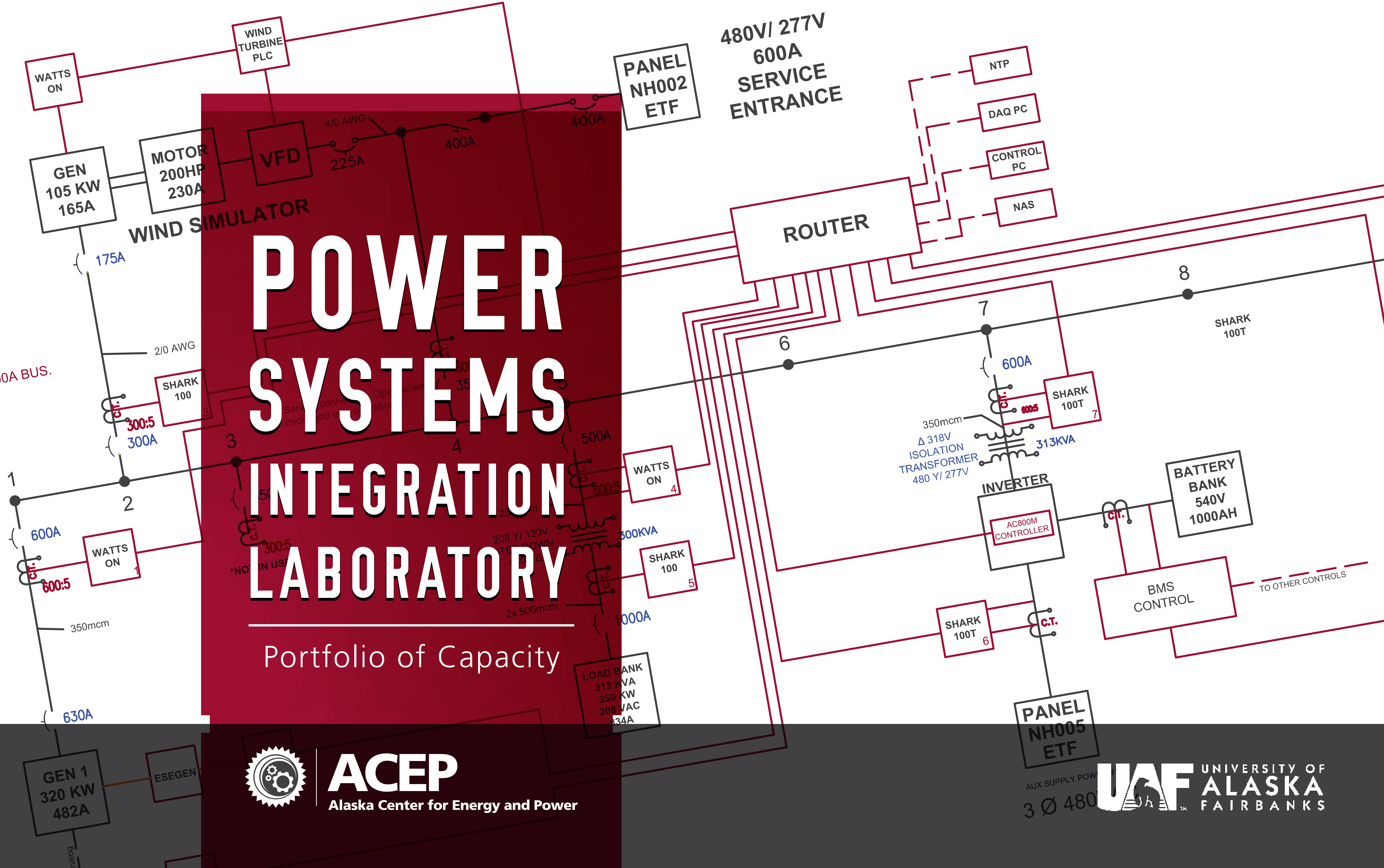
POWER SYSTEMS INTEGRATION LABORATORY

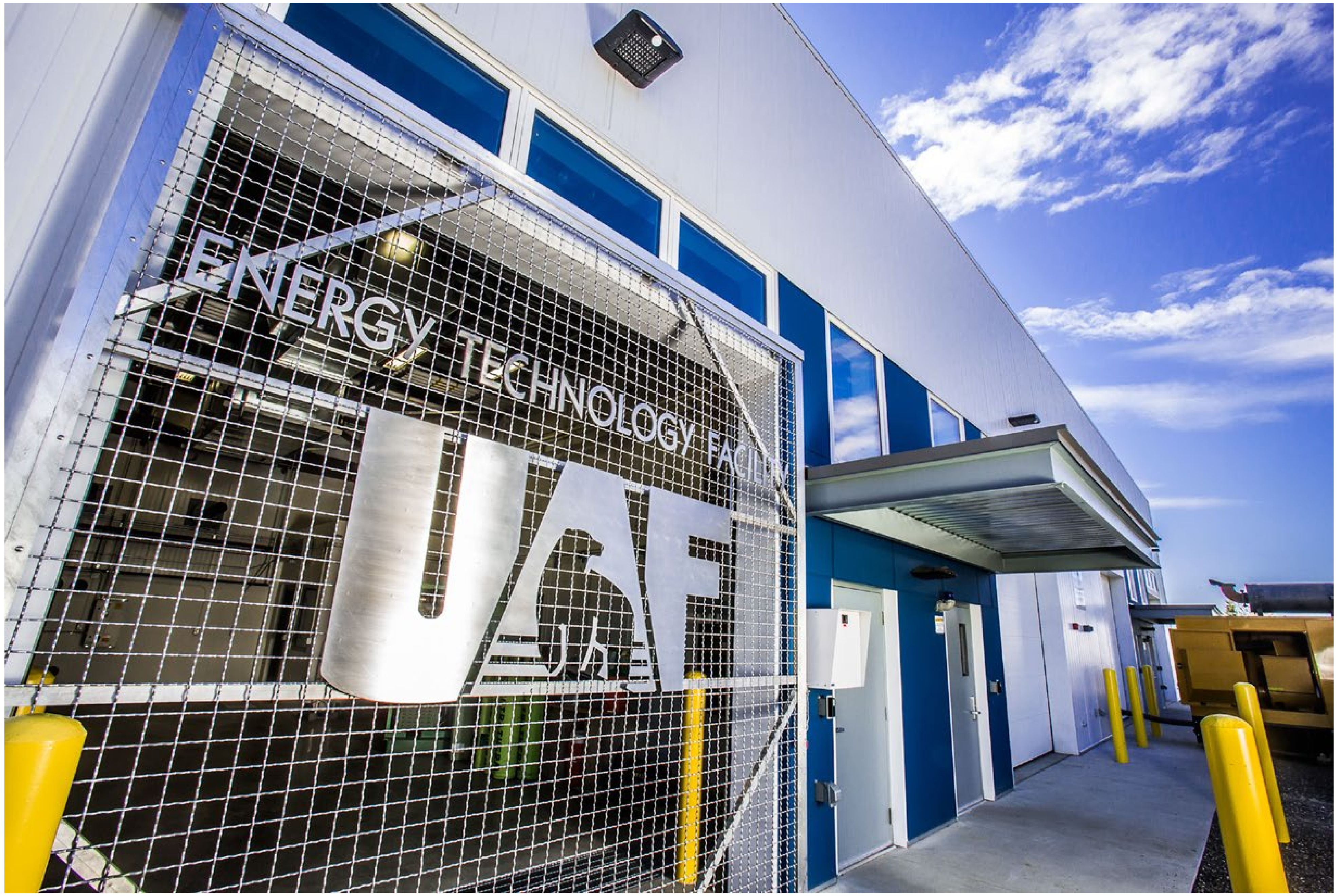
Portfolio of Capacity



ACEP
Alaska Center for Energy and Power

UAF UNIVERSITY OF ALASKA FAIRBANKS

Power Systems Integration Lab

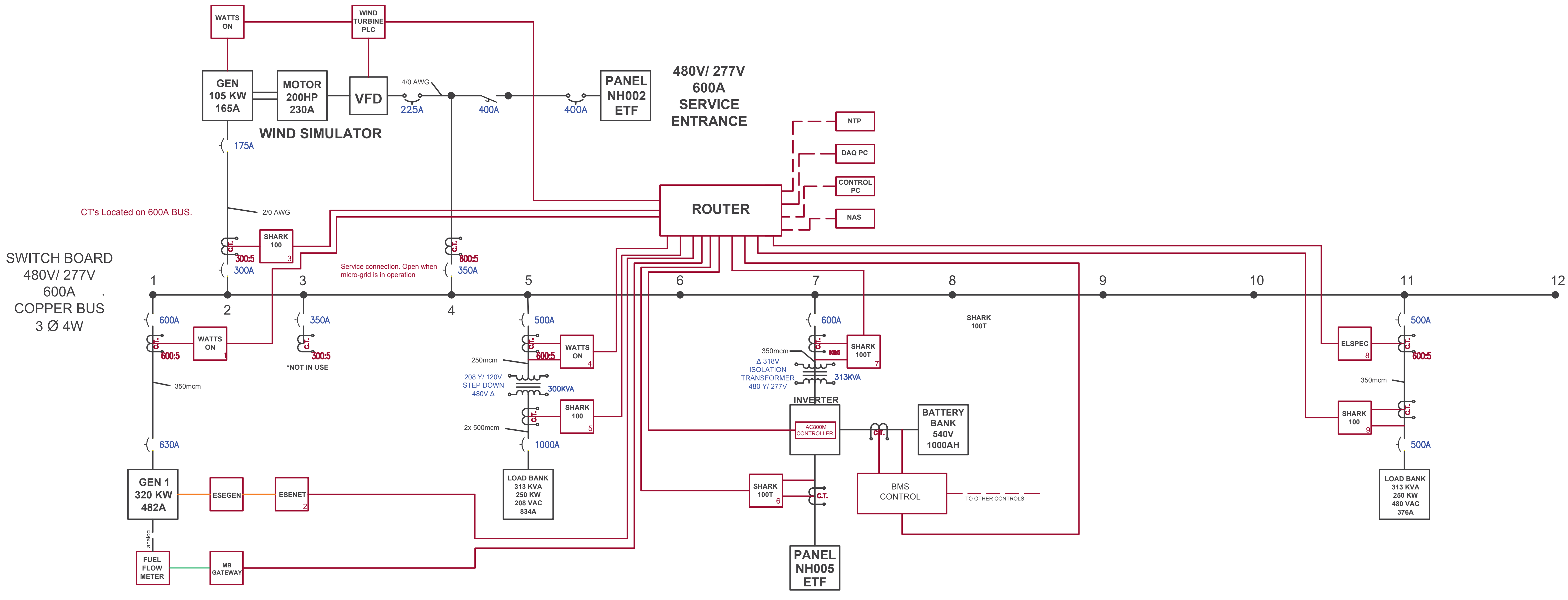


The Power Systems Integration Lab operates on the same scale as a village power system and has the ability to be modified for individual test scenarios.

The lab emulates an isolated hybrid-diesel grid at up to 500 kW of permanently installed capacity and potential capacity of several MW. The lab transforms a potentially chaotic field testing environment into a continuously improving process for optimizing efficiencies.

The R&D and testing capabilities of the PSI Lab are complemented with experienced faculty and staff providing engineering and research services from energy analysis, and design development and review, through full-scale in-system R&D, product testing and hardening.

Opposite: Conceptual overview of the laboratory configuration.



Network ID

1. Gen
2. Gen easygen
3. WTG
4. Load 2 WO
5. Load 2
6. InvCtrl
7. Inverter
8. Load 1 elspec
9. Load 1

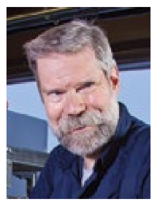
Communication Protocol

RED- Modbus TCP
ORANGE- CAN
GREEN- RS485
DASHED RED- ETHERNET/ MIXED

Power Systems Integration Lab Staff and Affiliates

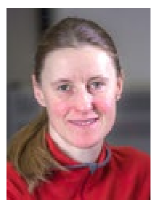
Dr. Marc Mueller-Stoffels

Marc is the Director of the Power Systems Integration Program and Research Assistant Professor with the Institute of Northern Engineering.



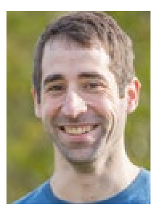
David Light

David is a Research Engineer for the Power Systems Integration Program and the Chief Engineer for the PSI Lab.



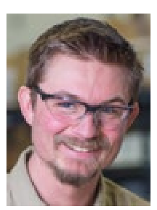
Heike Merkel

Heike is a Research Engineer in charge of Project Management for the PSI Lab.



Luis Miranda

Luis is a Research Engineer for the Power Systems Integration Program.

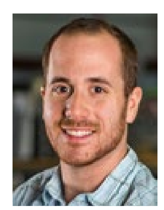


Jeremy Vandermeer

Jeremy is a Research Engineer for the Power Systems Integration Program.

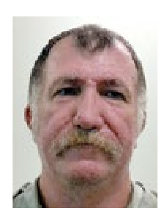
Dr. Daisy Huang

Daisy is the Assistant Professor for Energy in Mechanical Engineering.



Nick Konefal

Nick is a Research Engineer for the Power Systems Integration Program.



Phil Maker

Phil is an Adjunct Research Professor for the Power Systems Integration Program.

