Eric John, Director Marketing and Sales FACTS, North America, November 11, 2013

University of Pittsburgh, EPIC 2013 FACTS and Retirements of Coal-fired Power Stations

Agenda
FACTS, Reliability, Generation Plant Retirements

- Introduction
- Background on macroeconomic events affecting coal generation
- Implications for power system reliability when plants are retired
- Alternative methods for grid reinforcements when plants are retired
- Oncor case study

FACTS – Flexible AC Transmission Systems
FACTS Portfolio – Two main areas

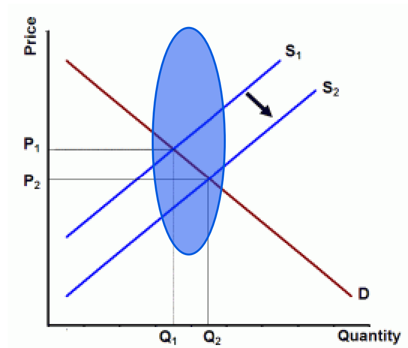
Shunt Compensation

- SVC
- STATCOM (SVC Light)
- Battery Energy Storage

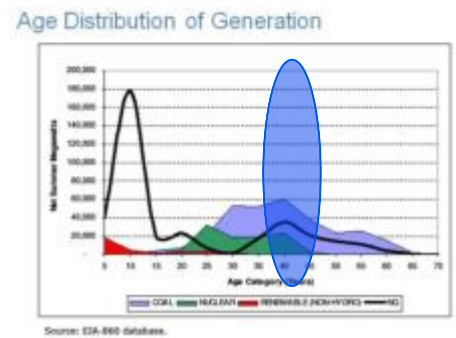
Series Compensation
Fixed
Controllable

Clean Air Initiative
Macro factors shaping power

New regulations driving fleet evaluations leading to retrofit or retire decisions.



Abundant NG supply putting downward price pressure on gas present & future. Making gas fired generation more attractive.



Significant coal assets > 40 years < 400 MW. Many have reached the end of their economic life.

Evolving EPA Regulations + Abundant Natural Gas + Aging Coal Fleet =
Disruptive Shift

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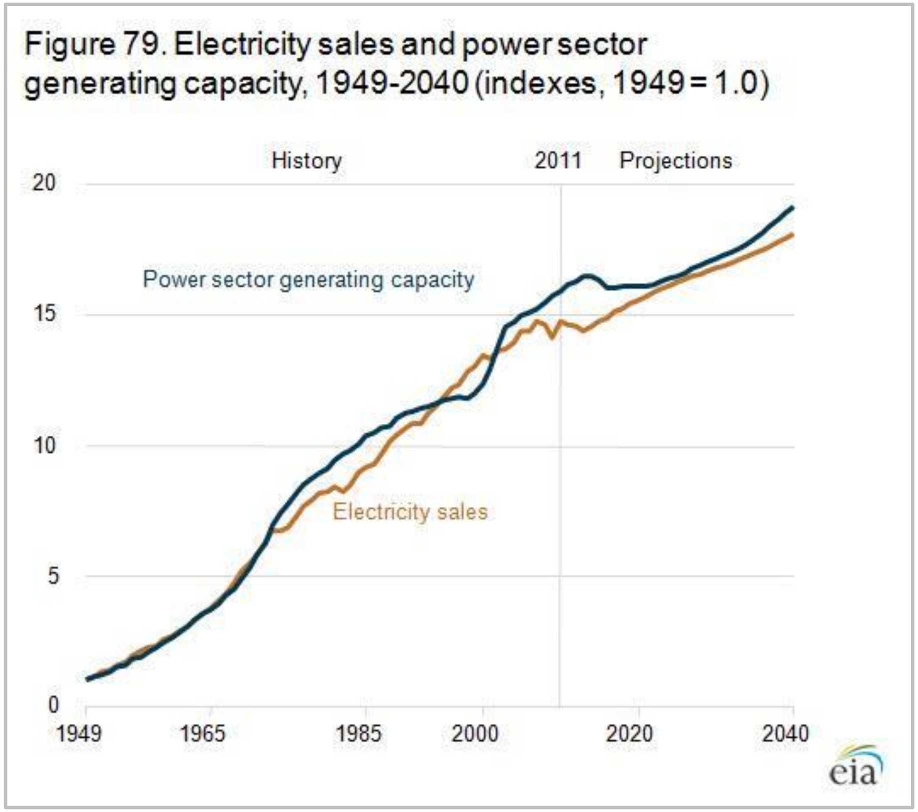
Grid stability emphasized by utilities



