CALCULATING VARIABLE TRANSFER LIMITS FOR DYNAMIC TRANSFERS

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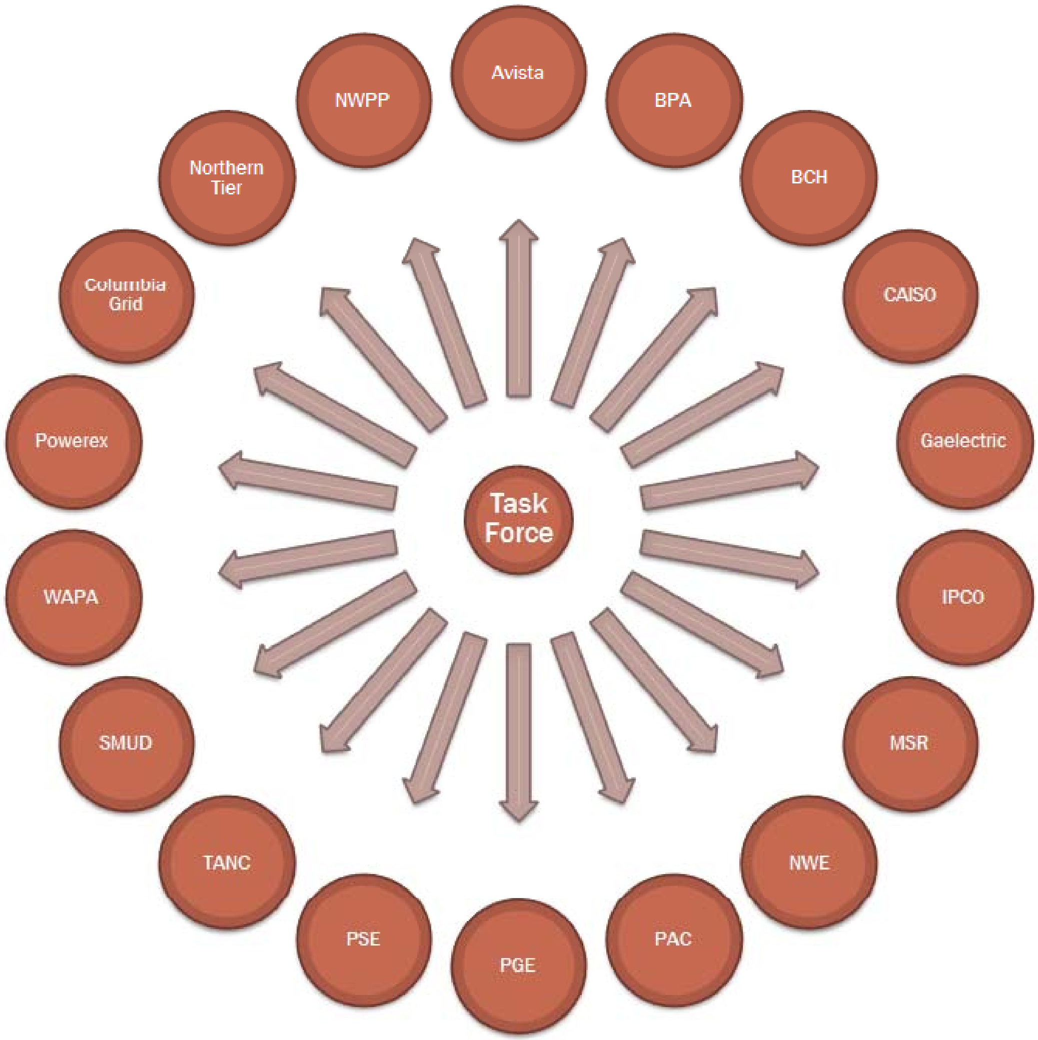
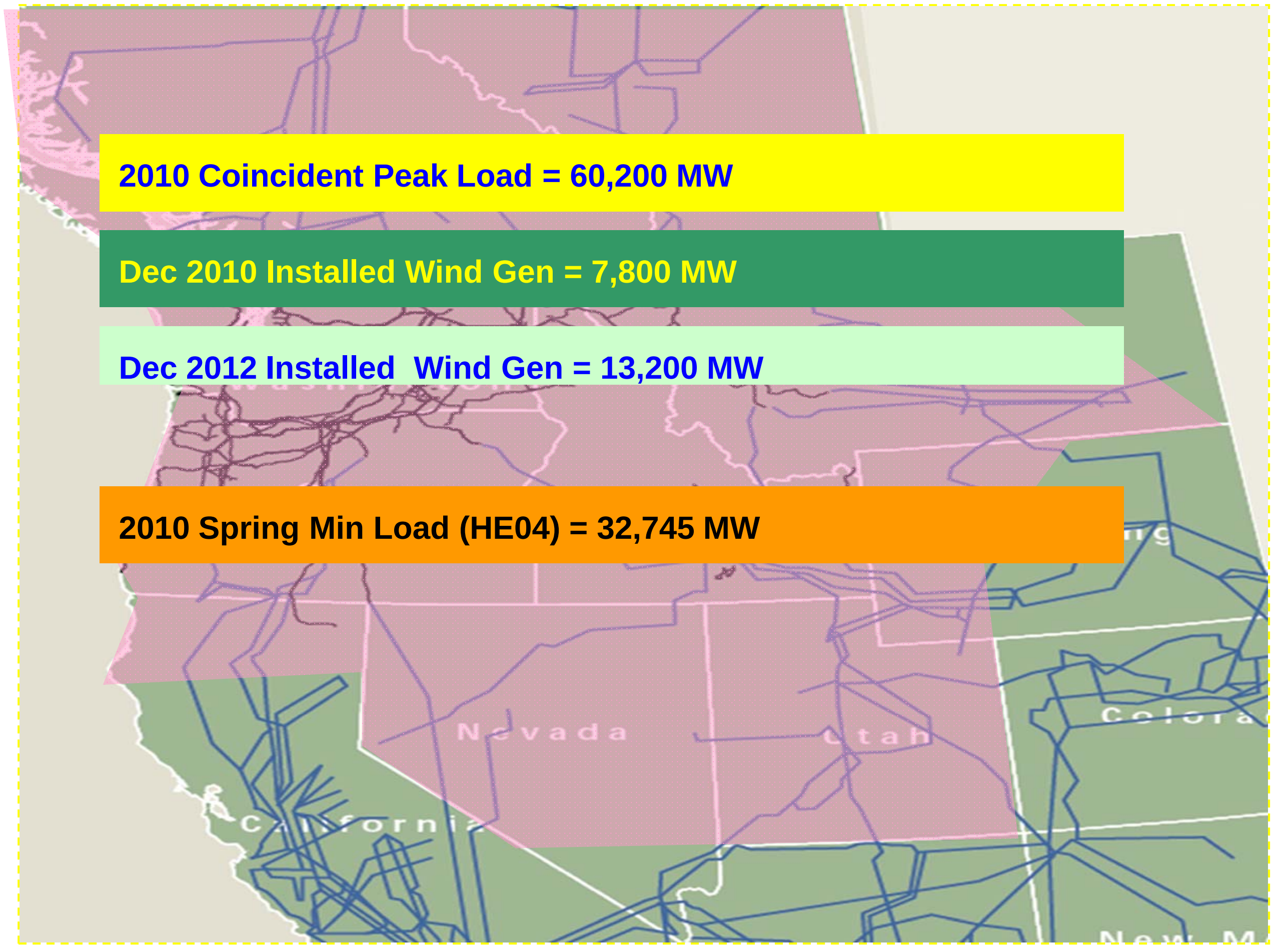