Dr. Hendrik Schaede

Hendrik joined ACEP as a Postdoctoral Fellow (faculty employee) for three months, working on energy storage application modeling, sizing and control integration. Hendrik also spent one month at Cordova Electric Corporation (CEC) to support an ongoing project with ACEP to maximize CEC's hydropower utilization.

"The Power Systems Integration Laboratory provides the ability to perform in-system R&D on hardware and control solutions for islanded microgrids. The PSI Lab is an essential tool in driving development of solutions for improved microgrids towards field-readiness. The PSI engineering team combines experiences from control system development and system modeling to product hardening and customization for successful deployments in austere conditions." — Dr. Marc Mueller-Stoffels, Director, Power Systems Integration Program

Power Systems Integration Lab Hardware

The Grid

The PSI Lab grid is based on a 480 VAC three-phase architecture, with secondary 208 VAC connections available.

The basic bus infrastructure is a 12 station switchgear that can carry up to 600 A continuous capacity. Particular grid configurations are achieved by switching of main circuit breakers.

Each piece of equipment is further protected by individual secondary circuit breakers, which generally also act as the switching breakers in automated control schemes.

Data Collection and Management

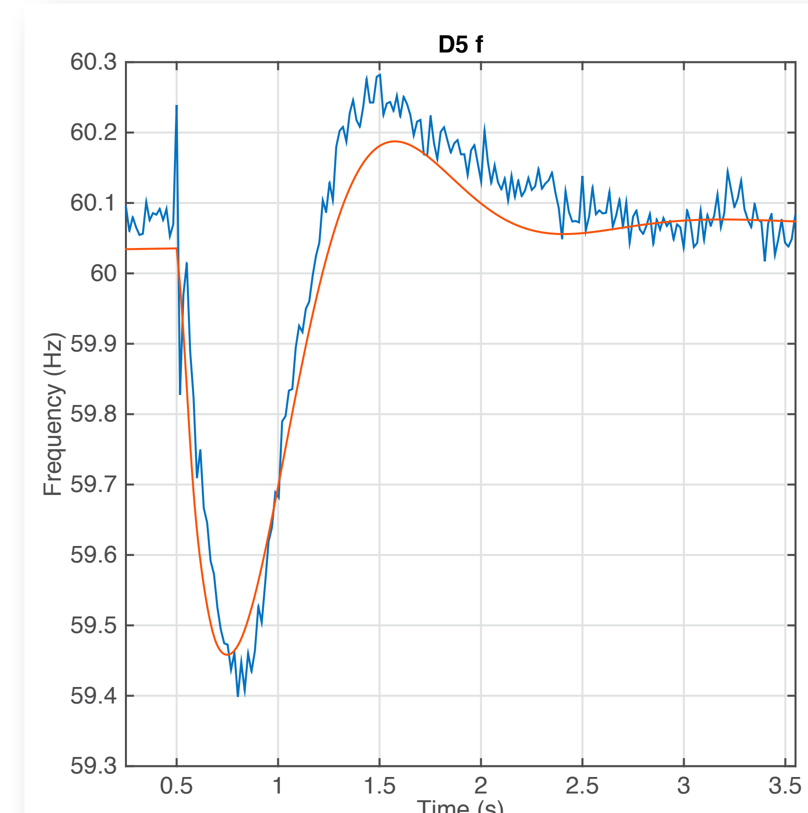
Data from over 1000 channels is permanently logged when the laboratory is in operation. This data ranges from basic electrical measurements to all available diesel generator data, and independent fuel consumption measurements. All data is stored in daily files, one per channel, in netCDF format, and can quickly be retrieved and searched for relevant events on the fly.

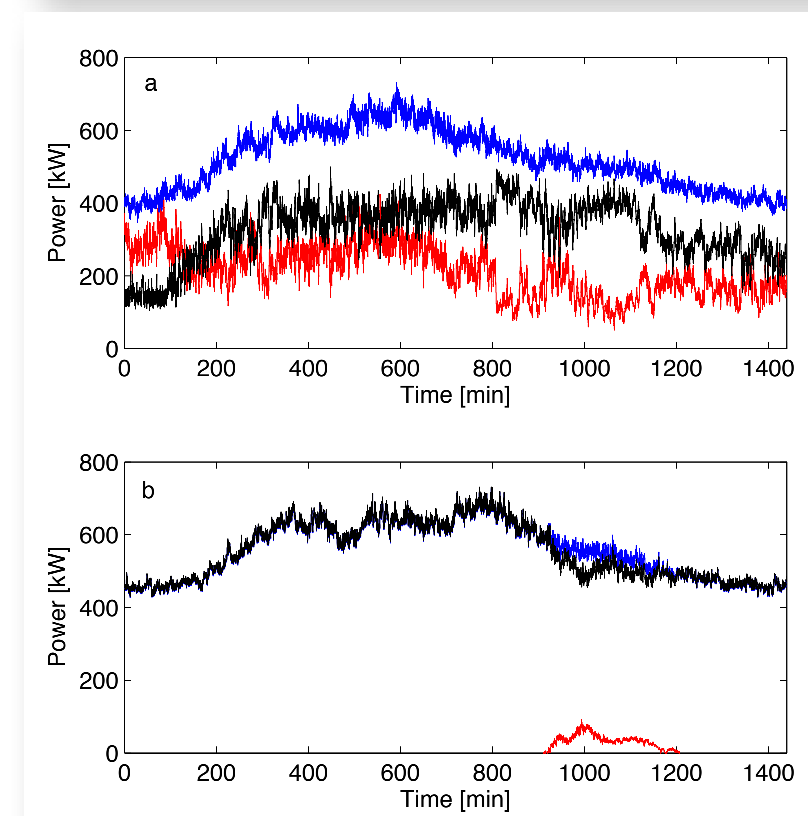
Meters

Meters used for general data acquisition from all energy sources and sinks are either Electro Industries' Shark 100 B and T, or Elkor WattsOn. All meters communicate via Modbus TCP. The meters provide data at a rate of about 5 S/s. In addition to the standard utility-grade meters, an Elspec GS4300 BlackBox power quality analyzer is permanently installed on the feeder to the 480 VAC load bank. This meter provides permanent logging of voltage and current waveforms at 1024 S/cycle and 512 S/cycle respectively.