- Excess generating capacity
- Continued slow economic recovery
- Demand response and energy efficiency have been widely deployed
- As much as 60 GW of coal fired generation projected to retire by 2020
- The number of utilities seeking help in identifying potential grid stability issues and weighing options to solve those problems has increased markedly
- In an environment of excess capacity, VAR support is a cost effective option

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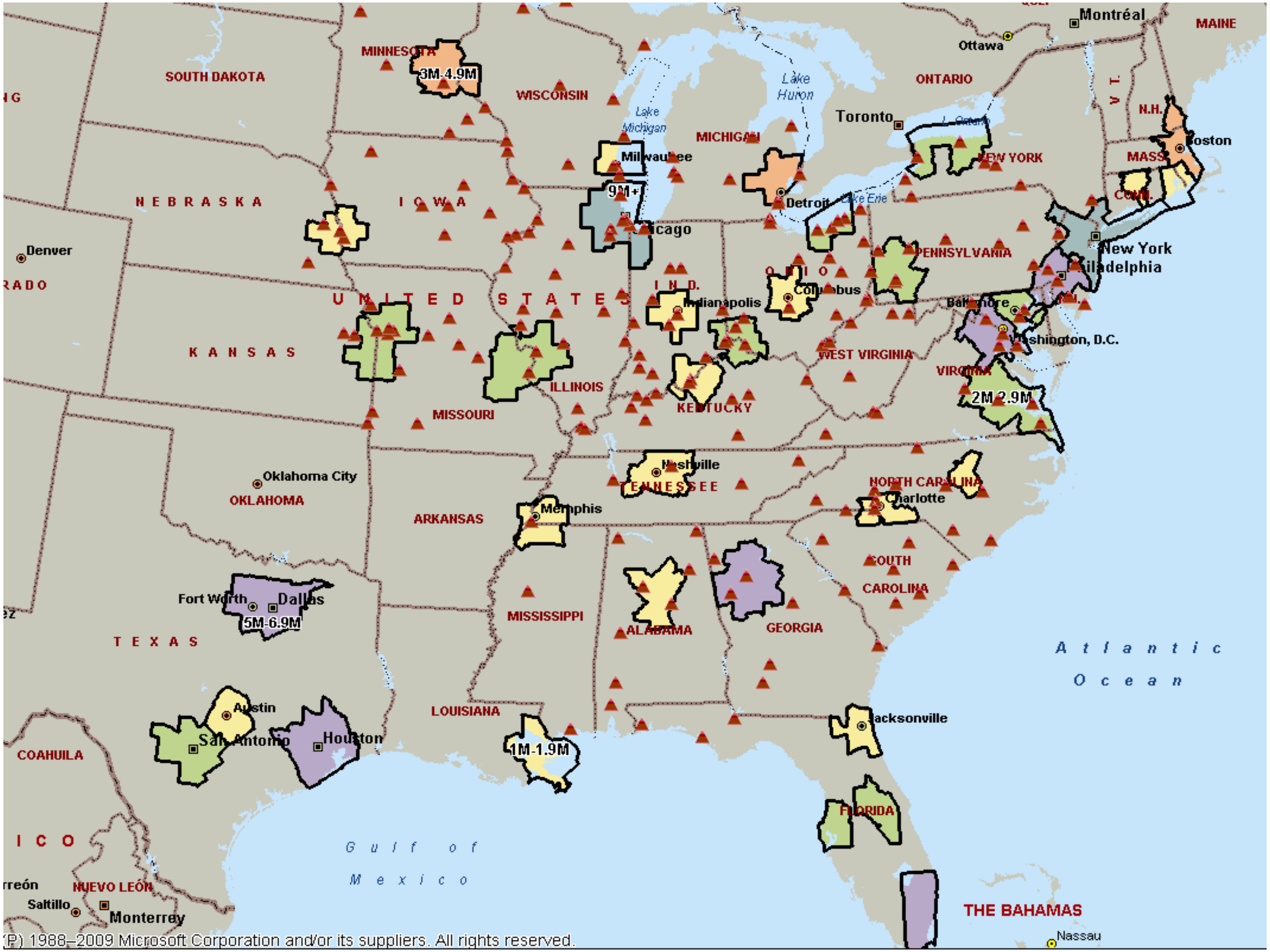
EPA rulings and potential generation retirements



