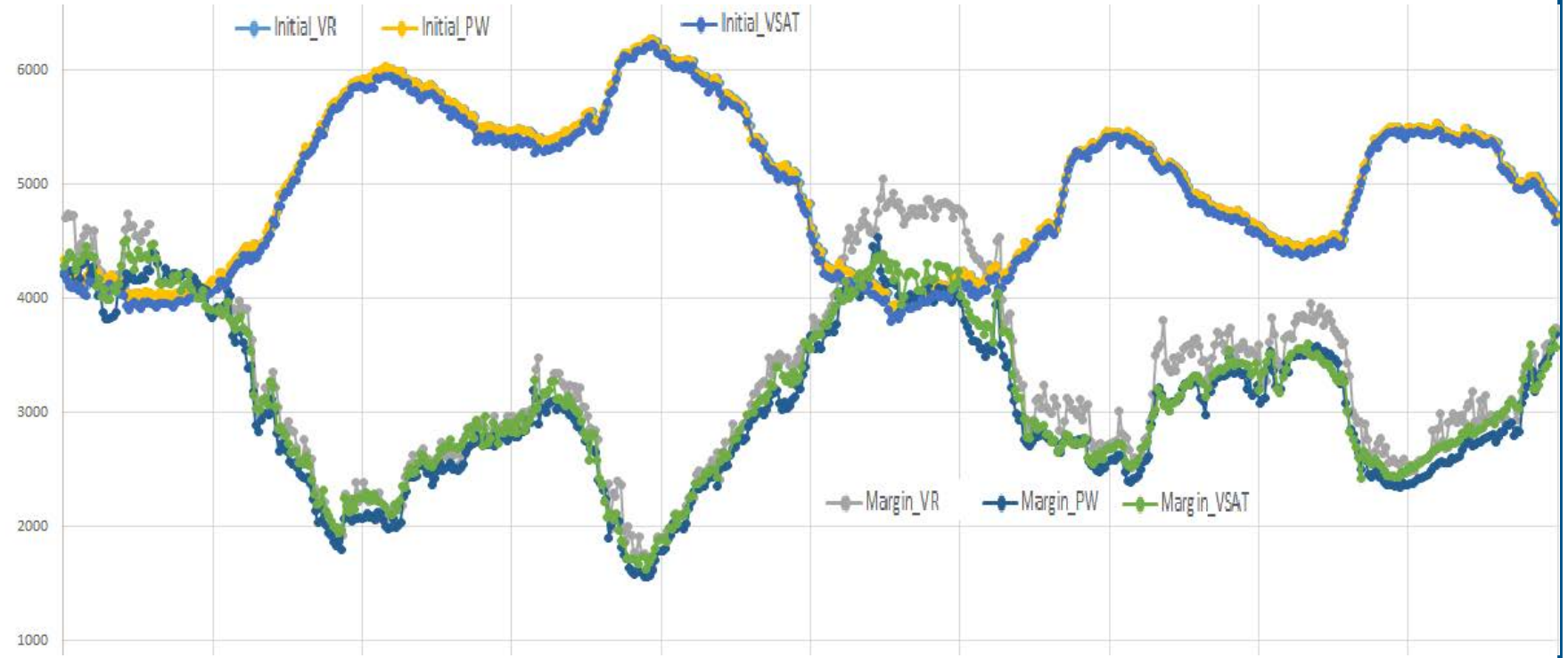
- ❑ Network (unit, load & transmission) condition is forecasted or assumed
- ❑ Offline units are placed in service to maintain normal their operating band
- ❑ Reactive reserves are maintained
- ❑ Enable Shunt Cap switching for both pre and post-contingency
- ❑ Indicates a ‘true’ operating limit

Peak ROSE Tool Validation Approaches

- Peak validated V&R ROSE against PowerTech VSAT and PowerWorld tools to check against
  - Solution impact of Bus-Branch vs Node Breaker Models
  - Existence of numerical instability under normal operation and extreme outage conditions
  - Difference of three VSA tools in solving 48 hours duration 5min interval autosave SE cases run in a batch mode
- Compared R-T VSA tool results with the entities'

