This is what actually happened
PV-curve is often used to measure voltage stability margin.
Voltage Stability Planning

- Reliability starts with good planning
  - Understand voltage stability risks
  - Make appropriate grid investments
  - Develop proxy metrics for voltage stability margins
    - E.g. dynamic reactive reserves in lower Columbia, operating procedures
  - Time sequence powerflow tools are needed to study voltage stability risks during wind ramps

- Planning studies do not cover all operating conditions (or controls)
  - On-line voltage stability assessment is required ...
On-line Model-Based Voltage Stability Analysis

- On-line model-based voltage stability analysis
  - Get a state estimator powerflow case
  - Conduct voltage stability studies for the current system state
  - Set operational limits hour ahead
On-Line Model-Based Voltage Stability Assessment

Limits are set using model-based stability analysis.
On-line Model-Based Voltage Stability Analysis

- Absolutely the right thing to do, but not the only thing to do
- Your model may be wrong
- Generator controls may operate differently or have un-modeled operational limitations
- Therefore, the model-based VSA limit could be wrong
- In fact, model-based VSA would not have predicted the above event
Measurement-Based Situational Awareness

- Measurement-based situational awareness is a critical component of the voltage stability strategy
  - Alarms
  - Trend displays
  - Operations procedures
Had we had trend monitoring
Voltage Stability – Defense in Depth

- **Reliability starts with good planning** – understand risks, make appropriate investments, develop operating metrics (e.g. reactive reserves)
  
  ... But operating conditions may be different from what was planned ...

- **Model-based system stability assessment** to set real-time operating limits
  
  ... But your model may be wrong, equipment failures are possible, or unexpected responses to disturbances ...

- **Operator alarms and trend displays**
  
  ... But there will be disturbances too fast for an operator to react timely ...

- **Response-based voltage stability controls**
Session Overview

- On-line Model-Based Voltage Stability Assessment Applications (15 min)
  - Marianna Vaiman, V&R Energy
  - Saad Malik and Zea Flores, WECC RC

- Measurement-Based Voltage Stability Applications (10 min)
  - Damir Novosel, Quanta Technology

- Integrating Voltage Stability Applications into EMS (10 min)
  - Jay Giri, Alstom Grid

- Q&A Session (15 min)