Technology Innovation

BPA Approach for Voltage Stability Applications

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Voltage Stability Approach – Defense in Depth

1. **Reliability starts with good planning**

   … But actual system conditions are often different from what is planned …

2. **Operational real-time studies - State estimator based real time contingency analysis**

   … But, your model may be wrong (model errors, control failures, etc) …

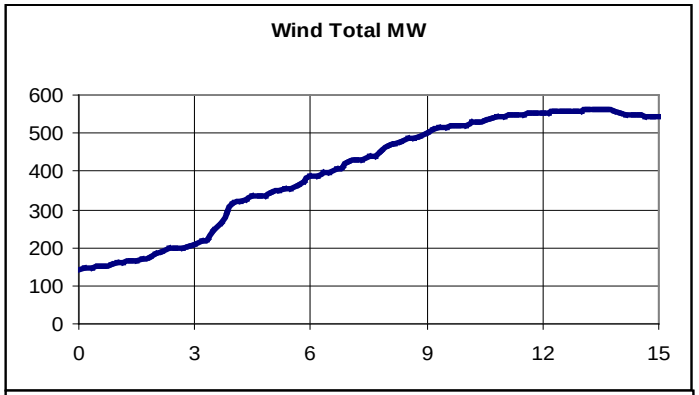
3. **Intrinsic indicators of voltage stability**

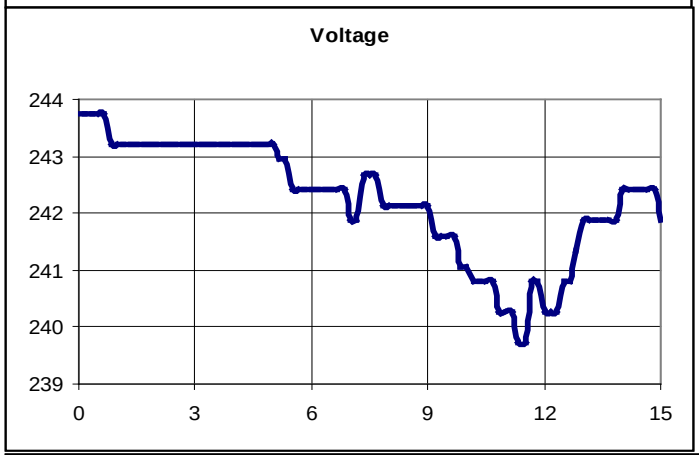
   … but disturbance may develop too fast for operators to respond

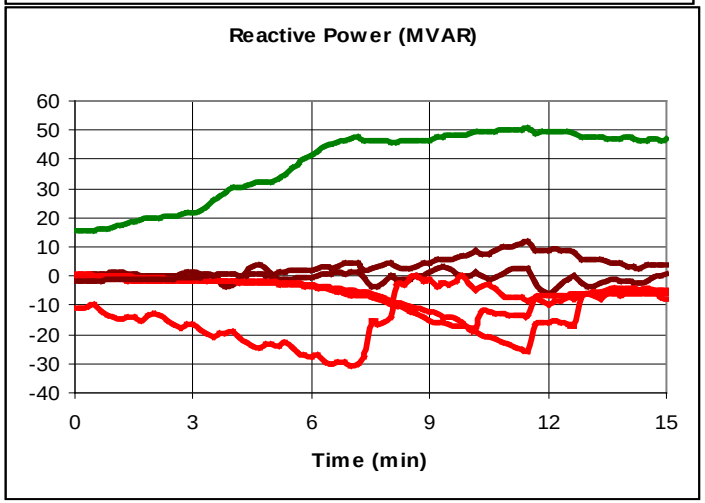
4. **Wide-area stability control and safety nets**

1. Better Planning Tools for Reliable Wind Integration

- **Conventional system**
  - Generation schedules are predictable, flows change slowly
  - Static snapshots are adequate for voltage stability assessment
- **System with variable generation**
  - Flows can change fast due to wind ramps, dispatchers may not be able to optimize voltage profile and reactive reserves
  - Need to have tools to study the impact of wind ramps on voltage stability
- Solution: BPA is developing **Time Sequence Power Flow** (TSPF) to study wind generation ramps and dynamic transfers



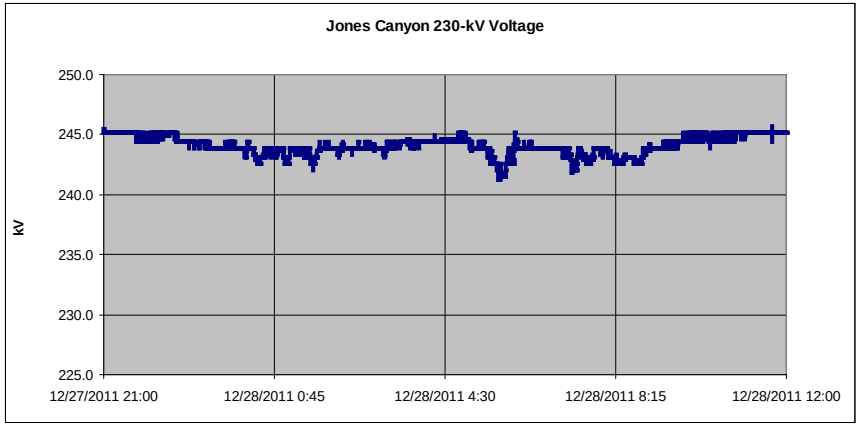




2. Operational Engineering Tools

- BPA Operating Engineers will start using state estimator cases for voltage stability assessment in April 2013 – Day Ahead and Outage studies:
  - Breaker-node models
  - Actual RAS modeling