Additional Equipment

The laboratory LAN is managed by a Netgear FSV318G router. Additional ports are made available via several switches. A WAN connection can be made available via an eWON Cozy router and eWON's VPN software. Time keeping for data acquisition and control is provided by a Tekron NTP server. Data acquisition is driven by a PC with Fedora Linux OS and data is routed to a Buffalo TerraStation, striped and mirrored RAID, network attached storage drive with four physical hard-drives.





Custom Control Architecture

The ETF SCADA is a Supervisory Control and Data Acquisition (SCADA) system, developed by ACEP to control the Energy Technology Facility (ETF) power generation and permanently monitor all available data channels.

It is a modular software composed of two separate programs:

- Data Acquisition (DA) module, responsible for requesting data from each individual device and broadcasting the data throughout the network;
- Supervisor Control (SC) module, receives the data from a DA module, which afterwards processes, catalogues and analyses the data in order to check if the values are within compliance or if an operator should be notified.

The ETF SCADA was designed to be fully customizable, adapting to any device that uses the Modbus TCP protocol. It is intended to enable users to automate the data collection, visualization and also automatically check if any variables are outside the acceptable range. It does not require a facility to have all their Modbus TCP devices from the same brand.

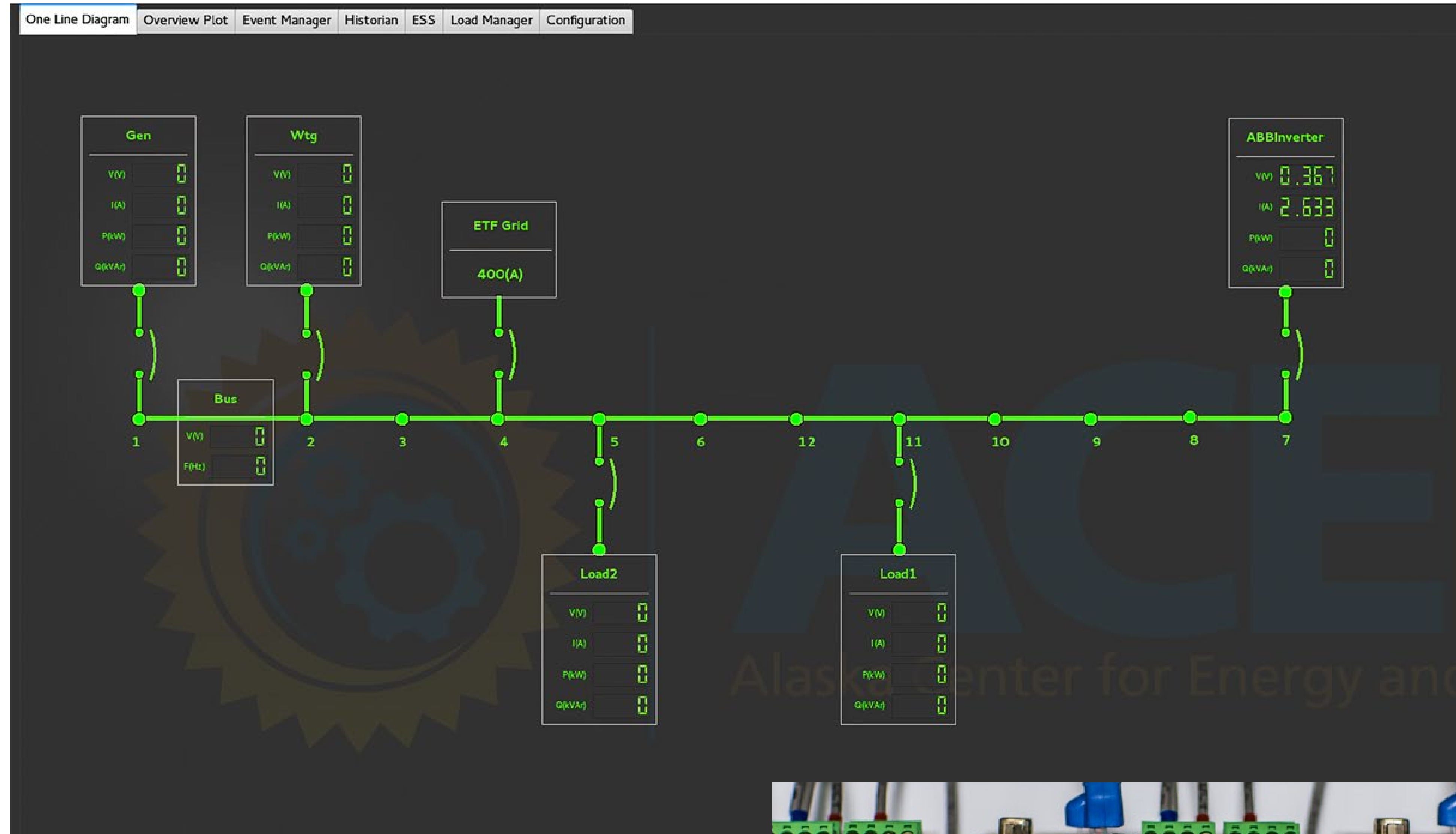
Data Acquisition Module

The DA module is able to handle the devices independently, in order to maximize the sampling frequency and minimize any maintenance or eventual malfunction downtime. In practice, this allows for plug and play connectivity from the devices, as soon as they appear in the network, the data collection is seamlessly resumed, without requiring any further input. The most typical limitation on the sampling speed is due to the device response time.

Experimentally we were able to collect data as fast as 400Hz, with better device hardware. Note that since this was not tested on a Real Time Operative System (RTOS) the resulting jitter was very significant, resulting in an average sampling frequency of 250Hz.

The typical hardware response times and Modbus maps limit the data collection from 3 to 5Hz, but this always depends on the specific device.

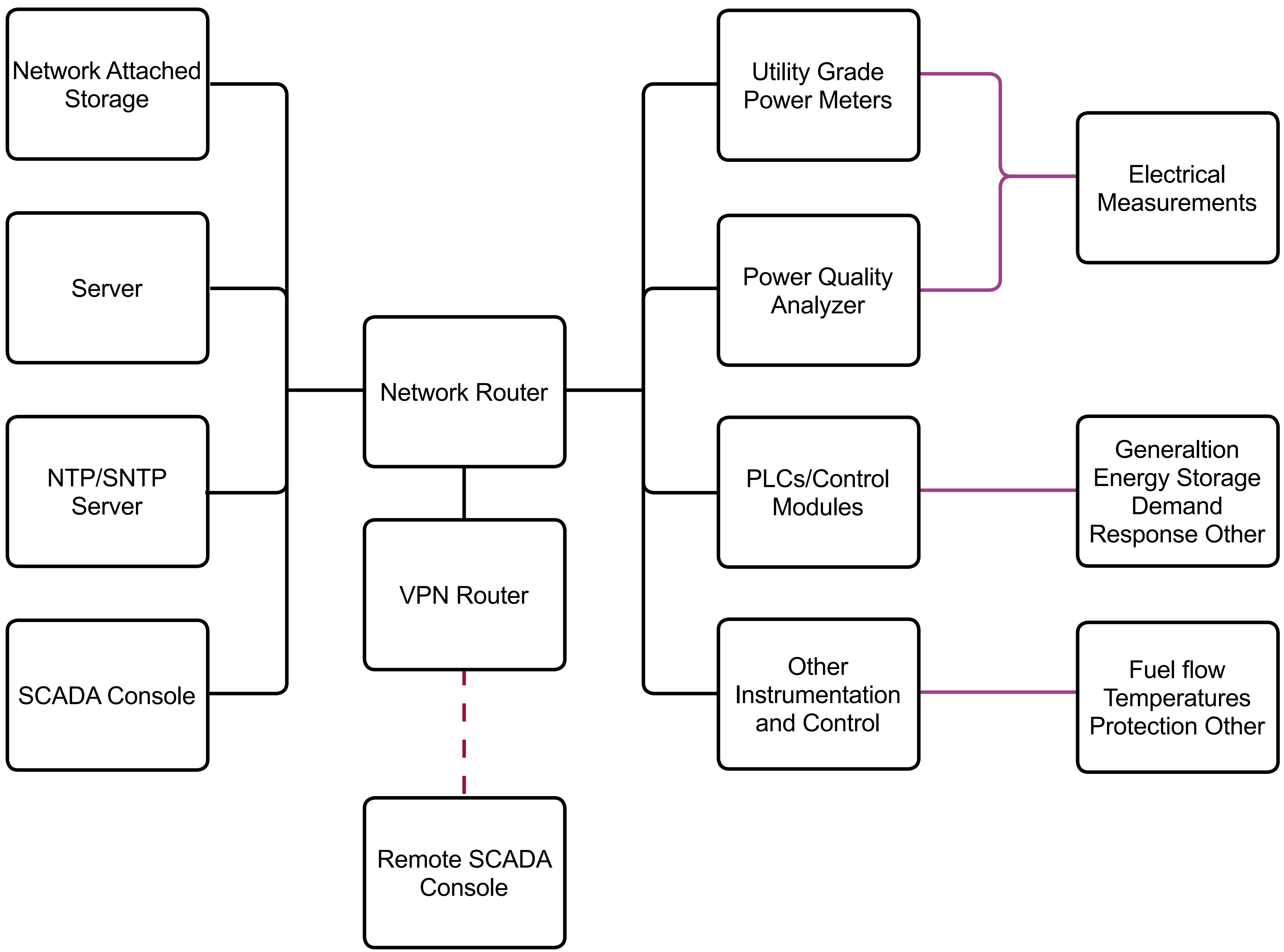
The Data is stored in netCDF files, intrinsically coupling the metadata to the collected data, so that the datasets always retain their original information.