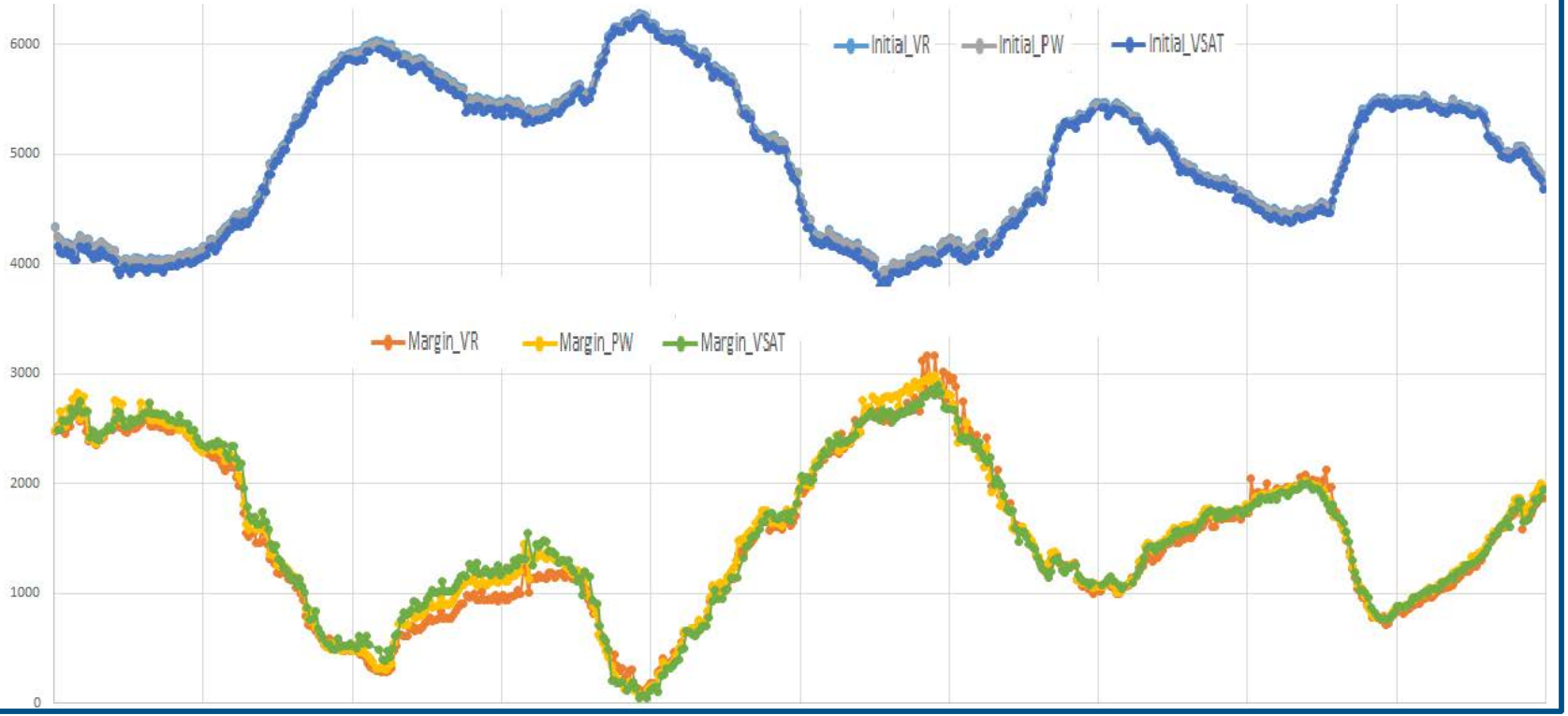
Calculated VSA Results from SE Cases

NW Washington Net Load IROL Scenario Validation (Normal Cases)