Public announcements of power plant retirements

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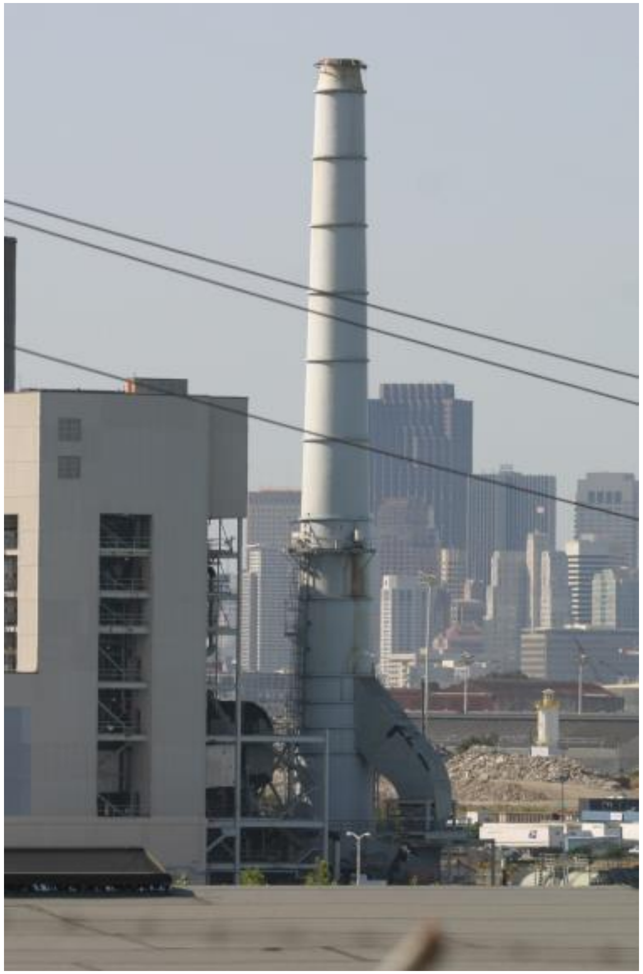
American Electric Power agrees to close 3 coal plants in emissions settlement.

By Juliet Eilperin and Steven Mufson, February 25, 2013

One of the the nation's largest utilities agreed Monday to close three of its coal-fired power plants as part of a settlement with government officials and environmental groups, the latest sign of how the nation's electricity supply is shifting away from coal.

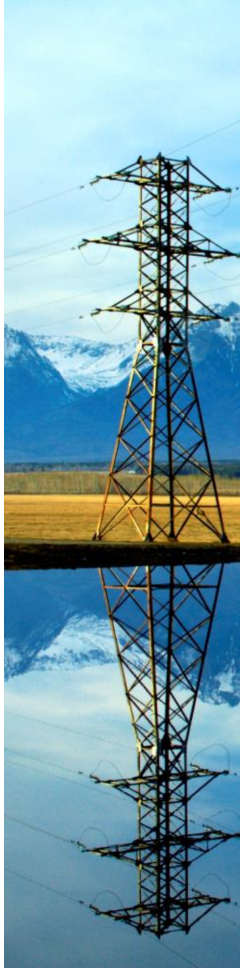
Updating an earlier 2007 settlement, American Electric Power will stop burning coal by 2015 at three power plants in Indiana, Ohio and Kentucky and replace a portion of that supply with new wind and solar investments in Indiana

Grid stability assessment
What happens when power plants retire?



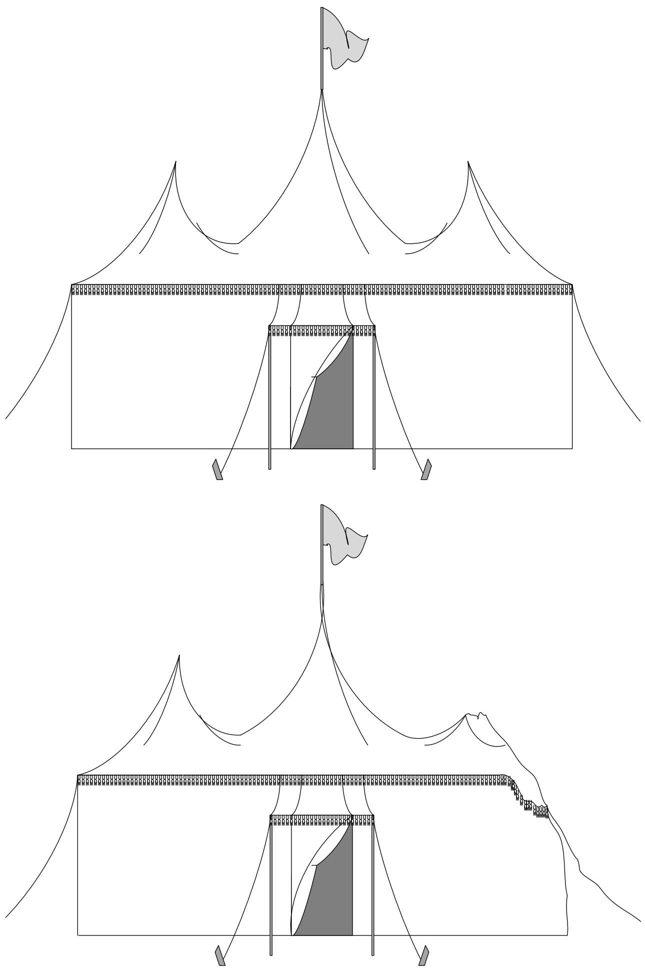
- Generation/load balance impacted
- Available reserves are reduced
- Local system strength decreases
- Resulting redistribution of power may adversely impact the system
- Net reactive power demand increases
- Local voltage support is lost
- Post-fault system recovery is weakened
- System transfer limits may change
- Some stabilizing torque is lost