Above: Overview screen of the ETF SCADA system. The system is highly flexible to be custom configured for any test campaign.

Right: Components of ABB MGC600 control system.

Power Systems Integration Lab **Hardware**



ETF SCADA conceptual overview of hardware arrangement.

Supervisory Control Module

This module can act as a passive terminal, collecting the data sent from a DA module. In this configuration the DA module can send data to an unlimited number of terminals.

The SC module can be configured, e.g., by adding limits to certain variables. The limits can be set as mathematical expression (including a potential time difference between 2 values), as level indication the severity of an event or to differentiate between reports and alarms, or as a tag for human readability.

If limits are set, the event manager is able to list past events along with all relevant information. The user can double click on a past event, which opens a dataset in that period with an actual tag from when the event was raised. Data can be cross-referenced from several devices and plotted in one single graph. Any variables from any device can be added to the plot.

Furthermore, in the SC module the sample frequency that is received from the DA module can be limited, the temporal display can be scaled, and the declared network devices can be viewed.

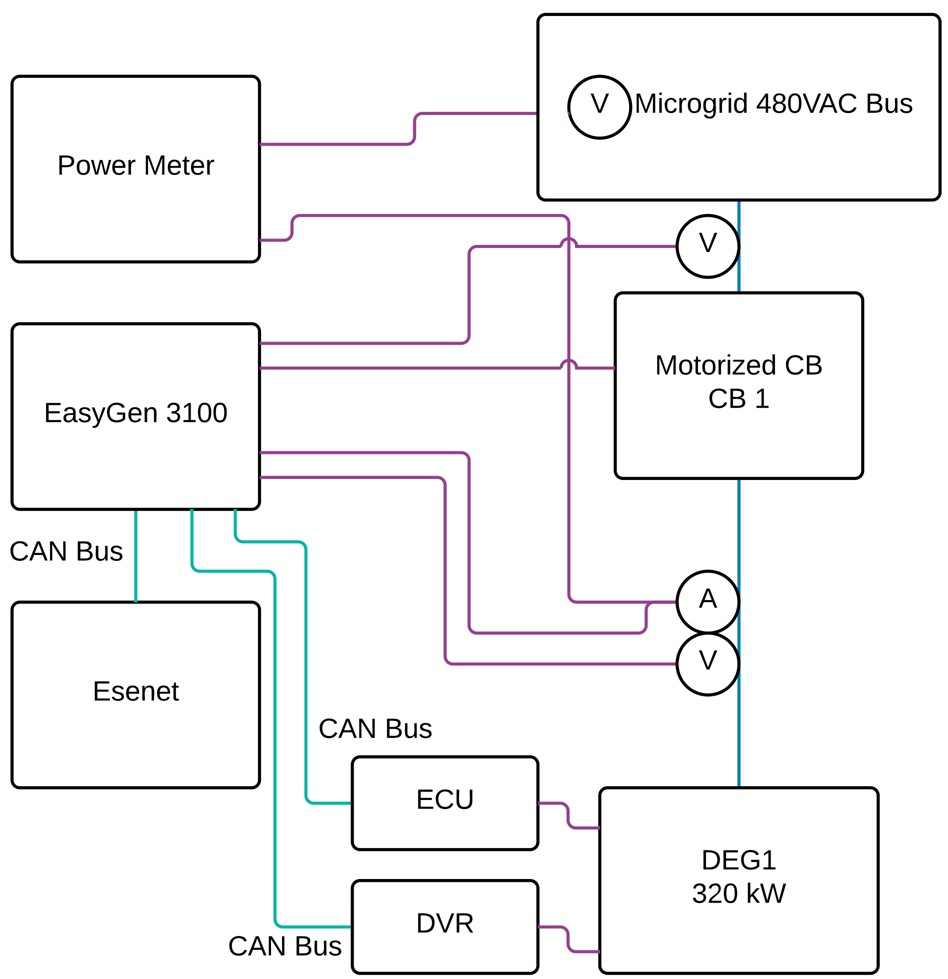
Hardware Configuration

The ETF SCADA is able to gather data from 11 devices, summing up to almost one thousand variables. Among those devices are the Shark100, the WattsOn, the Elspec G44K, the Woodward Esegen 3100 and the ABB PCS100. In the current state, we have a server running the DA module and use other computers as terminals, running the SC module. We have also successfully tested routines to control a Loadbank by running a specific scenario file, as well as experimental ABB PCS100 controls. Figure 2 gives a conceptual overview of the hardware configuration deployed.

Power Systems Integration Lab Equipment Specifications

Diesel Generators

The lab provides a flexible infrastructure to test diesel engines from 50 kW to several MW nameplate capacity. The built-in cooling and exhaust systems can receive generators up to 400 kW nameplate capacity. Larger generators require their own cooling system.



Caterpillar C-15

The Caterpillar C-15 is installed in a mobile package with in-house designed Arctic modifications to ensure operability down to -30° C. The engine is directly managed by a Caterpillar ECM, and the electric generator is controlled by a Basler digital voltage regulator. Both systems can be adjusted and modified via available software tools. On top of these generator controls operates a Woodward EasyGen 3200 controller that acts as the interface to laboratory controls and data acquisition. A ProconX Esenet CAN-to-Modbus TCP interface is installed to enable Modbus TCP communications. This module preserves the Modbus RTU addressing scheme provided by Woodward for the EasyGen 3200. In addition, direct integration into the CAN bus or to hardwire I/O by additional controls is possible.