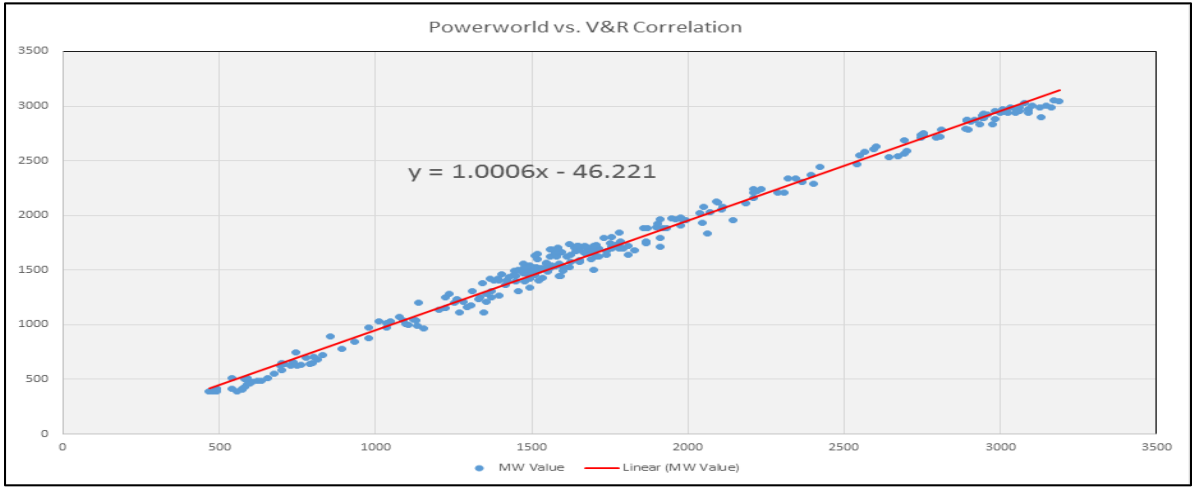
VSA Results w Outages Applied in SE Cases

NW Washington Net Load IROL Scenario Validation (Outage Cases)



Tool Validation: Findings and Conclusion

- The programs converge nicely to lower margins and diverge sometimes for higher margin periods
- Strong correlation of VSA tool results confirmed



A **true Lower Margin** really matters to RCs

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VSA Results Validation: Peak vs. CAISO

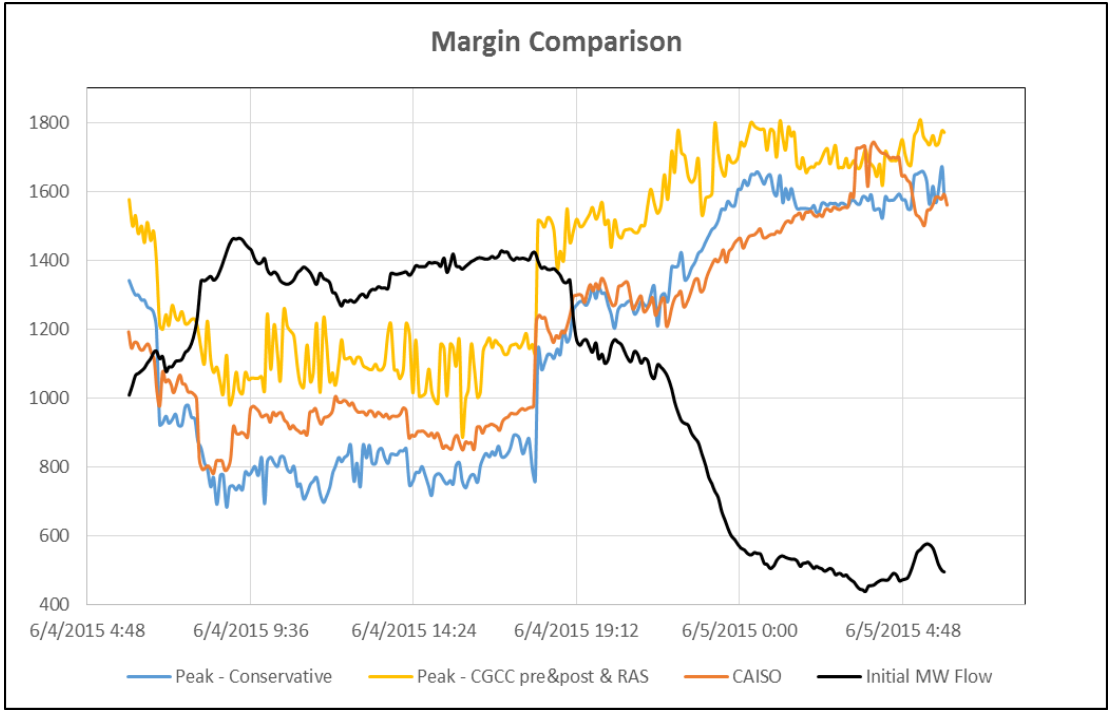
- Peak and CAISO modeled and calculated SDGE Summer Import IROL in their R-T VSA tools (V&R ROSE vs. Bigwood)
- Worked collaboratively to compare both results and identify the causes of the gap. For example,
  - SE model impact (WSM vs. CAISO regional models)
  - RAS modeling and program settings for Var regulation
  - Negative reactive load: estimation and stressing