Grid stability and power plant retirements



- Generation provides both real (MW) power and dynamic (spinning) reactive power (MVAr) contributions to power system
- When generation is retired in load centers, reactive power needs generally increase as imports increase
- Voltage is highly dependent on the physical location of reactive sources
- Dynamic reactive power is essential to voltage recovery following critical faults
- Voltage recovery has a high degree of sensitivity to the type of load served in a particular location
- Loads in loads centers is often dominated by small motor loads (air conditioning) that drive post-fault system dynamics

Grid stability assessment
What happens when power plants retire?



- Local voltage support is lost
  - Locally supplied reactive power is removed
  - Easier for high load levels to cause voltage collapse
- Post-fault recovery weakened
  - Lower ability to dynamically stabilize the system

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Alternatives to maintain stability
Option 1: Repower at the same site

- New plant must operate during critical system conditions – many coal facilities that are candidates for retirement are low-cost producers and therefore base load units
- New generation may be mid-merit combined cycle or peaking, which will not operate 24/7 as would a base load unit that is being retired
- Need for reactive support and plant operation may occur not only during times of peak loads but also at times of peak imports
- Out of merit dispatch for reliability results in increased RMR costs in most market environments

Alternatives to maintain stability
Option 2: Convert generator to synchronous condenser

- Provides spinning mass (contributes to fault current)
- Capital cost to convert (typically performed by generator OEM)
- The age and condition of the existing GSU transformer should be factored in to the total conversion cost as the entire installation is critical to grid reliability
- Introduces significant operating losses to transmission system
- High operating costs for operations (typically a manned station) and maintenance
- Contractual mechanism to be compensated for a former generation in a market environment

Alternatives to maintain stability
Option 3: Deploy a greenfield synchronous condenser

- Must consider all system integration issues in the planning process
  - Step-up transformer specification
  - Fault current contribution and impact on station breakers
- Typically higher capital cost (~3-4x of SVC)
- System losses and financial impact of losses
- Utility experience of 50+ years

Alternatives to maintain stability
Option 4: Deploy a FACTS Device, Static Var Compensators (SVC) or STATCOM

- Substation transmission equipment, clear tariff mechanisms under FERC rules for transmission ROI
- Much faster response time (20-50 msec) compared to synchronous condensers
  - Technical benefits related to dynamic voltage recovery can be realized from faster response time in networks with high concentrations of air conditioning load and shunt capacitors
- Lower operating costs than rotating options that have spinning mass
  - System losses
  - Normally reside in unmanned stations
- No contribution to fault current
- Utility experience of 30+ years