Capacity
400 kVA

Controller
EasyGen 3200

Protocol
Modbus TCP/RTU, CAN, hardwire

Switching
Motorized CB

Status
Operational

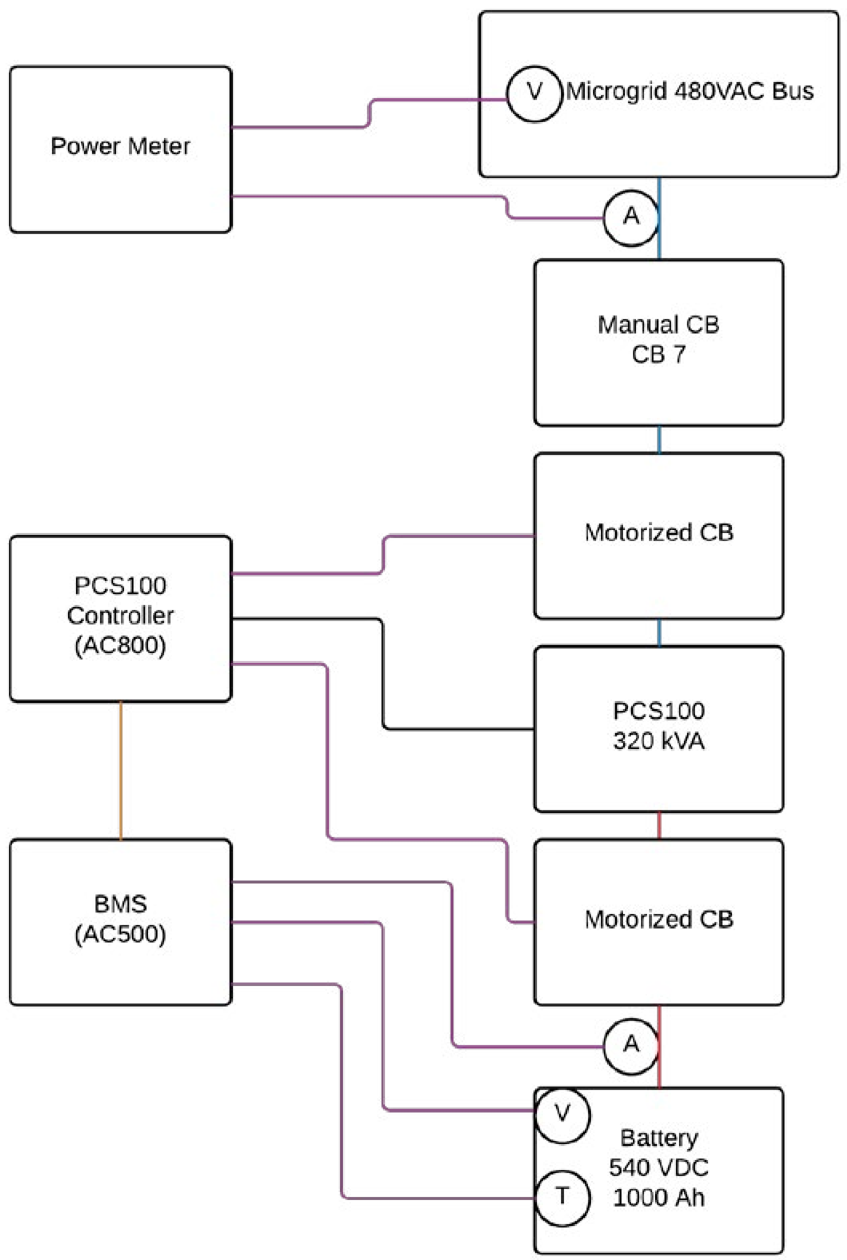


ABB PCS100 ESS

A 313 kVA ABB PCS100 line-up is used as the power conversion unit for energy storage systems. The line-up comprises six PCS100 modules which are directly controlled and coordinated via CAN bus and a control computer. The interface for basic HMI, interaction with battery management systems, and external control is provided by an ABB AC800M PLC via Modbus TCP. This PLC coordinates AC and DC motorized breakers, provides top-level controls and status, as well as coordination for various protective settings. The PCS100 modules are of the high DC voltage type, and designed to achieve nominal AC output voltage (318 VAC) between 450 VDC and 1100 VDC. Grid voltage is achieved via 318 to 480 VAC Delta-Wye isolation transformer. The inverter can be operated at voltages between 250 VDC and 450 VDC. At these lower DC inputs it only achieves 254 VAC, additional tabs at the isolation transformer allow stepping this voltage up to the required 480 VAC grid voltage.

Currently, the ABB PCS100 is integrated with a valve-regulated lead acid (VRLA) battery (540 VDC/1000 Ah) with a usable capacity of 270 kWh. The PCS100 control PLC interacts with a battery management system to retrieve DC voltage, current, state-of-charge, available charge/discharge current, and available capacity. The BMS is an in-house development that runs on an ABB AC500 PLC, with Modbus TCP communication.

Capacity
313 kVA

Controller
ABB AC800M PLC

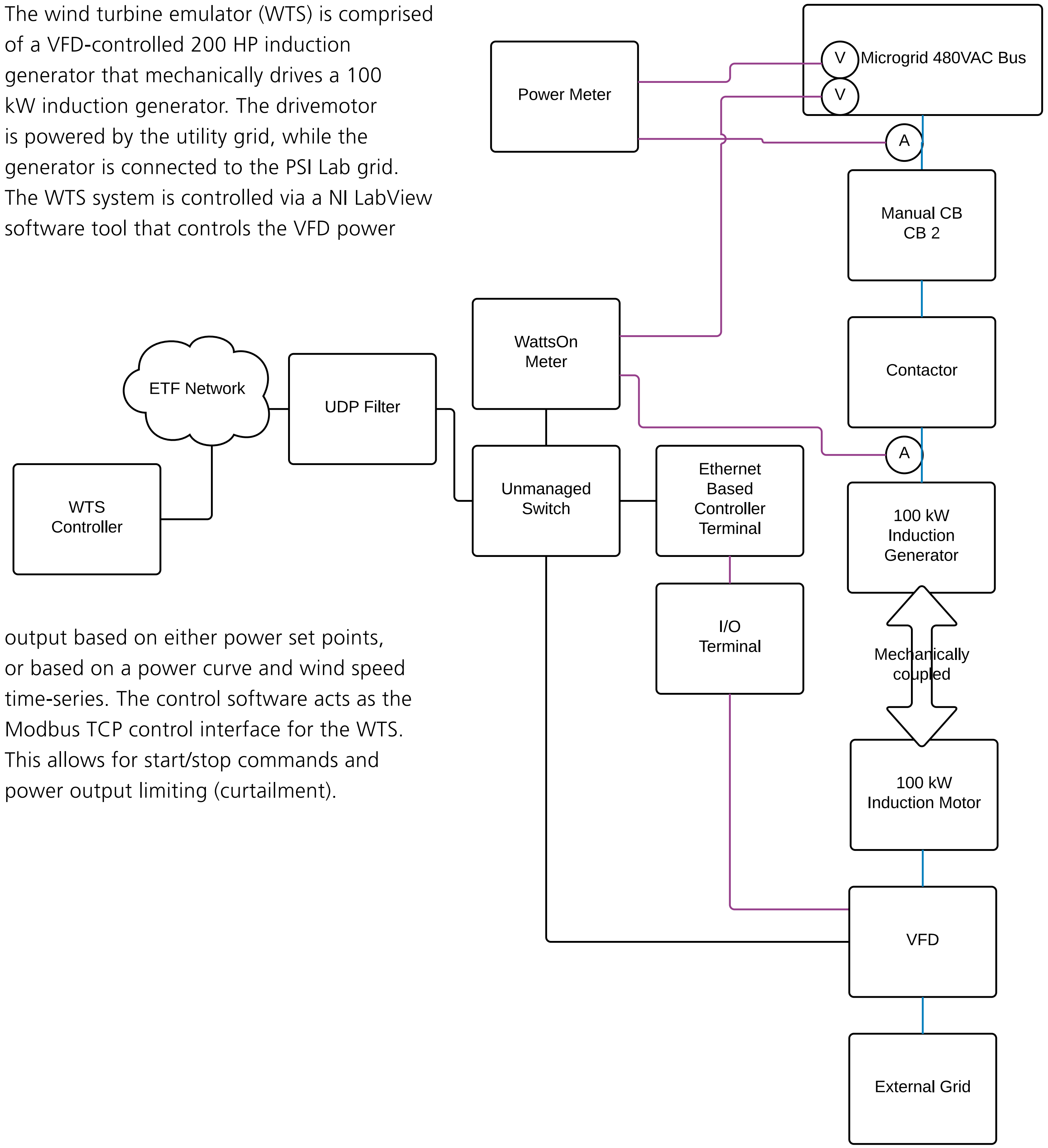
Protocol
Modbus TCP, hardwire

Switching
Motorized CB

Status
Operational

Wind Turbine Emulator

The wind turbine emulator (WTS) is comprised of a VFD-controlled 200 HP induction generator that mechanically drives a 100 kW induction generator. The drivemotor is powered by the utility grid, while the generator is connected to the PSI Lab grid. The WTS system is controlled via a NI LabView software tool that controls the VFD power output based on either power set points, or based on a power curve and wind speed time-series. The control software acts as the Modbus TCP control interface for the WTS. This allows for start/stop commands and power output limiting (curtailment).