NWPP Wind Generation Levels



2010 Coincident Peak Load = 60,200 MW

Dec 2010 Installed Wind Gen = 7,800 MW

Dec 2012 Installed Wind Gen = 13,200 MW

2010 Spring Min Load (HE04) = 32,745 MW

Variable Transfer Example

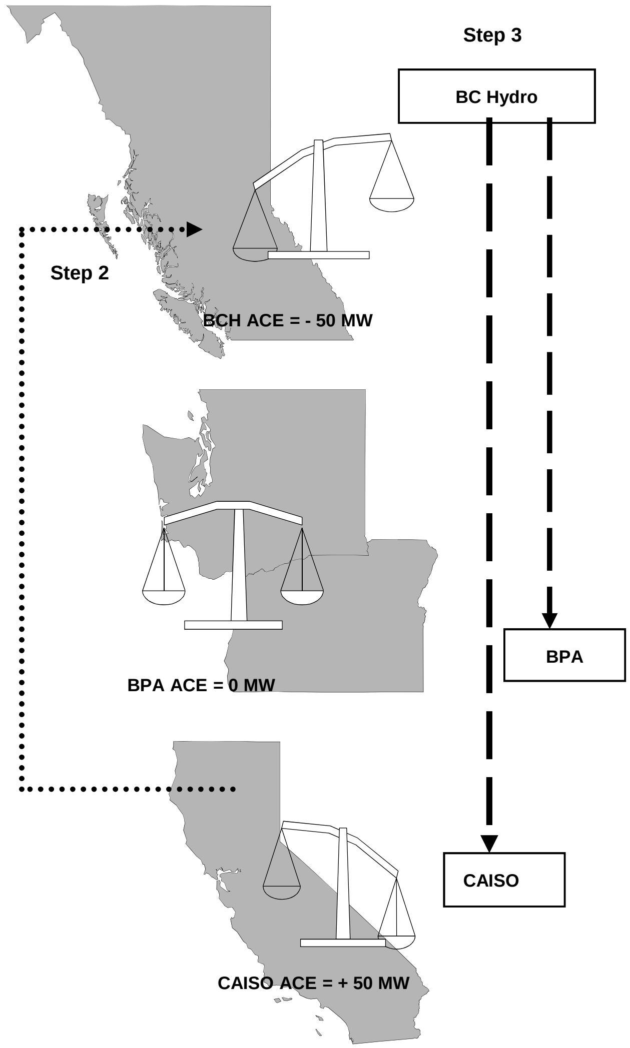
<u>Real-time Operating Hour</u>

1. Initial state - all ACE's = 0

2. CAISO requests 50 MW of Regulation

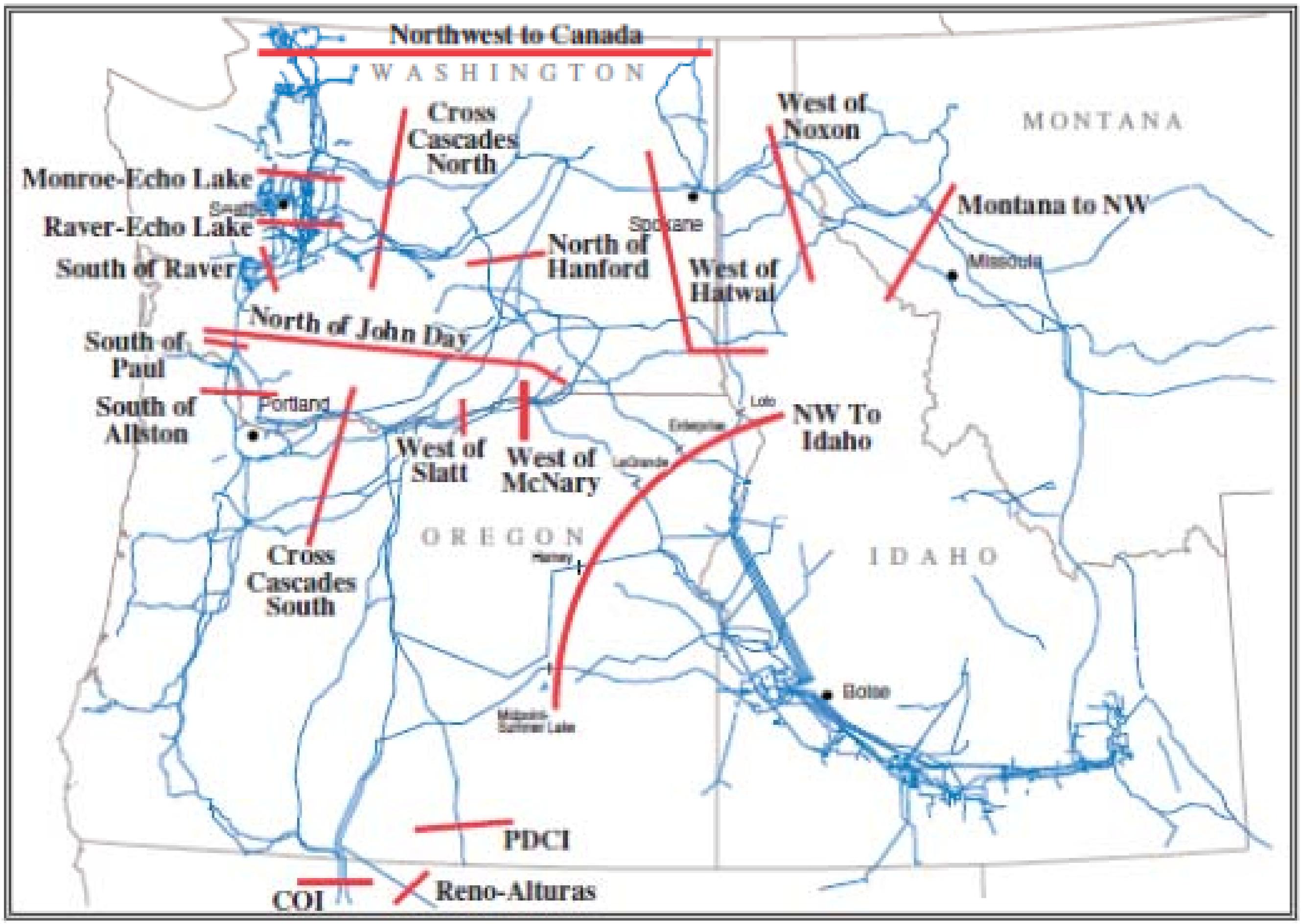
3. BCH sends official Dynamic Schedule to BPA & CAISO.