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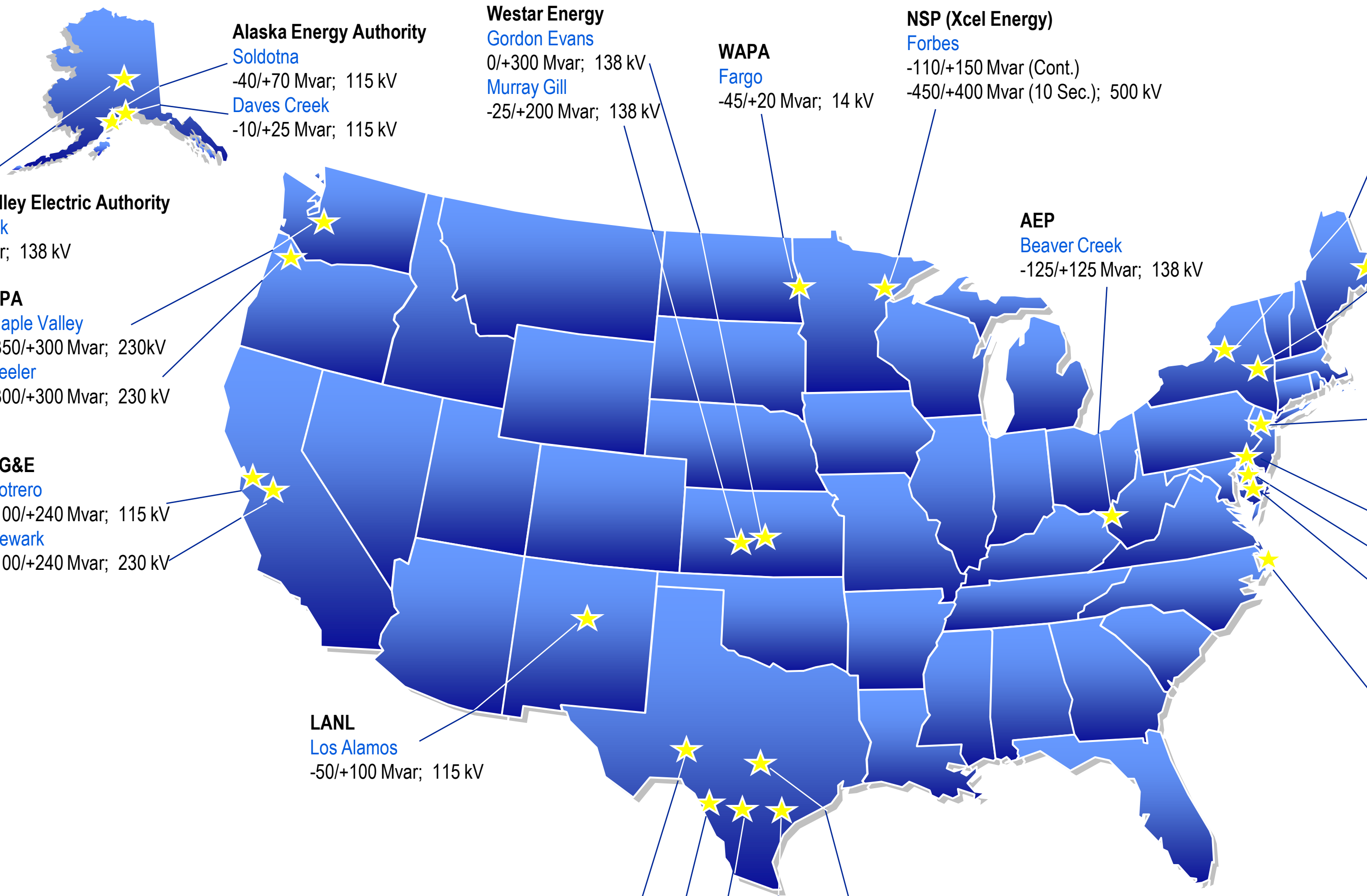
U.S. SVC & STATCOM Utility Installations (until 2005)*

***ABB SVC and Statcom utility installations**



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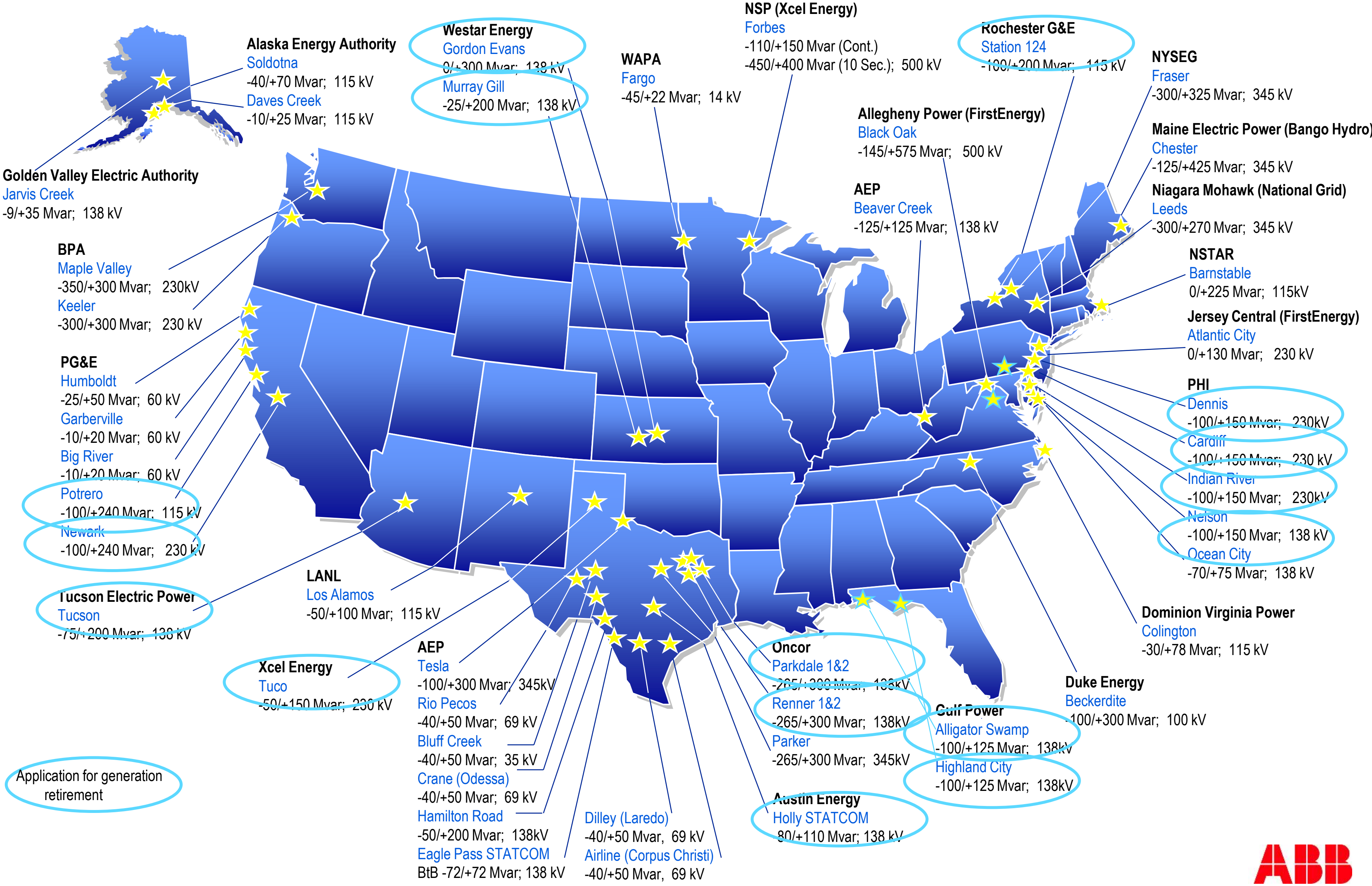
U.S. SVC & STATCOM Utility Installations (until now)