Capacity
125 kVA

Controller
NI LabView

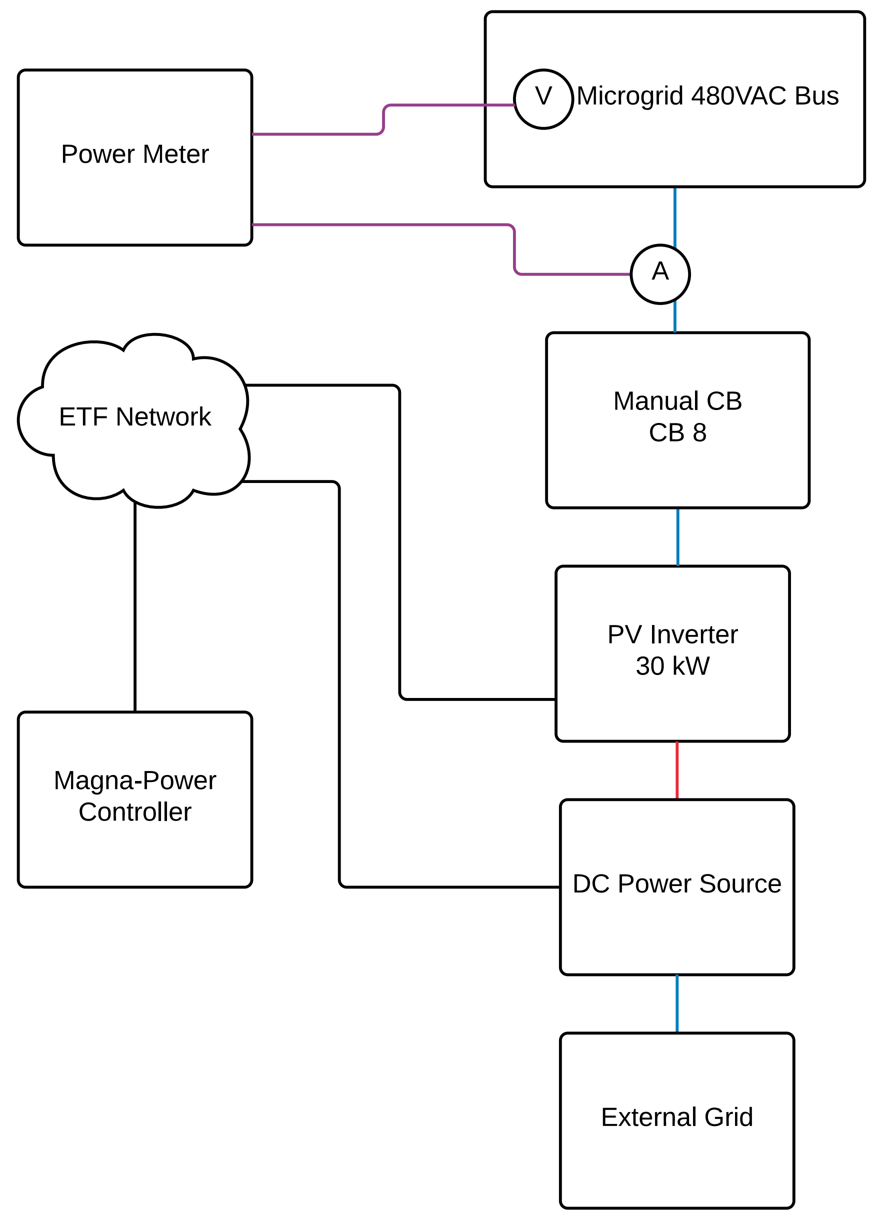
Protocol
Modbus TCP

Switching
Contractor

Status
Operational

PV Emulator (DC Power Source)

A 100 kW MagnaPower MT-series DC power source is available to simulate PV power. This unit provides high slew rate DC output ramping at up to 1000 VDC allowing the emulation of current industry standard PV installations. The DC power supply is flexible enough to also simulate other DC sources, e.g., rectified direct-drive generator output with slight AC-noise on the DC power output. This allows for testing of power electronics solutions for grid-tie applications for energy storage and DC generation.



Capacity
100 kVA DC

Controller
NI LabView/C++ API

Protocol
Modbus TCP, others

Switching
Contractor

Status
Operational

Fronius Symo PV Inverter

To convert direct current from the PV emulator to alternating current to feed into the grid we recently installed a Fronius inverter with a Datamanager2.0 card. The transformerless Fronius Symo 24.0 kW is a compact three-phase solar inverter for commercial applications with a 480VAC grid connection. Available features include Wi-Fi and SunSpec Modbus interfaces for seamless monitoring and datalogging, and field proven Arc Fault Circuit Interruption (AFCI).

The inverter operates by automatically monitoring the power grid. If there is sufficient power input from the emulator, the inverter feeds power into the grid and synchronized it with the grid voltage. If conditions are inconsistent, the inverter shuts off operations.

Magna Power DC power source | Fronius inverter | power meter

Capacity
24 kVA

Controller
Datamanager 2.0

Protocol
Modbus TCP and RTU - SunSpec compatible

Switching
Manual CB, DC disconnect

Status
Operational

LoadTec Load Banks

Two 313 kVA reactive load banks on separate feeders are available. Both load banks can be controlled in 5 kW/3.75 kvar load steps and can operate down to 0.8 power factor at full load. The older load bank operates at 208 VAC and is couple to the grid via Delta-Wye step down transformer. This load bank can be controlled via an HMI panel or via a software tool with RS-232 connection. Efforts are underway to decode the communications protocol and place an RS-232 to Modbus TCP decoder as the main communications interface.

The newer load bank operates at 480 VAC and is directly coupled to the grid. This load bank can be controlled via an HMI panel or via a software tool with TCP communication.

The TCP communication has been decoded such that the load bank can be controlled via ACEP-custom developed software. This will also allow to simulate demand management with this load bank. An auxiliary connection is available on this feeder to connect a 55 kW manually operated load bank such that moderate phase imbalances can be created for testing.

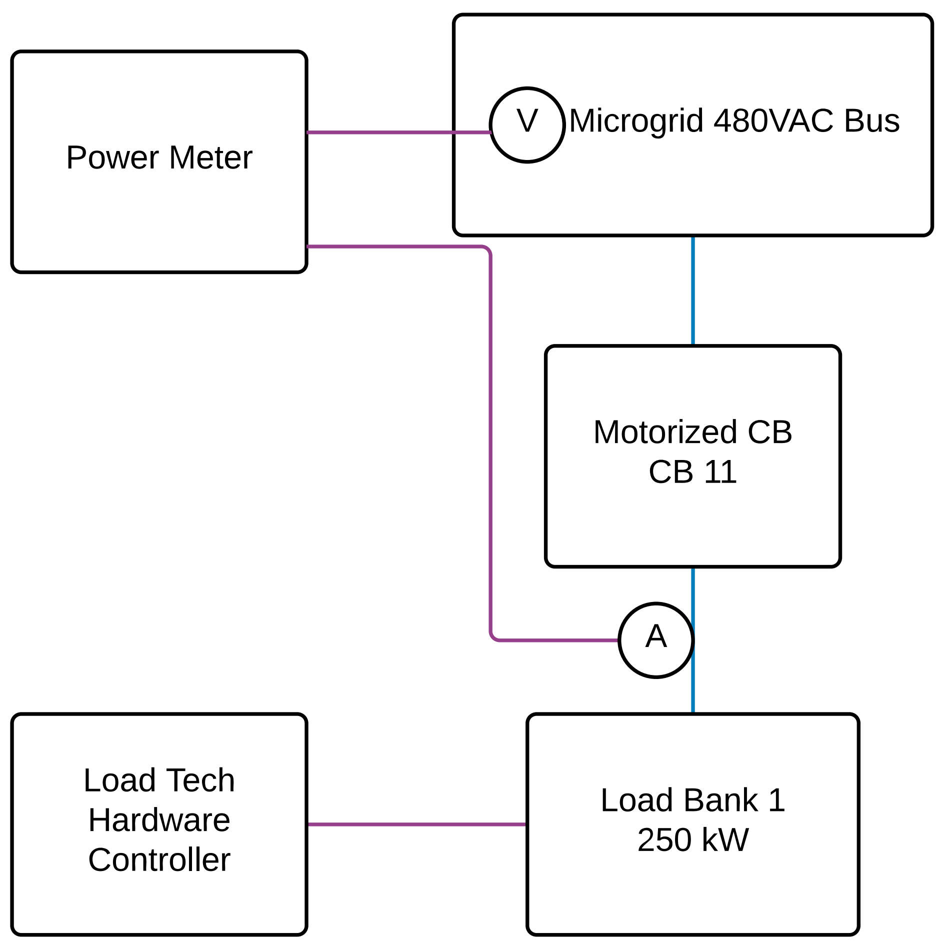
Capacity
2 x 313 kVA

Controller
LoadTec

Protocol
Proprietary TCP/Serial

Switching
Contactor

Status
Operational



Power Systems Integration Lab Expansion Plans

Fault Emulator

The fault emulator provides the means of creating bolted faults in the PSI Laboratory grid with fault currents up to 10 kA at 480 VAC. This capability allows us to ascertain the fault response of equipment in the laboratory that could be encountered under typical fault conditions in the distribution grid, both under phase-to-phase and phase-to-ground fault conditions.

Understanding fault dynamics is important when transitioning from synchronous machine-based to power electronics-based generation. For the latter, fault dynamics are less well understood, and configurations of breaker coordination and trip dynamics may have to be reassessed.

At the core of the fault emulator are distribution cut-out fuses, which can be selected for fast, high-current fault characteristics or slower lower current fault characteristics. The emulator can be controlled such that a it can close into a particular point in the wave-form, allowing for controlling AC and DC fault components.