Difference of Calculated VSA Margins

Margin Curve Comparison

- Initial interface MW Flow
- CAISO calculated margin
- Peak calculated margin while CGCC* scheme and RAS disabled in both pre and post contingency
- Peak calculated margin while CGCC* scheme and RAS enabled in both pre and post contingency

What caused the difference of margins solved by two tools?



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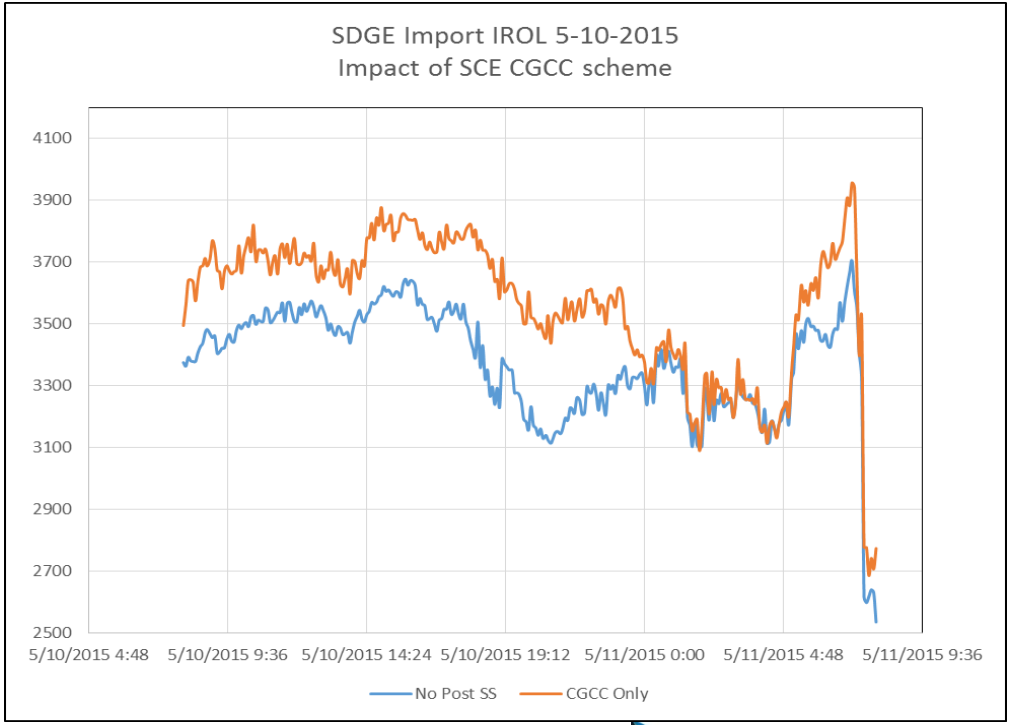
Impact of CGCC to Margin Calculation

- Centralized Grid Capacitor Control (CGCC) is automatic
  - ~63 capacitors @ 35 substations of SCE
  - To prevent capacitor hunting, post-transient issue and voltage collapse condition
  - Applicable for pre/post-CTG
- CGCC model has impact on VSA margin calculation