***ABB SVC and Statcom utility installations**



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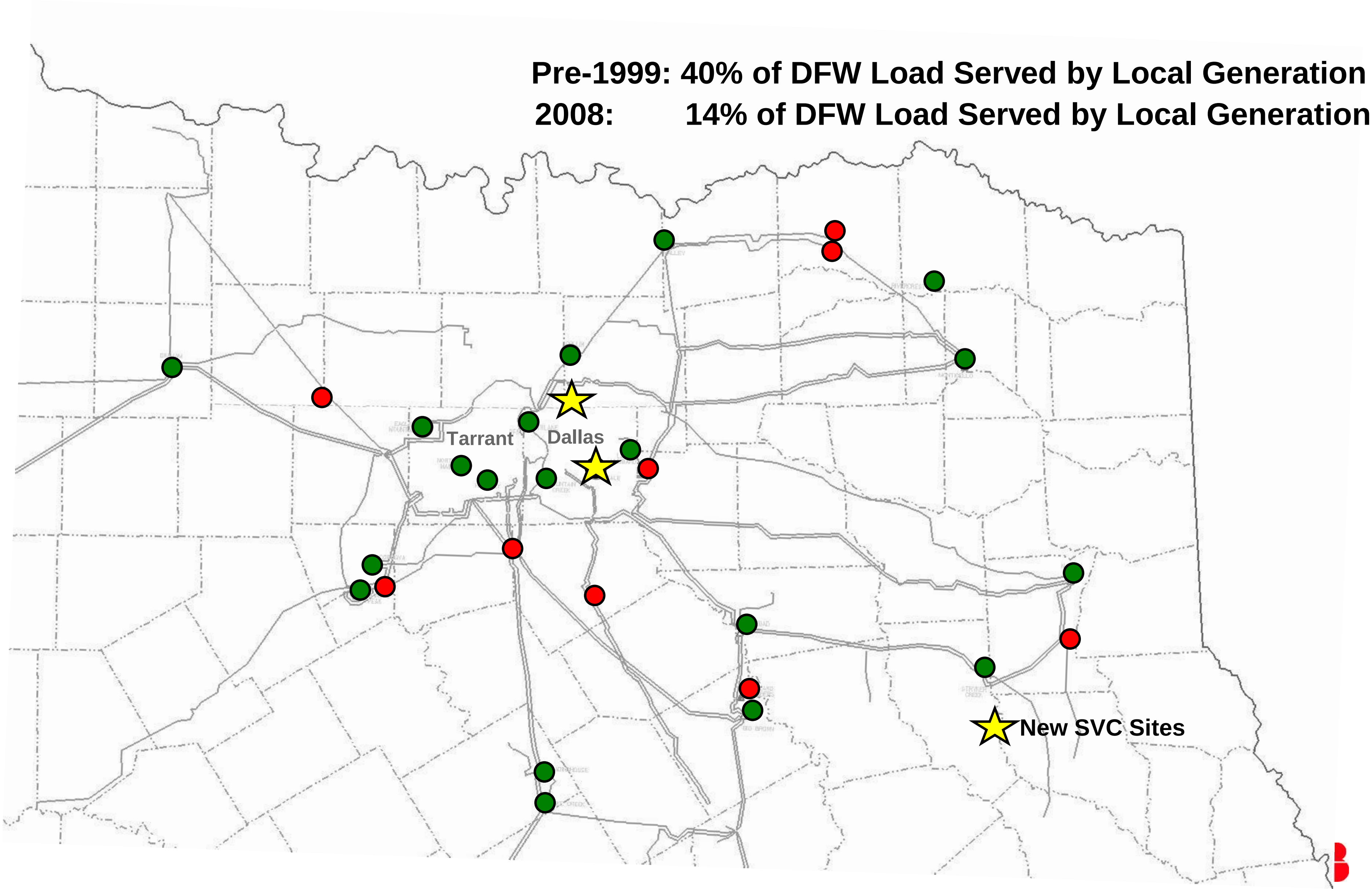
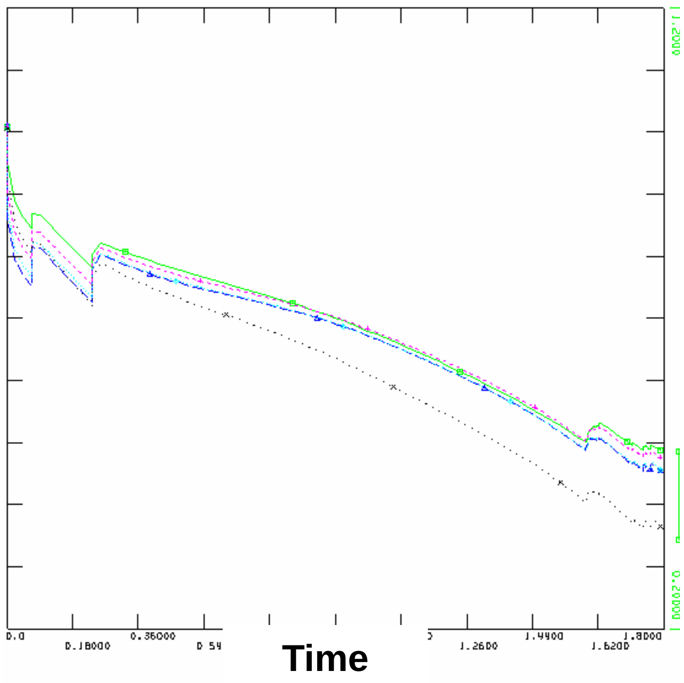
North Texas Generation Changes 1999-2008

