

SCE perspective

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Power Research Workshop University of Southern California

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Power System Research – Utility Perspective

- Introduction – San Diego Blackout
- Key Issues
- Present day challenges
- How USC can help
- Power Systems Research Areas
- Funding sources for USC's Power Systems Research

San Diego Blackout – Sept. 8, 2011

- Massive blackout rolled through San Diego, Orange County, and Mexico
 - Complete restoration took 15 hours
- Began at Yuma Substation when a Tech switched off a malfunctioning voltage regulator.
- Within minutes a critical transmission line linking Yuma Sub with Phoenix tripped.
- A massive power swing caused several transmission lines and SONGS to trip.

Key Issues

- Aging electric power infrastructure.
- Limited network capacity to absorb sudden power flow surges.
- Reduced utility power flow control capability.
- Weakened “System” (power network) inertia.
- Substation devices / equipment monitoring and self-diagnosis.
- Need for enhanced power flow monitoring and adaptive protection schemes
- Optimization of generators, transformers, circuit breakers, bus bars, etc., that configure a power system network.

Present Day Challenges

- Increasing Demand
 - Miles of overhead transmission lines:
 - Reaching end of service life
 - Stressed beyond their design limits
- Rights-of-Way
 - Acquisition of land or use of Rights-of-Ways
- Regulatory Environment
 - Ever-changing and Complex
 - Permitting is a long arduous process
 - No guarantee for return-on-investments
 - Rates utility can charge are mandated

Present Day Challenges - Continued

- Dense Loads
 - Huge concentrated power demand (e.g. high-rise buildings)
- Infrastructure Constraints
 - Existing U/G cables and conduits are maxed out
 - Existing transmission line capacity is maxed out
 - Near or end of designed life
- New Generation
 - Built in remote areas
 - No capacity on existing transmission corridors
 - 33% renewables mandated for 2020

Present Day Challenges - Continued

- Financial Resources
 - Limited
 - Too costly to completely replace the aging system
 - **Utilities / universities must develop new methods, technology, devices, and systems.**
- Human Resources
 - Power engineer shortage
 - Since 1970's Universities have cut back on power engineering courses and research efforts.
 - There is an industry-wide shortage of power engineers and faculty.
 - 60% of utility engineers are of retirement age and there is nobody in the pipeline to take over
 - **Universities must enhance power engineering education and research programs.**

How USC can help

- Innovate
 - A. New technology
 - B. New components
 - C. New systems
 - D. New optimization techniques
- Human Resources
 - Revamp power engineering education and research programs
 - Mint new engineers and researchers

USC can benefit California utilities and residents, the nation, and the world.

Power Systems Research Areas

- Power Angle Control
 - Devices / systems to replace divested generating stations' power angle control capability.
- Energy Storage (Magnetic)
 - Devices / systems to compensate loss of rotating mass (generator inertia).
- Voltage / VAR
 - Devices / systems which can support the voltage and reactive power.

Power Systems Research Areas - Transformers

- Dissolved Gas Analysis
 - Transformers
 - On-Load Tap Changers
- Online Infrared Monitoring
- 3D Acoustics Analysis



Power Systems Research Areas – Circuit Breakers

- Fault Current Limiting
 - Limit the fault current
 - Reduce downstream bus/equipment/devices stresses
- Online Infrared Monitoring
- Circuit breaker post and bushings monitoring
- Radio Frequency SF6 density monitoring (SF6 circuit breakers)



Power Systems Research Areas

– Transmission & Distribution Lines

- Transmission line insulator contamination monitoring
- Tower and transmission span sag monitoring
- Tower structural and foundation strength monitoring
- Automatic line compensation



Power Systems Research Areas

– Underground T & D Cables

- Underground cable temperature / hot spot monitoring
- Underground cable insulation / water treeing monitoring
- Cable duct moisture / water content monitoring



Power Systems Research Areas

– Renewable Resource Integration

- Customer photovoltaic generation monitoring
- Wind generator excitation monitoring and optimization
- Dynamic power source
 - Alter / control flat power source output



USC Funding Opportunities

- Partnerships
 - Local utilities
 - Equipment / system manufacturers
- Power System Research Project Proposals
 - U.S. Dept. of Energy (as per their research program)
 - California Energy Commission (as per their research program)
 - Other state research agencies (e.g. NYSERDA, NREL, LBNL, and others)
 - EPRI, CEATI, and others
 - Foreign electric utilities (e.g. EDF, National Grid, and others)

Thank you

**Let us enhance USC's Power Systems
Engineering Education and Research Programs.**

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Advanced Technology

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