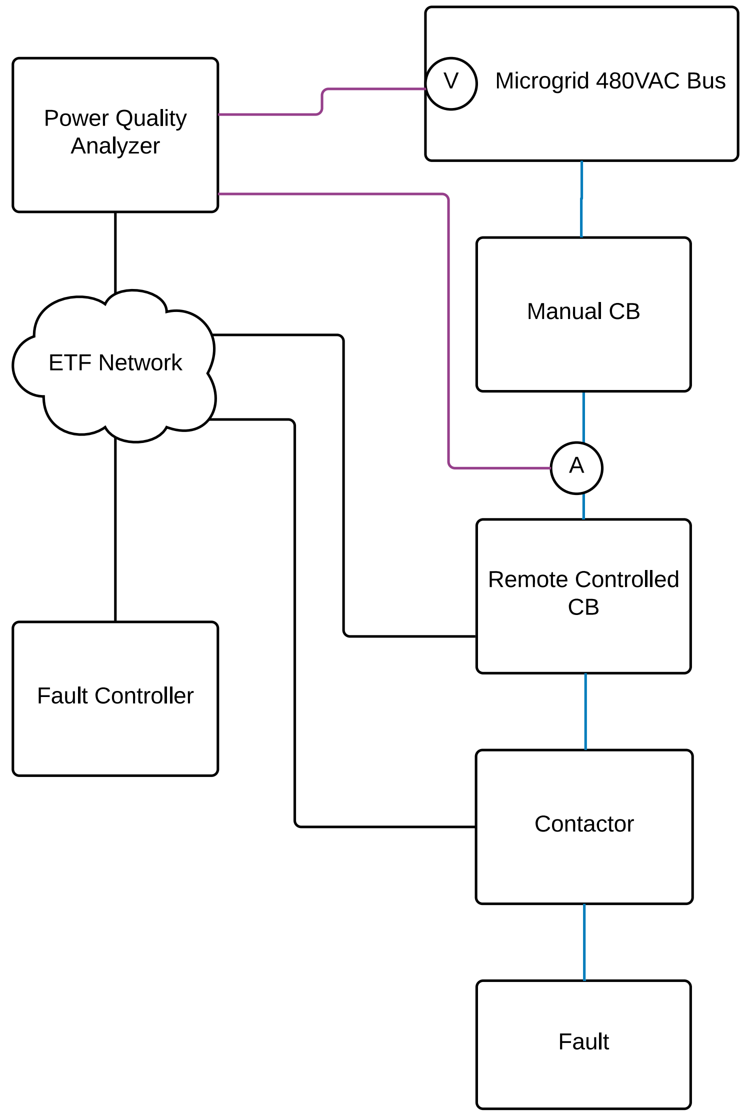
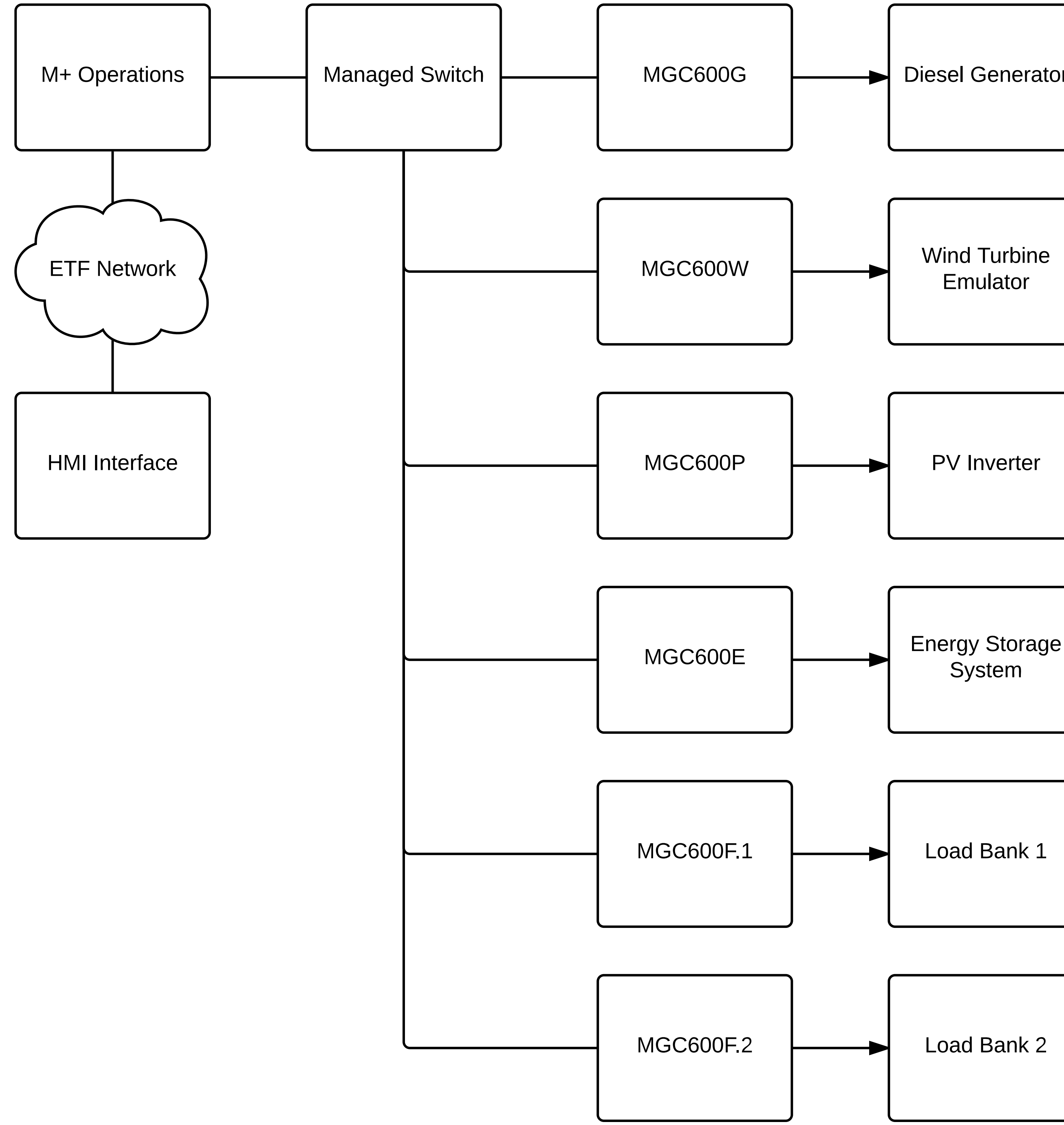


ABB MGC600 Distributed Control System

The ABB M+ Control System is a distributed top-level control system specifically developed for islanded microgrids. The system is comprised of dedicated control modules for each generation source and feeder (MGC600), and a central data aggregator and HMI interface (M+ Operations). The M+ manages dispatch of renewable and diesel power, controls services provided by energy storage systems, and provides the ability to automate a remote power plant, including black start capabilities, if equipment permits.

Depending on the underlying local controller, the M+ communicates via Modbus TCP, Modbus RTU, or hardwire I/O, where time sensitive decisions have to be transmitted.

The M+ system in the PSI Lab consists of two MGC600G (diesel), two MGC600F (feeder), MGC600W (wind), MGC600P (PV), and MGC600E (energy storage). Additional modules can be added as required for a particular system configuration.



The ABB M+ Control System was generously donated to ACEP/UAF by ABB.

Project Spotlight: Hatch Associates Consultants, Inc.

FLYWHEEL ENERGY STORAGE INTEGRATION

From the summer of 2014 to mid-January 2015 Hatch tested a flywheel energy storage system (FESS) and associated control system in ACEP's Energy Technology Facility (ETF). The project integrated a Williams MLC200 flywheel (200 kW/1.5 kWh), an ABB PCS100 inverter, a 320 kW diesel generator, and the Hatch Microgrid Control System which coordinated the flywheel and diesel power outputs in response to variations caused by the programmable wind tubine simulator and load bank.

In addition to demonstrating the performance of the flywheel, Hatch also developed and optimized control algorithms to manage the components of a wind diesel- flywheel system in order to maximize diesel fuel savings. Hatch aims to solve this problem with their FESS but first needed to test their technology in a controlled microgrid setting. ACEP was able to provide the needed test bed with its ETF located at the University of Alaska Fairbanks.

Subsequently, Hatch has deployed a system based on the design tested at ACEP at the Raglan Mine in Northern Canada.

Above: A new ABB Inverter was purchased by ACEP for the testing of Hatch's flywheel system. UAF PHOTO BY TODD PARIS

Right: Flywheel energy storage system in ACEP's ETF. ACEP/UAF PHOTO BY MAX FREY

"The ACEP team was a pleasure to work with and critical to the successful execution of our project. As a complement to the first class test facility, they brought a deep knowledge of remote microgrids and the technical know-how which resulted in an error free installation, so we could focus on testing our technology." — Dave Delves, Manager, Technology Development–Project Delivery Group, Hatch Associates Consultants, Inc.

Project Spotlight: Cordova Electric Cooperative

HYDROPOWER ENERGY STORAGE AND DEMAND RESPONSE SOLUTIONS

Project Need

Historically, Cordova's hydropower has been sufficient to meet nearly all demand during the summer months. However, recent increases in energy demand from the fish processing industry has exceeded the capacity of the hydropower plants, forcing CEC to supplement with diesel generation.

Currently, when hydropower is the sole generation source, one 3 MW hydropower turbine is used for frequency regulation, which results in a reduction of 500 kW of available capacity. While hydropower capacity is not sufficient to meet daytime demand, the hydropower plants do not operate at full capacity during off-peak hours. Since these hydropower systems do not include dams that provide water storage, the water that is normally diverted for power generation is simply spilled down the creeks. The result is significant loss of potential power production and, thus, power sales from a very cheap generation resource. The need for alternative frequency regulation services, along with the desire to maximize the use of hydropower, is the impetus for this study, which assesses the technical and economic feasibility of achieving maximal hydropower use via energy storage and demand response technologies.

Initial assessments show that in 2012/2013, over 2,000 MWh of potential hydropower production were not realized due to demand being below hydropower capacity. While it is not certain that the full amount of lost production is recoverable, this gives a tangible initial economic case to further explore possible solutions.

Project Description

Research partners are analyzing data provided by CEC to better understand the economic potential of an energy storage and demand response solution to utilize this spilled energy. An energy balance model (EBM) has been employed to model the generation and demand mix and to develop a range of scenarios that optimally incorporate energy storage and demand response solutions. Maximum value of an energy storage and demand response system can be achieved only if it precludes diesel generation during peak demand periods, so load growth scenarios will be added to the model to understand the future value of a solution.