Pre-1999: 40% of DFW Load Served by Local Generation

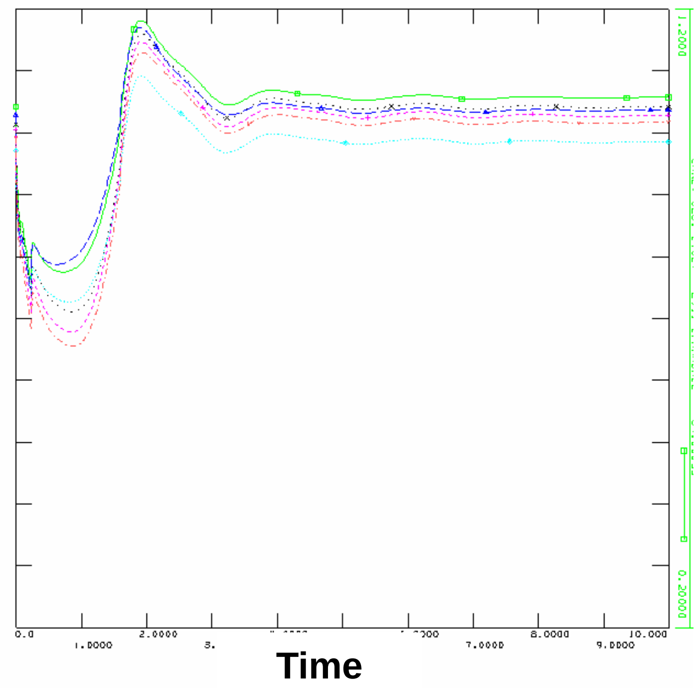
2008: 14% of DFW Load Served by Local Generation



Oncor Parkdale & Renner SVCs
System Need for SVC



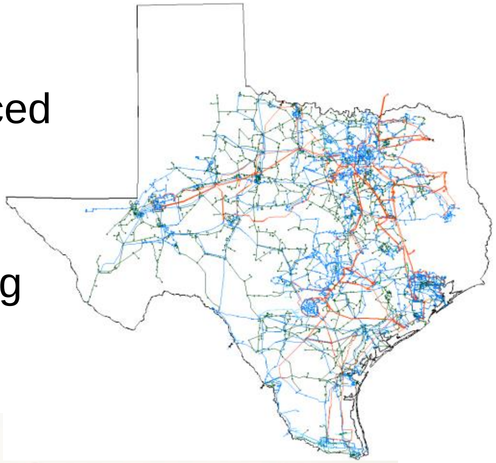
Post contingency bus voltages with 263 MW of DFW area generation off-line.