4. BCH and CAISO's AGC respond to new Dynamic Schedule.



Are Variable Transfer Limits Needed?

NW Constrained Paths



Why Was the Issue of Transfer Variability Limits Studied?

- Additional large and frequently varying Dynamic Transfers on top of stressed static conditions raised concerns for System Operators in 2005;
- TOPs concerned about increasing Dynamic Transfers to facilitate wind integration without assessing impact on transmission grid.
- How much and how frequently can transfers vary over 15 minute intervals outside of ramp periods?

What Was Found?

Increasing the magnitude and frequency of Transfer Variability can results in potential:

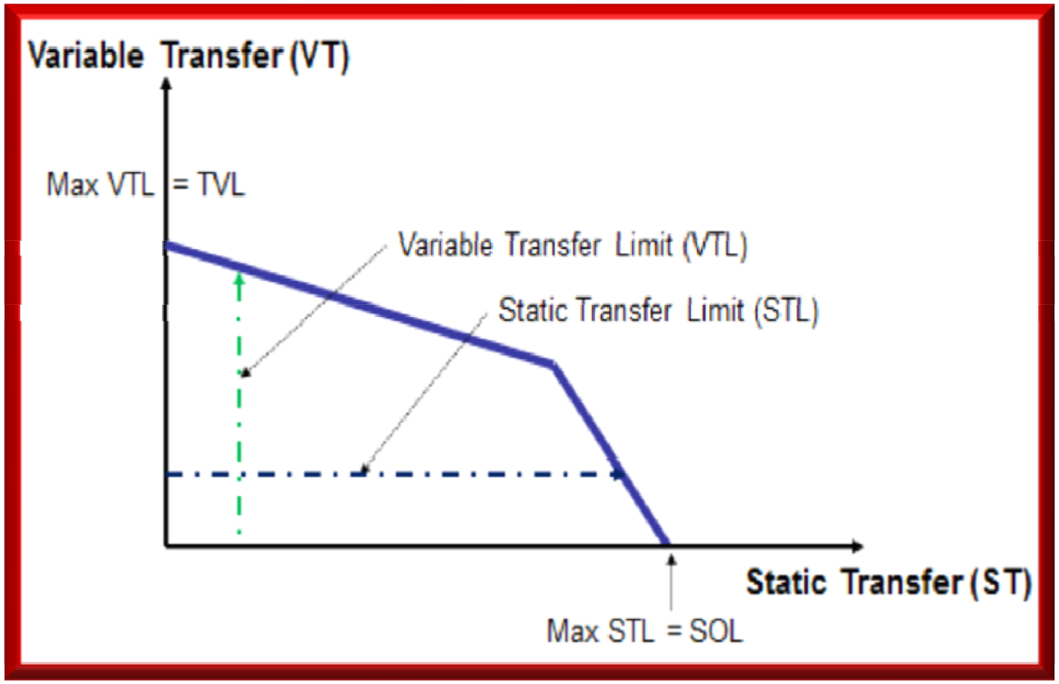
- Impacts to system reliability;
- Impacts to system equipment;
- Impacts to customers.

