CURENT RESEARCH

curent.utk.edu/research

Fact Sheet

Vision

- A nation-wide transmission grid that is fully monitored and dynamically controlled for high efficiency, high reliability, low cost, better accommodation of renewable sources, full utilization of storage, and responsive load.
- A new generation of electric power and energy systems engineering leaders with a global perspective coming from diverse backgrounds.

Why CURENT is Needed

- Energy sustainability is one of the most fundamental societal challenges.
- Reliance on fossil fuels creates significant environmental and national security issues.
- Solutions are being pursued which focus mostly on source and load.

CURENT System

In order to achieve our vision, CURENT will develop a system that can showcase wide-area control and monitoring technologies with large penetration of renewables.

Year 1~3	Year 4~6	Year 7~10
Generation I	Generation II	Generation III
Regional grids with >20% renewable (wind, solar), and grid architecture to include HVDC lines	Reduced interconnected EI, WECC and ERCOT system, with >50% renewable (wind, solar) and balance of other clean energy sources (hydro, gas, nuclear)	Fully integrated North American system with >50% energy (>80% instantaneous) inverter based renewable resources (wind, solar) and balance of conventional (hydro, gas, nuclear)
System scenarios demonstrating a variety of seasonal and daily operating conditions	Grid architecture to include UHV DC lines connecting with regional multi-terminal DC grids, and increased power flow controllers	Grid architecture to include UHV DC super-grid and interconnecting overlay AC grid and FACTS devices
Sufficient monitoring to provide measurements for full network observability and robustness against contingencies, bad topology or measurement data	System scenarios demonstrating complete seasonal and daily operating conditions and associated contingencies, including weather related events on wind and solar	Controllable loads (converter loads, EV, responsive) and storage for grid support
Closed-loop non-local frequency and voltage control using PMU measurements	Full PMU monitoring at transmission level with some monitoring of loads	Fully monitored at transmission level (PMUs, temperature, etc.) and extensive monitoring of of distribution system
Renewable energy sources and responsive loads to participate in frequency and voltage control	Fully integrated PMU based closed-loop frequency, voltage and oscillation damping control systems, and adaptive RAS schemes, including renewables, energy storage, and load as resources	Closed loop control using wide area monitoring across all time scales and demonstrating full use of transmission capacity and rights-of-way
		Automated system restoration from outages

Engineered Platforms

Large Scale

- Develop a large scale simulation platform to demonstrate CURENT Technology.
- Demonstrate to stakeholders how CURENT technology can improve the existing system.

Hardware

- Emulate electric grid system with interconnected clusters of scaled-down sources and loads.
- Use modular, reconfigurable converters for sources, loads, flexible network and scenario emulation.

Generation 1 System Level Projects

HVDC & FACTS

- Develop technologies needed for the future hybrid AC-DC transmission network, including:
  - Advanced HVDC converter technologies
  - Meshed and multi-terminal HVDC control & protection
  - Architecture scheme for better utilization of transfer capability
  - PMU based remedial action scheme for hybrid AC-DC systems

Measurement Based On-Line Grid Condition Assessment Toolbox

- Utilize fast, wide-area monitoring to facilitate improved protection and control functions
- Develop better visualization and support tools for system operators

Frequency Regulation and Control with Large Renewable Penetration and Inverter Control

- Develop methodology and provide characterization on using wind and PV solar energy for dynamic grid frequency and voltage support over wide areas.
- Explore the effects of inverter-connected sources and loads on electromechanical system stability.
- Quantify contributions of distributed, local control policies to system-wide robust stabilization.

Measurement Based Wide-Area Voltage Security

- Use real-time measurements for voltage security assessment (VSA)
- Develop a hybrid VSA scheme integrating model based and measurement based approaches, in particular, for load areas supplied by multiple interface lines.

Resilient Multi-Level Wide-Area Dynamic State Estimator and Cyber Security

- Develop a dynamic state estimator:
  - Tracking the dynamic system state based on available measurements
  - Remaining robust and accurate against measurement delays, losses or errors
  - Estimating network parameters
- Establish cyber security methods:
  - Detect attacks made on measurements and communication systems
  - Share and/or store data securely

POINTS OF CONTACT

Kevin Tomsovic
865.974.3461
tomsovic@eecs.utk.edu
The University of Tennessee Knoxville

Ali Abur
617.373.3051
abur@ece.neu.edu
Northeastern

Joe Chow
518.276.6374
chowj@rpi.edu
Rensselaer

Greg Murphy
334.727.8995
gvmurphy@mytu.tuskegee.edu
TUSKEGEE

research funding provided by