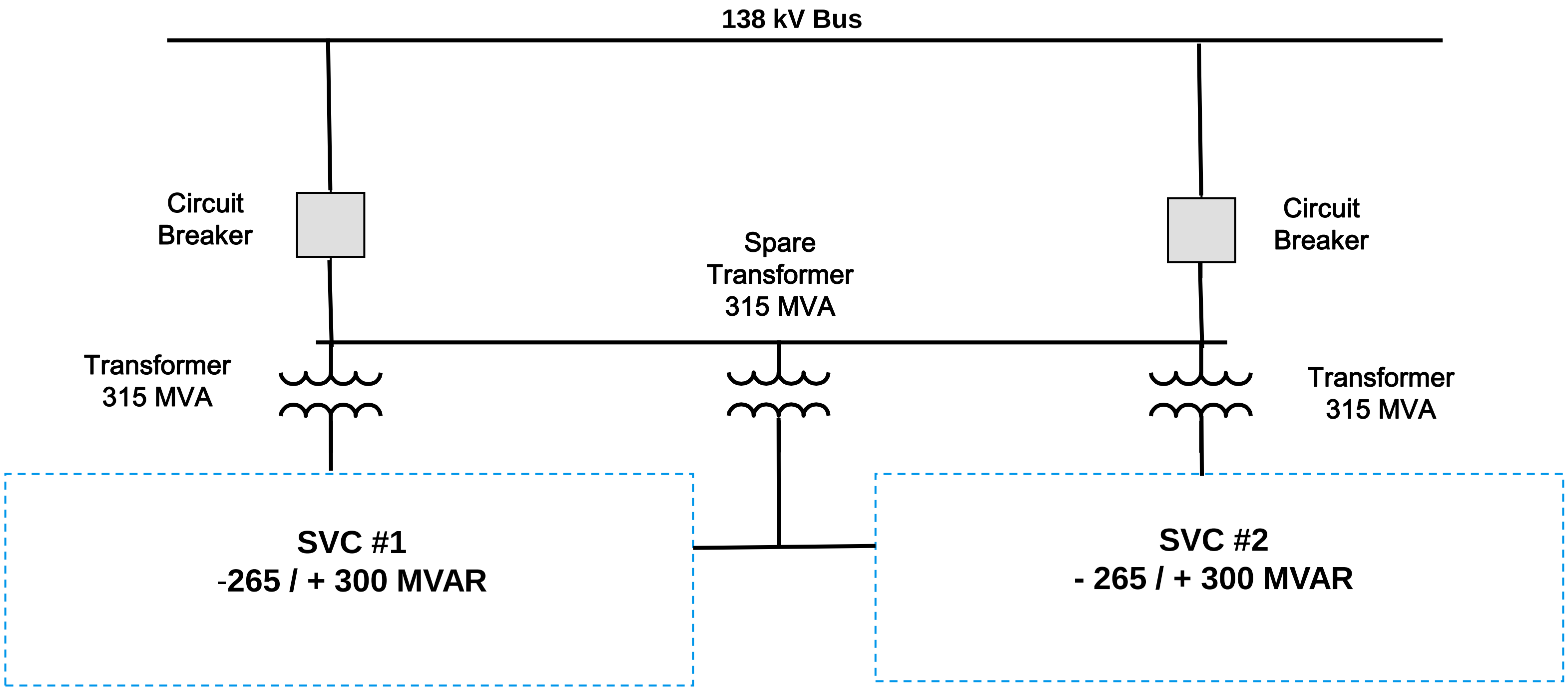
Post contingency bus voltages with all DFW area generation on-line

Oncor Parkdale & Renner SVCs

- -265 / +300 Mvar, 138kV
- Oncor's first SVC is located in East Dallas, at the site of the former Luminant Parkdale Generating Station (generating units originally placed in service 1953 – 1956)
- Oncor's Parkdale SVC site was the world's largest cluster of SVCs
- The SVC response time required for the DFW area is the fastest-acting in the world



Oncor SVCs, Station Configuration



SVCs include:

High speed switched capacitors for coarse voltage control of undervoltages

High speed switched inductors for fine voltage control and limiting overvoltages

Harmonic filters for voltage waveform smoothing

Protection and control system

Cooling system for power electronics

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for a better world™