Customer Impact Acceptable?

Equipment Impact Acceptable?

Operating Point Reliable?

Static vs. Variable Transfer



- Sum of the variable transfers plus the static transfers on a path must be less than or equal to the SOL; **ST + VT <= SOL**

Optimization Formulation:

Objective:

Max ∑ Abs(Transferi (z))
for i = 1 to m source / sink pairs

Subject to

H(z) <= 0

Where

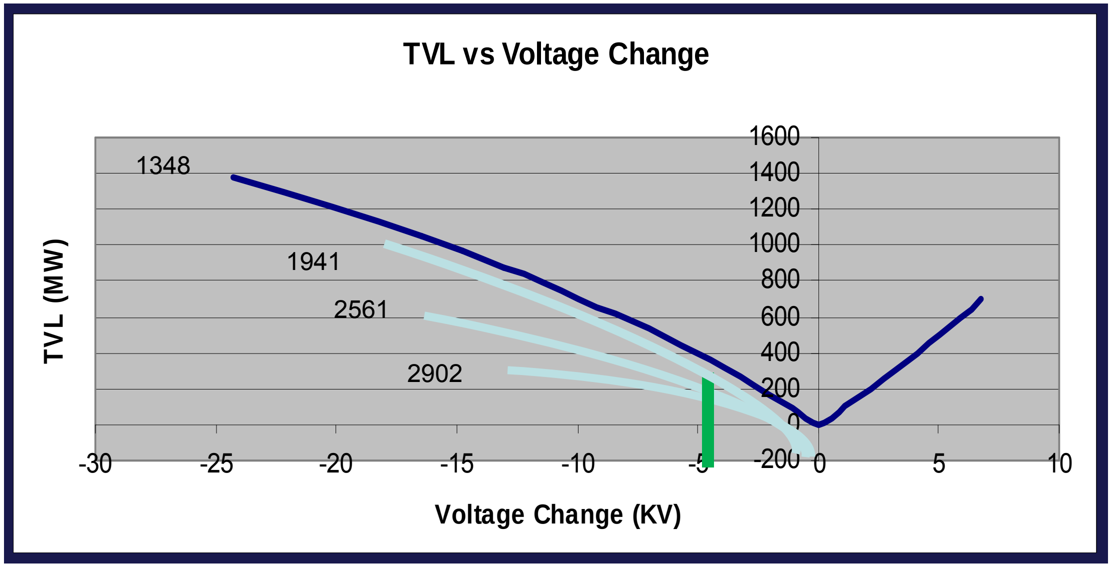
z = is the vector of decision variables that includes both control and state variables
H(z) = is vector of operating conditions that cannot be violated

Factors Influencing Variable Transfers

- Amount of static transfer
- Allowed Voltage variation
- Reliability criteria
- Location of balancing resources
- Automatic voltage control devices
- System conditions such as topology, Remedial Action Schemes (RAS), Load/Generation patterns etc.

Impact on Customer vs. Operating Point

Path 3 Flow N to S	TVL
1348 MW	400 MW
1941 MW	379 MW
2561 MW	295 MW
2902 MW	257 MW

