Energy Reliability and Security (ERISE) Laboratory

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Research Mission

The ERISE Laboratory is engaged in the development of innovative systemic approaches to facilitating secure and reliable energy delivery solutions. These systemic approaches integrate system architectures, protection, control and communication.

Recent and Ongoing Research Projects

ERISE researchers are developing several integrative solutions that enable secure and reliable energy delivery. Some of the major projects are described below.

A Lyapunov Function Based Remedial Action Screening (L-RAS) Tool Using Real-Time Data. This $1.5 million project was sponsored by the US Department of Energy (DOE) and was led by Prof. Mitra. It significantly advances the state of the art in real-time stability solutions that empower superior decision-making in power system control centers.

Following a disturbance that can potentially destabilize the grid, the system can evolve along any of numerous possible trajectories, which may be exacer-bated by subsequent events or ameliorated by operator action. At present, there is no effective tool to assist the operator in making a well-informed choice from amongst a profusion of remedial action alternatives. Using the tools available today, it is impossible to evaluate or screen every trajectory the system could assume—the computational challenge of performing time-domain simulation of every, or even a selected set of probable trajec-tories, within the time available to an operator, is simply unassailable. ERISE researchers are developing a screening tool that uses an approach based on Lyapunov functions to enable, without time-domain simulation, the selection of appropriate remedial actions that are most likely to result in stabilizing trajectories. If necessary, these trajectories may then be quickly evaluated using existing simulation tools. Even during the process of screening and evaluation of remedial actions, the system would be dynamically evolving, so the tool will be continuously updated using real-time data from the SCADA (supervisory control and data acquisition) system.

The L-RAS also represents a significant mathematical innovation toward enabling the understanding of catastrophic failures in power systems and the rapid and correct selection of remedial actions. The project team includes ERISE researchers and collaborators from the University of Illinois–Chicago, the Center for Advanced Power Systems at Florida State University, Los Alamos National Laboratory, and Southern California Edison.

Transformer-less Unified Power Flow Controller for Wind and Solar Power Transmission. This $2.4 million project was sponsored by the Advanced Research Projects Agency–Energy (ARPA-E). Prof. Fang Peng, Director of the ZELRI Power Electronics Lab at MSU was lead investigator and Prof. Mitra, Director of the ERISE Lab, was co-investigator. This development will lead to a smaller, lighter, and more economical alternative to traditional unified power flow controllers (UPFC).

UPFCs play an important role in modern power systems, with a wide range of applications from facilitating the integration of renewable resources to relieving transmission system congestion. The development of a smaller, lighter and cheaper

Graduate students at work in the ERISE lab.

UPFC will pave the way for more widespread deployment of grid control devices, leading to increased reliability and efficiency in the power grid.

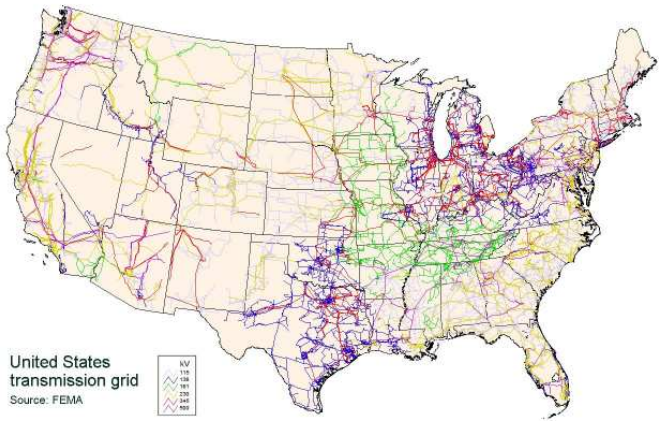
While ZELRI researchers were engaged in the development of the hardware for the transformer-less UPFC, ERISE researchers worked on system integration issues, such as development of advanced models, analysis tools and protection schemes, simulation of use cases and deployment scenarios, and cost-benefit analyses under various deployment options.

Impact of Increased Renewable Generation in Michigan's Lower Peninsula. ERISE researchers recently completed research project funded by Consumers Energy Corporation to perform economic and reliability analyses of the impact of varying levels of renewable energy penetration, and to provide recommendations for suitable compositions of renewable portfolios for the MISO (Mid-Continent Independent System Operator) Zone 7 footprint.

Architecture of Resilient Microgrids. This body of work comprises several projects, supported by multiple grants from the National Science Foundation and Sandia National Laboratories. It concerns the development of reliable topologies and microsource deployment strategies, robust and autonomous control strategies, and an integrated framework for control and protection of microgrids.

A microgrid is basically a small power system with embedded generation; often it also includes storage capability. It can be a part of the grid, such as a distribution system or part thereof, with distributed energy resources; or it can be a standalone system, such as an island system, a military base, or a shipboard system. Microgrids are diverse in topology, resources, and requirements. In a majority of applications, microgrids are required to meet reliability (dependability) specifications or at least enhance system reliability; often, resilience, i.e., robustness in the presence of disruptive forces, is an added requirement, such as in military microgrids or naval systems.

ERISE researchers have been developing methods for optimal network configuration in microgrids, optimal sizing and location of distributed resources within microgrids, distributed analytics for robust operation of microgrids, multi-agent system based autonomous control architectures, observer-based sensing and protection systems, and integrated protection and control platforms for resilient microgrids.



The US Grid has over 160,000 miles of transmission lines, operating which requires considerable coordination by grid operators. The L-RAS tool will allow stable control of the system while the UPFC project will allow control of individual line flows and lead to higher utilization of grid assets.

Other research problems being investigated by ERISE researchers include grid-scale and distribution-scale storage to assist renewable energy integration, reliability modeling of clusters of resources, and identification of catastrophic failure modes in power systems.

Funding Sources

ERISE projects have been funded by the National Science Foundation, Department of Energy, Advanced Research Projects Agency for Energy, National Laboratories and Electric Utilities.

Laboratory Location

The ERISE Lab is located in the Engineering Research Complex, Room C-24B. The street address is 1439 Engineering Research Ct, East Lansing, MI 48824. Please call (517) 353-8528 to arrange a visit.

ERISE Team

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