

Technology Innovation Project



*Closing
Project Brief*

TIP 328: Real-Time Load Composition Estimation

Context

Dynamic stability analysis, power system control, variable generation integration, and demand response deployment all benefit from accurate real-time estimation of load characteristics. Loads can be categorized broadly as commercial, industrial, or residential. Each of these three types have different characteristics. For example, commercial loads are comprised of large HVAC and lighting systems; industrial loads can be large three-phase motors; and residential loads are lighting, HVAC, single-phase induction motors, and information technology loads.

Knowledge of how a substation or bus can be further delineated in terms of the load sector it serves can be leveraged for more accurate control and modeling.

Description

This project work was to develop, test, and validate a real-time active and reactive power flow composition methodology. Synchrophasor technology was utilized in real-time to estimate bus and line active and reactive power flow in terms of percentage serving residential, commercial, and industrial loads. This information can be used in turn to inform the accurate parametrization of the WECC Composite Load Model.

Testing and validation of the load composition estimation methodology was conducted using the Oregon State University campus as the test bed. The campus provides examples of each load type—commercial, industrial, and residential—that are readily defined: dormitories and housing for residential; office buildings for commercial; and manufacturing and testing facilities (e.g., the WESRF) for industrial. The presentation of the methodology is very similar to the visual interface of the popular power system simulation software PowerWorld, except that power flows along buses and along lines are differentiated as fractions serving residential, commercial, and industrial loads.

The methodology operates in near real-time utilizing data from Phasor Measurement Units (PMUs). The entire Oregon State University campus—which is already outfitted with several PMUs—served as the validation test bed. Loads of up to 750 kVA were modulated using the WESRF to test and validate the

tool for power flows over the entire OSU Corvallis campus.

The sequence of project tasks was:

1. Determine PMU placement;
2. Install PMUs and connect to Phasor Data Concentrator (PDC);
3. Determine load composition of OSU campus;
4. Determine ow estimation method;
5. Write code for estimation method streams as well as historical records on storage;
6. Develop GUI; and
7. Test and validate campus flow estimation using WESRF.

Benefits

The research provides improved dynamic understanding of system vulnerabilities and opportunities by improved dynamic load modeling. It has the potential to provide a substantial financial benefit through avoided blackout costs, improved blackstart capability and exploitation of demand response resources.

Accomplishments

The goal of TIP328 was to develop, test, and validate a real-time load composition estimation methodology that can be used to enable accurate utilization of the Western Electricity Coordinating Council (WECC) Composite Load Model.

The work included installing additional PMUs on the Oregon State University campus, and characterizing key buses on campus in terms of the load composition they serve, to create a test network.

The project developed and refined a methodology for estimating load composition in terms of commercial, industrial, and residential components at key buses using real-time PMU observations.

Finally, it developed a Graphical User Interface (GUI) for visualizing and archiving the data for either real-time or a posteriori analysis.

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Project Start Date: October 1, 2014

Project Cost

Project End Date: December 31, 2015

Total Project Cost: \$688,726

Deliverables

Final Report.

All data, results, and code is available to BPA and the project partners upon request.

All infrastructure developed and deployed for the project will be leveraged for additional research opportunities beyond the projects conclusion. These research paths are identified in the final report.

For More Information Contact:

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Links

Related Projects

Participating Organizations

Oregon State University School of Electrical Engineering & Computer Science
Oregon State University College of Engineering
Built Environment and Sustainable Technologies Center (BEST)
Ford Motor Company
Grainger Center for Electric Machinery and Electromechanics (CEME)
Portland General Electric (PGE)
The Wallace Energy Systems and Renewables Facility (WESRF)