The goal of the EBM is to understand the value of making the additional 500 kW of hydropower generation available to meet energy demand and creating an energy storage solution to shift generation from peak to off-peak periods and assessing how off-peak demand can be increased while reducing peak demand through demand response solutions. Based on model results, possible energy storage and demand response solutions for both applications will be identified and incorporated into the EBM, facilitating recommendations for optimal sizing and scheduling.

Furthermore, ACEP researchers have studied the potential and options for installing controlled electro-thermal loads at the Orca Diesel Power Plant and the Bob Korn Memorial swimming pool in Cordova. The Orca plant currently utilizes diesel-fueled boilers to keep engines in hot standby when the grid is running on 100% hydropower, which results in fuel costs for heat of over $80,000/year (2014 numbers). Similarly, the swimming pool requires over 16,000 gal/year of diesel fuel for heat. Utility-dispatched electric heaters that would supplement heating loops when excess hydropower is available, may significantly reduce diesel fuel use. Conceptual designs developed by ACEP incorporating efficiency upgrades and thermal storage systems may reduce fuel use by over 20,000 gal/year for both systems.

"ACEP is more than a capable team…more like a high-functioning unit; the Seal Team 6 of Energy and Power. Half of the energy industry claims to have smartgrid and energy storage solutions, but for our community's remote micro grid system in our rugged environment, we turn to ACEP with our complex technical challenges, because promises and theories don't keep the lights on." Clay Koplin, CEO, Cordova Electric Cooperative

Project Spotlight: Nome Joint Utility Services

GEOTHERMAL RESOURCE INTEGRATION WITH A COMMUNITY POWER GRID

Project Description

The project goal was to provide Nome Joint Utility Services (NJUS) with data analysis, models, and additional information to support technical and economic decision-making processes. The Power Systems Integration Program directly provides technical information to NJUS, and informs the Economic Analysis Group at ACEP of technical information relevant for economic modeling. The first phase was concerned with the interaction of energy resources (wind, geothermal, and diesel), to understand the impact of several generation scenarios on the overall amount of wind power that can be added to the grid, with risk of under-loading diesel generators. Since NJUS recently added additional wind resources and new diesel gensets, existing historic data could not be directly employed to drive model development. Statistical methods were employed to extrapolate wind power output from the extended wind farm. This data was fed into a time-series energy balance model (TSEBM). The TSEBM matched energy generation with demand while considering the operational envelope of the diesel generators (scheduling and minimum and maximum optimal loading) and general grid stability. Information gained from TSEBM outputs showed the amount of wind power that cannot be admitted to the grid (spilled wind) and the optimal diesel-scheduling scheme based on current generation assets. The second phase explored how energy storage solutions may be used to:

- ensure greater grid stability and power quality, should that be required, and
- determine if an energy storage solution can economically reduce the use of diesel fuel by replacing the spinning reserve generally provided by a diesel generator.

Project Results

Different capacities of geothermal plants were simulated. Adding geothermal generation to the grid reduced the amount of wind power that could be admitted into the grid (increased spilled wind), thus there was a diminishing return for increasing geothermal generation. Above 2.75 MW of geothermal capacity the incremental reduction in diesel generation dropped off sharply, as significant amounts of renewable energy went unused. Scenarios where smaller diesel generators were added to the grid resulted in a greater reduction in diesel generation. Scenarios where energy storage was added to the grid to supply spinning reserve resulted in a greater reduction in diesel generation and reduced some of the stress on the diesel generators induced by adding geothermal generation.

"ACEP's breadth of technical expertise has been extremely helpful on a range of issues from alternative energy integration to resource evaluation and economic analysis of our energy options. It has been vital to have the ability to partner with ACEP on our energy projects, and I look forward to continuing to work together closely in the future." — John Handeland, General Manager/COO, Nome Joint Utility System

R&D and Consulting Services

The ACEP PSI Team offers a one-stop shop for remote power and islanded microgrid R&D services.

- **Design reviews** – We can review your design and support plotting pathways to successful commercialization and deployment.
- **Data analysis** – We can perform analysis from single components or entire microgrids. We also have extensive data sets available from remote microgrids to develop case studies.
- **Model development** – From power flow to dynamic models, we can develop models suitable to study technical and economic performance metrics.
- **Hardware R&D** – We are able to design, build and test solutions from specialized electronics and mechanical components to fully packaged systems.
- **Software R&D** – We are able to design, implement and test solutions from training programs through specialized PLC and embedded computing software and cyber security features.
- **Systems Integration** – Within our laboratory and on specialized test benches, we can identify system level interactions that are crucial to successful deployment, and provide solutions where hurdles exist.
- **In-System R&D and Testing** – Our unique laboratory allows for testing of solutions within an operating grid, without disruption to customers. This allows for overcoming hurdles before they become problems.
- **Professional Training** – The PSI Laboratory can be configured as a 'flight simulator' to expose operators to particular scenarios. The novel equipment available provides training opportunities in a controlled environment that ensures that your staff is on the bleeding edge of technology developments.

Doing Business With Us

The ACEP PSI Team looks forwards to working with you.

We can engage via several mechanisms:

- **Direct consulting contract** – We are able to engage via direct consulting contracts. This type of contract generally would be used for design reviews, data analysis, model development and professional training.
- **Corporate sponsored research** – We can contract to exclusively develop solutions, and perform R&D and testing. Such a contract would generally be used to engage the PSI Team and Laboratory for extended R&D and test campaigns.
- **Collaborative projects** – Where opportunities exist and interests are aligned we can collaborate in pursuing third-party grants and awards. Our team can provide expert input in the proposal process, from identification of potential funding sources through full proposal development.

Contact us directly to learn more about our rate structures and possible avenues to engage.

ACEP Partners

ACEP fosters a wide range of partnerships outside the university at the local, state, national and international levels to ensure our research is relevant, current and world class.

ACEP CLIENTS AND COLLABORATORS (2008 – PRESENT)

ABB
ABS Alaskan
Air Force Research Laboratory
AK Department of Environmental Conservation
AK Division of Geological and Geophysical Surveys
AK Division of Forestry
Alaska Energy Authority
Alaska Housing Finance Corporation
Alaska Power and Telephone
Alaska SeaLife Center
Alaska Village Electric Cooperative
Alaska Wood Energy Development Task Group
Ambri
Argonne National Lab
Battelle
Begich Middle School
Bering Straits Native Corporation
Boise State University
Boschma Research
BP
Bureau of Land Management
Bristol Bay Native Association
Charles Darwin University
Chena Hot Springs Resort
Chena Power
City of Galena
City of Nenana
City of Nome
City of Tanana
City of Tenakee Springs
City and Borough of Yakutat
Cold Climate Housing Research Center
Cordova Electric Cooperative
Crowley Marine Services
Denali Commission
DoD Alaska Command
DOE Advanced Manufacturing Office
DOE Indian Energy Program
DOE Office of Electricity
Doyon, Limited
Eielson Air Force Base
ElectraTherm
Elim Tribal Council
Elmendorf Air Force Base
Energy Concepts
Energy Efficiency Evaluations
Environmental Protection Agency
Fairbanks Economic Development Corporation
Fairbanks North Star Borough
Golden Valley Electric Association
GraphiteOne
Hatch Associates Consultants
HOMER Energy
Huslia Tribal Council
Idaho National Laboratory
Inland Barge Service
Inside Passage Electric Cooperative
Interior Regional Housing Authority
Institute of the North
Jacobs Engineering
Joint Base Elmendorf Richardson
Jon's Machine Shop
Juneau Economic Development Council
Kawerak
KidWind
Kodiak Electric Association
Kodiak Island Borough School District
Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
Manley Hot Springs Tribal Council
Mary's Igloo Native Corporation
Marsh Creek Energy Systems
McGrath Tribal Council
McKinley Services
Minto Tribal Council
Mount Edgecumbe High School
NANA Corporation
National Renewable Energy Laboratory
National Energy Technology Laboratory
Nenana Native Council
Nikolai Tribal Council
Nome Chamber of Commerce
Nome Joint Utility Systems
Norton Sound Economic Development Corporation
Northern Power
Northern AK Career and Technical Education Center
Northwest Arctic Borough
Northwest National Marine Renewable Energy Center
Ocean Renewable Power Company
Oceana Energy
Oregon State University
Oregon Wave Energy Trust
Patriot Solutions
Pilgrim Geothermal LLC
Polarconsult Alaska
Potelco Inc
Power and Water
Prudent Energy
Regulatory Commission of Alaska
Renewable Energy Alaska Project
Renewable Energy Solutions
Resolute Marine Energy
Ruby Marine
Ruby Tribal Council
Sandia National Laboratory
Sealaska
Shell Wind Energy
Sherrod Elementary School
Siemens Building Technologies
Sitnatuak Native Corp
Southern Methodist University
Southwest Alaska Municipal Conference
Stanford University
Strategies 360
Susitna Energy Systems
Sustainable Automation
Tanana Chiefs Conference
TDX Power
Teck Cominco
TerraSond
Unaatuq
University of Maine
University of Massachusetts
University of Texas at Austin
University of Washington
United States Coast Guard
United States Geologic Survey
Usibelli Coal Mine
Village of Eyak
Village of Elim
Village of Igiugig
Vortex Hydro Energy
Western Community Energy
WHPacific
White Mountain Native Corporation
Williams Engineering
Your Clean Energy

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