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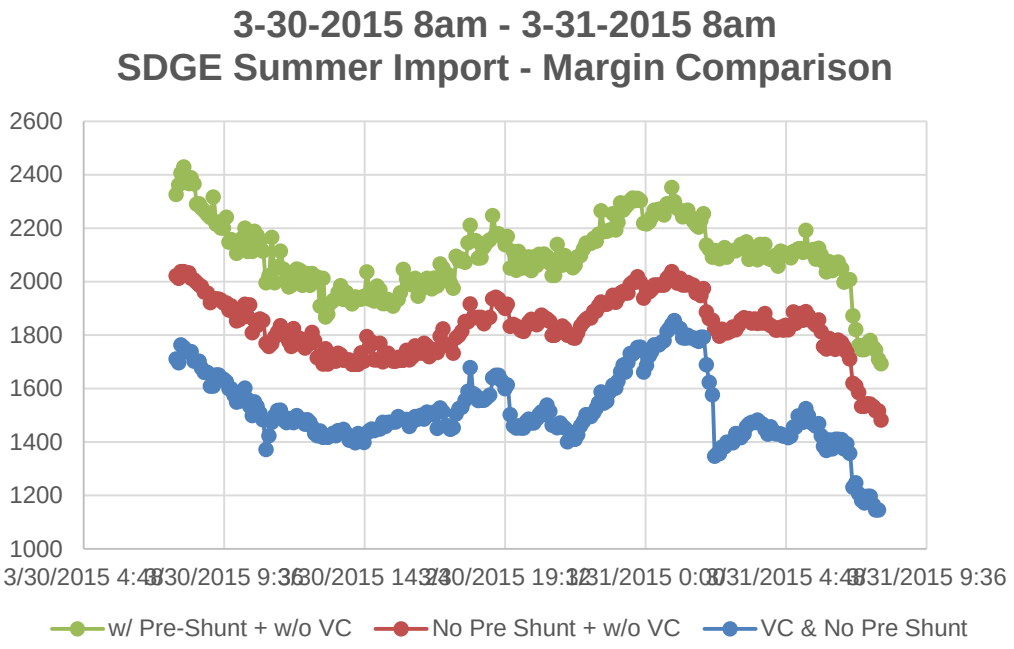
Impact of Cap Switching to Margin Calculation

Calculated Margin Curves by three different Options

1. *No pre-contingency (pre-CTG) Shunt switching and no Voltage Constraint (VC)
2. pre-CTG Shunt switching disabled and VC enabled
3. Pre-CTG Shunt switching enabled and VC disabled

* Given that R-T VSA tools solve for every 5 min, Peak and CAISO agreed upon Option 1



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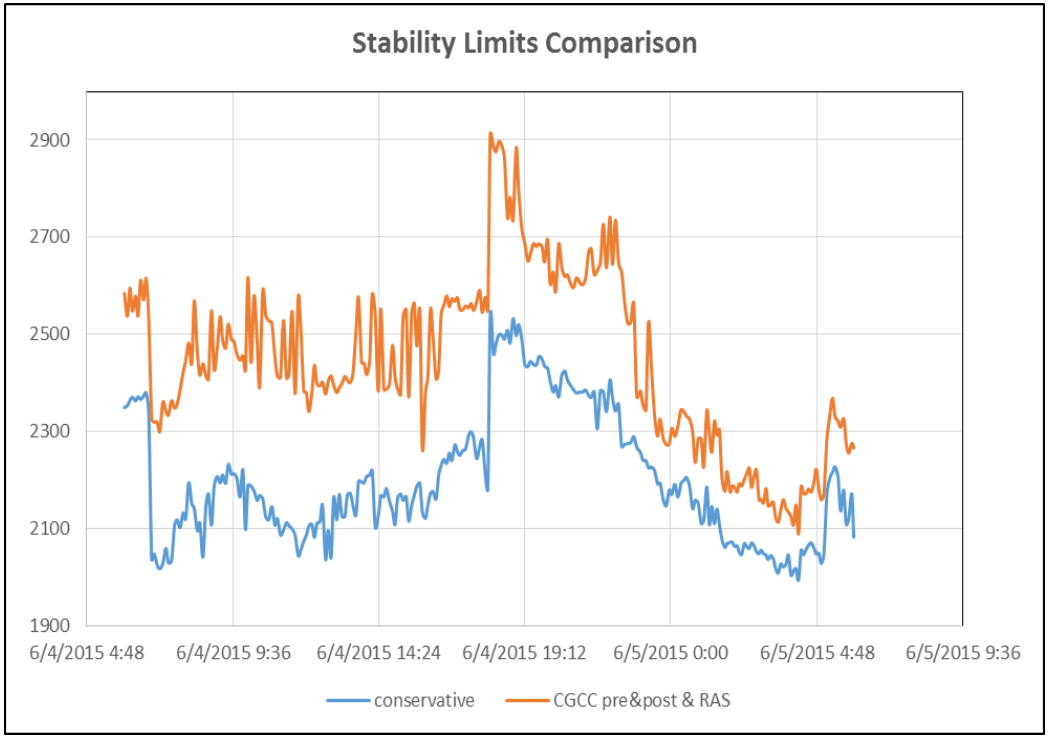
Impact of RAS Model to Margin Calculation