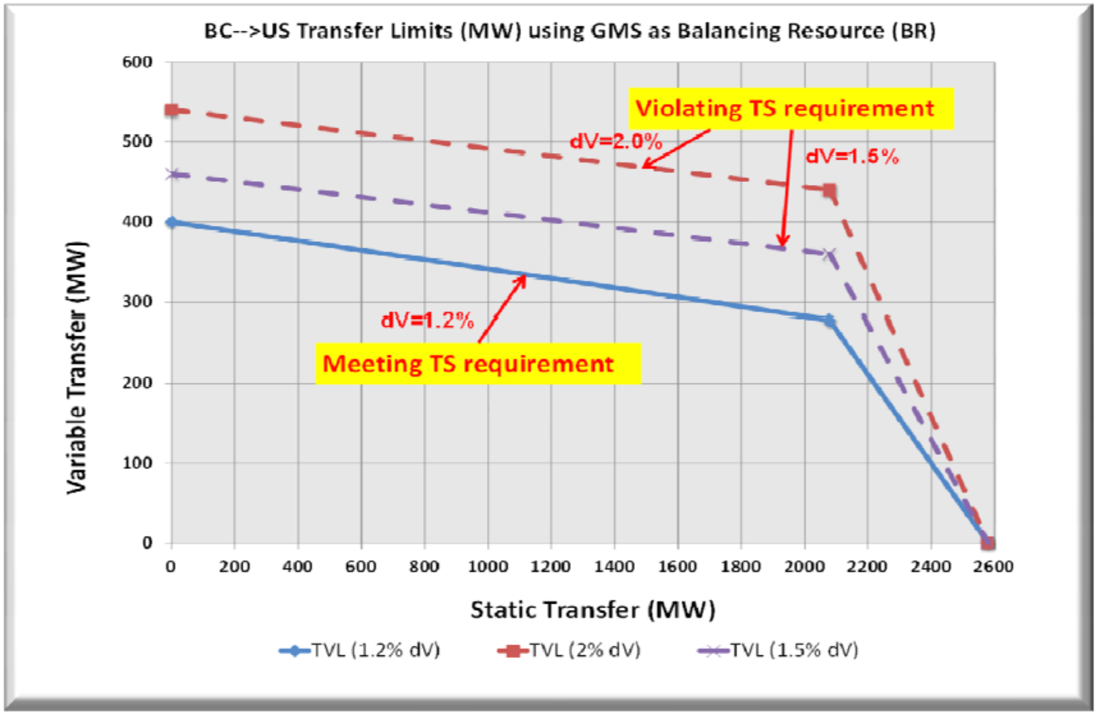


Reliability
Voltage Stability Analysis

No	COI flow	Collapse point	Margin 2.5 % n-2 5% n-1	Voltage Stability Limit
1	4796 MW	5190 MW	130 MW	5060 MW
2	4670 MW	5140 MW	128 MW	5012 MW
3	4467 MW	5080 MW	127 MW	4953 MW
4	4050 MW	4980 MW	125 MW	4855 MW

- Voltage stability limit is decreasing as the “modified point” moved further from the initial cases.
- TVL limit is taking the margin out of point at path rating

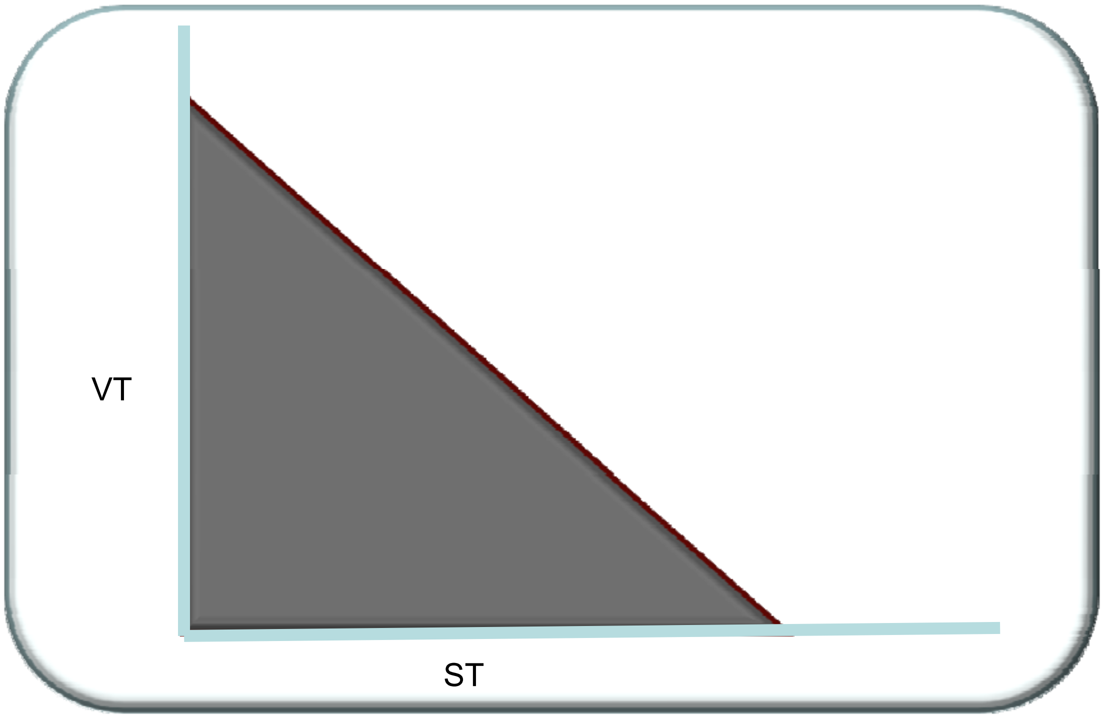
Reliability
Transient Stability Analysis