- BPA developed applications for voltage control monitoring
  - Implemented in OSI Soft PI DataLink
  - Currently applied at large wind hubs
  - Example at Next slide …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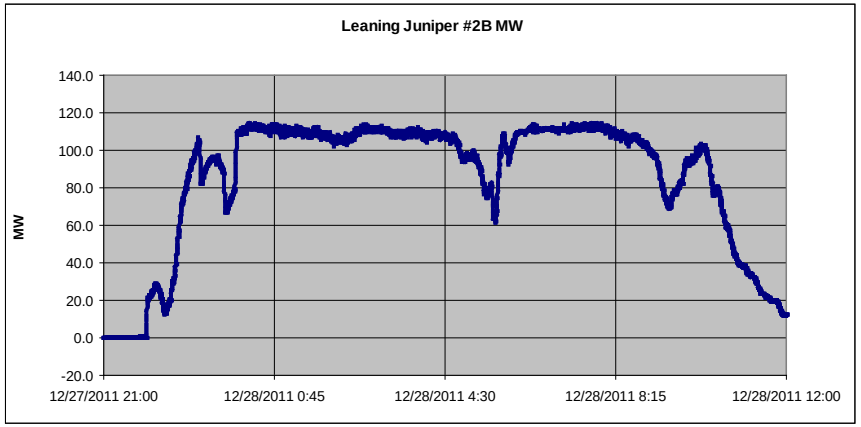
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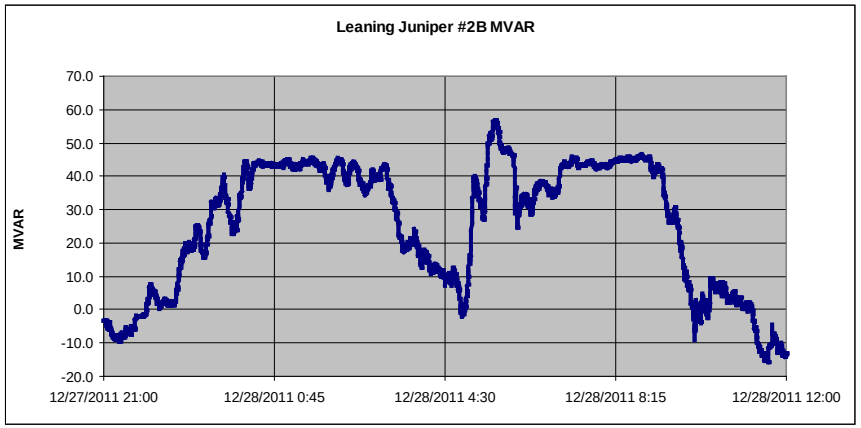
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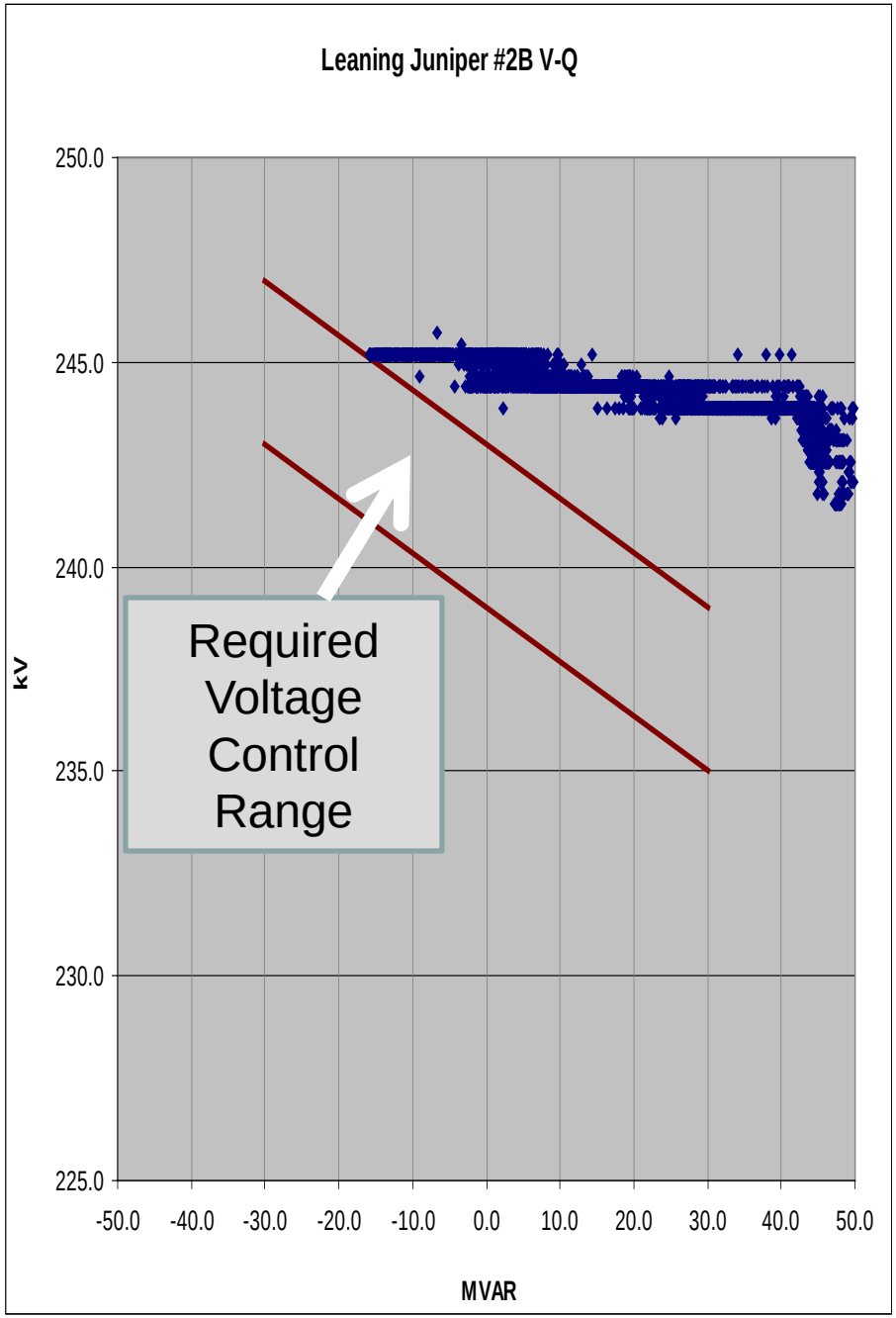
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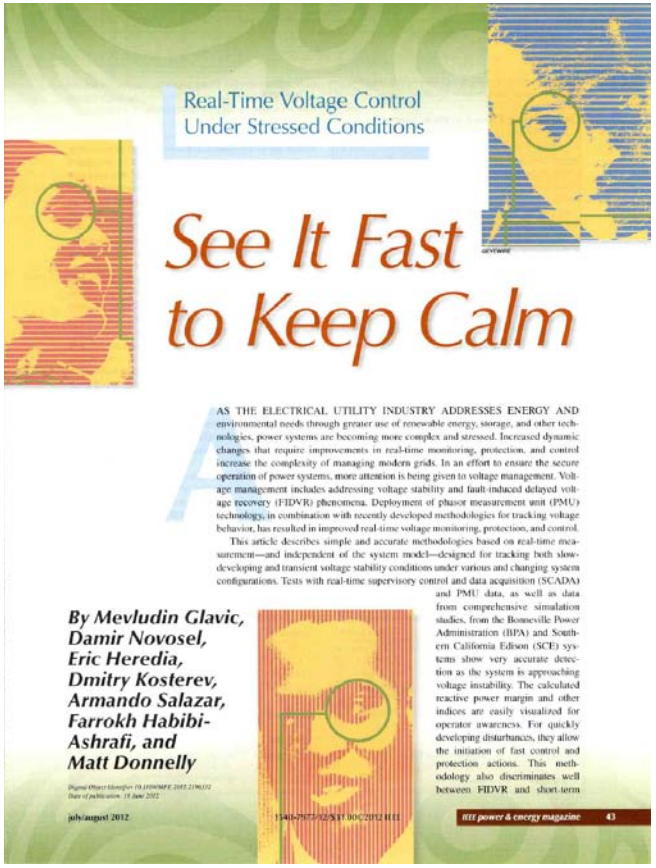
-10.0
0.0
10.0
20.0
30.0
40.0
50.0
MVAR
Required Voltage Control Range

3. Measurement-Based Voltage Stability Applications

- Several algorithms are considered:
  - Quanta Technology Reactive Power Margin is researched by the project
  - University of Wisconsin Singular Value Decomposition is researched by this project
  - DOE-supported voltage stability project by Rennesellaer Polytechnic Institute
- <u>BPA approach:</u>
  - Develop test cases to select most effective approaches
  - Prototype and test the selected algorithm in BPA synchrophasor lab



IEEE Publication

4. Wide Area Controls under Development

- Response-based controls, take actions within 1/2 second
- Start with low risk actions:
- shunt capacitor switching
- Use wide-area synchronized measurements
- BPA deliverable under WISP