Calculated Limit Curves with and without RAS modeled

1. 8 RAS are modeled in SDGE Summer Import IROL scenario by VB scripts
2. RAS Arming status is received from TOP via ICCP and used for RAS logic
3. The RAS heavily impacts VSA limit/margin calculation. Calculated VSA limit/margin is raised by RAS protection typically. However, there is exception for attention



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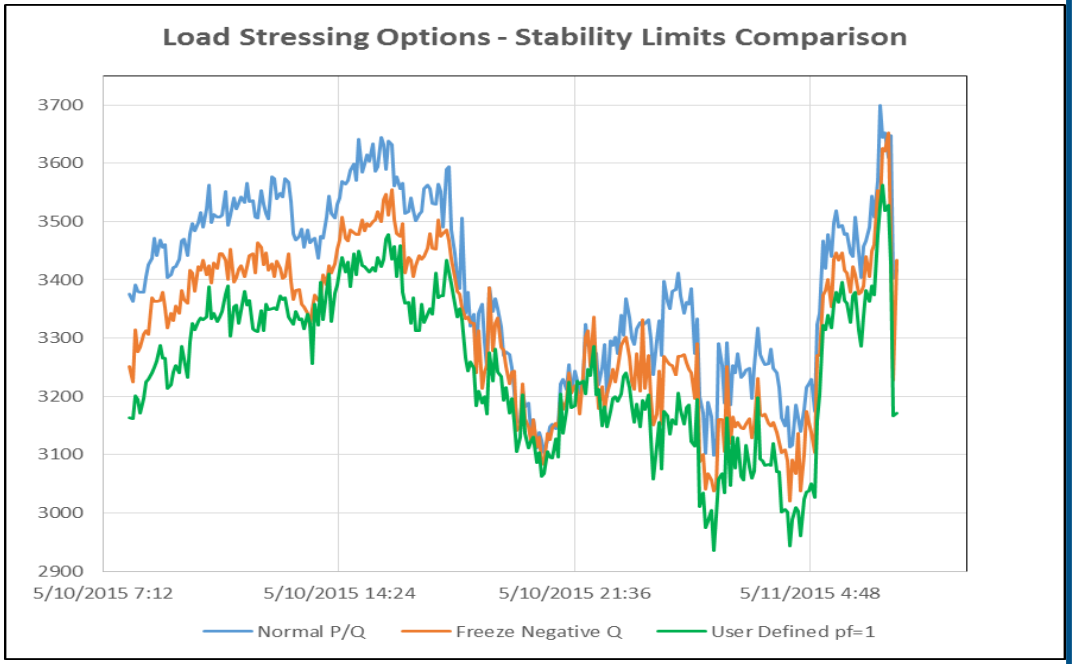
Impact of Negative Q Loads to Margin Calculation

Why negative reactive loads how to scale them in VSA calc?