Location of Balancing Resources

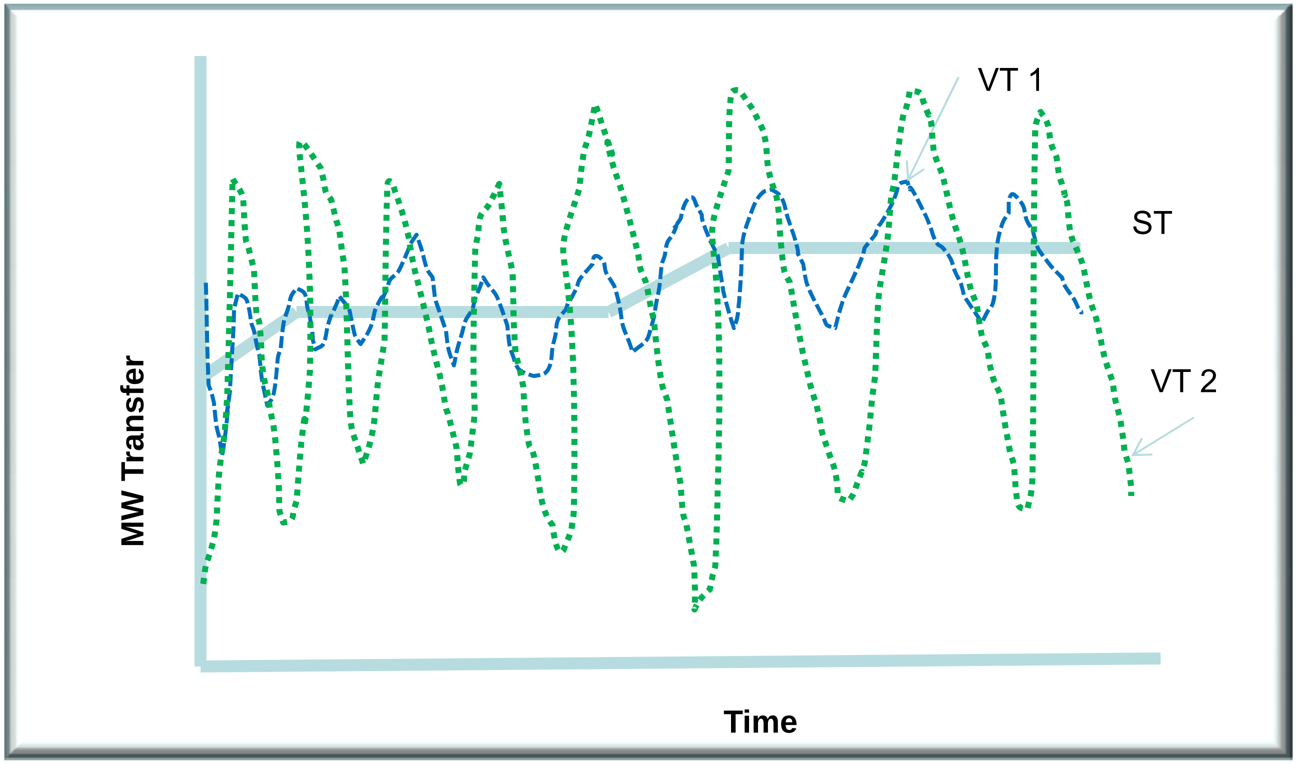
Economic Benefits

Ideal Case



- VT is maximum when the slope is 45 degrees

Can We Achieve Ideal Case ?



- VT increases voltage variation will increase
- VT variation can be decreased by automatic voltage control devices
- Transfer Variability Limit (TVL) <= SOL
- Reliability issues due to MW change

Observations

- Variable transfer (VT) cost higher than static transfer.
- The VT cost needs to account for loss in static transfer revenue.
- The best cost for variable transfer is same as static transfer. Variable transfer cost cannot go below the static transfer.
- Many factors influence DT Limit
- Making more devices automated will increase DT Limit

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