- Negative values estimated for SDGE loads by SE is due to sub 69kV network reduction, that ignores lots of Distributed Generator (DG) components and shunts
- Peak ROSE offers three options for stressing negative Q: **Normal P/Q ratio**, **Freeze negative Q** and **User defined PF**
- PF option is pro-conservative



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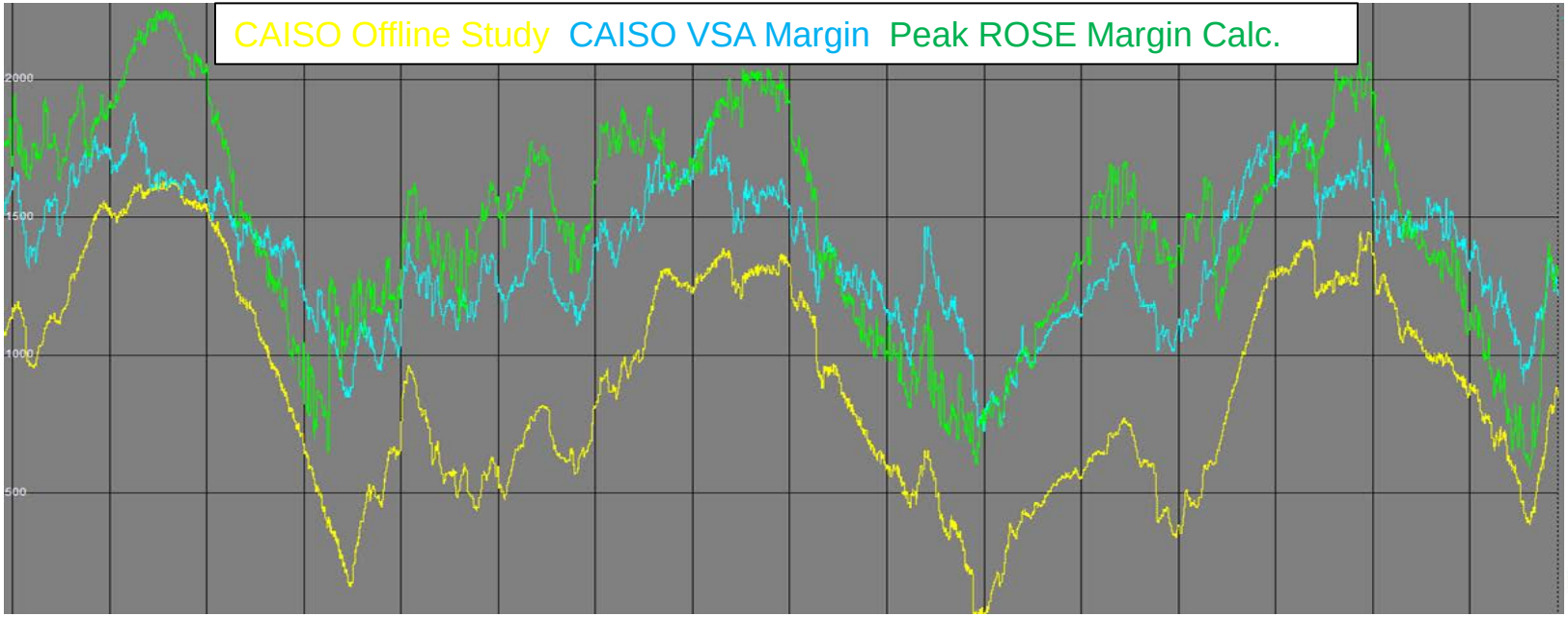
Recent R-T VSA Tool Comparison Results

- Peak ROSE and CAISO VSA tool started to produce similar VSA limits/margins after extensive validation effort



BILITY

Peak ROSE Implementation Milestones

- Completed tool benchmark testing against ***PowerWorld*** and ***PowerTech-VSAT*** and outreach on 2/25/2015
- Rolled out ***SDGE Summer Import IROL*** near real-time monitoring in production on 7/20/2015
- Rolled out ***NW Washington Net Area Load IROL*** in production on 9/10/2015
- New IROLs will be modeled, validated and rolled out orderly
- Implements V&R software enhancements through PRSP grant funded by DOE, 8 entities and Peak

Lessons Learned from Implementation

- Neither model nor software is perfect. Therefore,
  - A thorough and rigorous test must be performed for each EMS/VSA model update and V&R ROSE software patch
  - Operation procedures & communication mechanism must be well defined to cover extreme cases-tool failure:
    - Peak VSA results – Primary; CAISO VSA results-Back-up. Both share real-time VSA results via ICCP
    - Offline VSA Study by Engineer In case of both real-time tools fail
    - Validate R-T VSA results with RTCA before actions taken

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