CASE STUDY

University of California, San Diego—San Diego, California

UC San Diego Optimizes Microgrid System With SEL POWERMAX® and Protection Relays

San Diego, California—The University of California, San Diego is one of the top 15 research universities in the world, covering more than 1,200 acres of coastal woodland in La Jolla, California. It is home to several world-class establishments, including the Scripps Institution of Oceanography, which is one of the world's oldest, most important centers for ocean, earth, and climate science research. Scripps has the world's largest oceanographic research collection and an aquarium sustaining a wide variety of plant and animal life.

UC San Diego also has a locally and nationally recognized hospital that makes up part of its multibuilding Health System. People come to the Health System for treatments that aren't available anywhere else in the region.

Places like Scripps and the Health System on UC San Diego's campus demand a reliable source of electric power. Losing power in these areas, even for a short amount of time, could compromise people's safety and have drastic effects on critical research. This led the university to build their own microgrid so that, even during emergencies, their critical facilities would always have power.

Figure 1—UC San Diego Campus. Copyright Regents of the University of California. Credit: UC San Diego Publications.

The UC San Diego microgrid has over 33 megawatts of installed onsite generation, including gas-turbine cogeneration and storage, solar, fuel cell, steam, and diesel. The onsite generation is only enough to support critical loads. To cover the rest of their load demand, the university purchases additional electric power from SDG&E. The idea behind UC San Diego's microgrid was that any time there was a disturbance in the main grid, they could disconnect and maintain power to critical facilities.

However, during the 2011 Southwest blackout, the UC San Diego microgrid disconnected from the main grid, but did not shed load quickly enough. This caused their cogenerators to shut down and many important facilities to temporarily lose power. Operators manually restarted the generators, but it took five hours before power was finally restored to the entire campus. The university couldn't risk something like this happening again. They needed a reliable way to shed noncritical load and maintain power to critical loads at all times. That's when UC San Diego engineers began looking for a solution and in 2013, contacted SEL's Engineering Services.

After listening to the situation, the Engineering Services team proposed their POWERMAX Power Management and Control System. POWERMAX is ideal for onsite generation and has automated control functions specifically designed to detect and mitigate system blackouts.

Over the next two years, SEL engineers created a custom solution for UC San Diego. The project scope ranged from the initial discussions to design and specification to developments and settings to Factory Acceptance Tests (FATs), and finally, to commissioning.

The following is a list of features and deliverables included in the POWERMAX solution.

- Primary contingency-based and backup under-frequency-based load-shedding system
- Synchrophasor-based monitoring, recording, and grid decoupling system
- Human-machine interface (HMI) with system topology and load-shedding screens
- Data acquisition, logging, and display of system alarms, events, and trends
- POWERMAX panel drawing package and panel delivery
- Real Time Digital Simulation (RTDS®) testing and studies for FATs
- RTDS testing report, including the under-frequency set points and the instantaneous generator pickup capacity set points
- Onsite simulator system for operator training and hot spares
- Radio-based, high-speed contingency detection

The primary load-shedding system is a fast algorithm that sheds load on a predicted power deficit. Its goal is to reduce the total facility load to less than the calculated available capacity; this would maintain power balance after a contingency event. Within the primary load-shedding system, there is a backup under-frequency-based load-shedding scheme for additional security and reliability. The load-shedding logic is executed every 2 milliseconds and provides a total round trip time of less than 40 milliseconds.

The customized POWERMAX solution for UC San Diego also provided high-speed protection capabilities, including bus differential protection schemes, overcurrent elements for feeder protection, reverse power detection, and overcurrent elements to protect the generators.

There are over 100 SEL devices used in this solution, from protective relays to automation control and communications equipment, and all are interoperable with devices from other manufacturers. The SEL-supplied products used in this solution are listed below.

- SEL-311L Line Current Differential Protection and Automation System
- SEL-751 Feeder Protection Relays
- SEL-487B Bus Differential and Breaker Failure Relays
- SEL-587Z High-Impedance Differential Relays
- SEL-700G Generator Protection Relay
- SEL-3530 Real-Time Automation Controller (RTAC)
- SEL-2411 Programmable Automation Controller
- SEL-2730M Managed 24-Port Ethernet Switch
- SEL-3031 Serial Radio Transceivers
- SEL-3354 Microgrid Controller
- SEL-3355 Computer
- SEL-3378 Synchrophasor Vector Processor
- SEL-5078-2 SYNCHROWAVE® Central
- HMI monitor, keyboard, and mouse

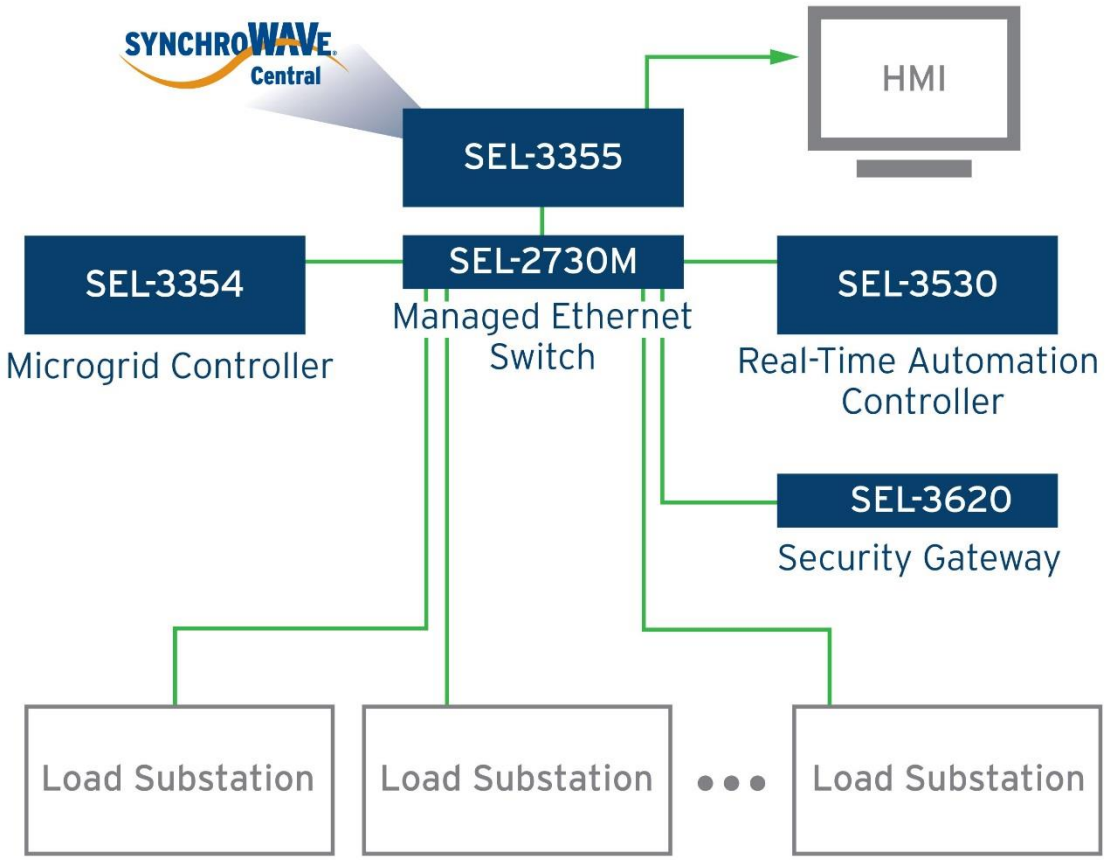

Figure 2—SEL POWERMAX Power Management and Control System for the UC San Diego microgrid.

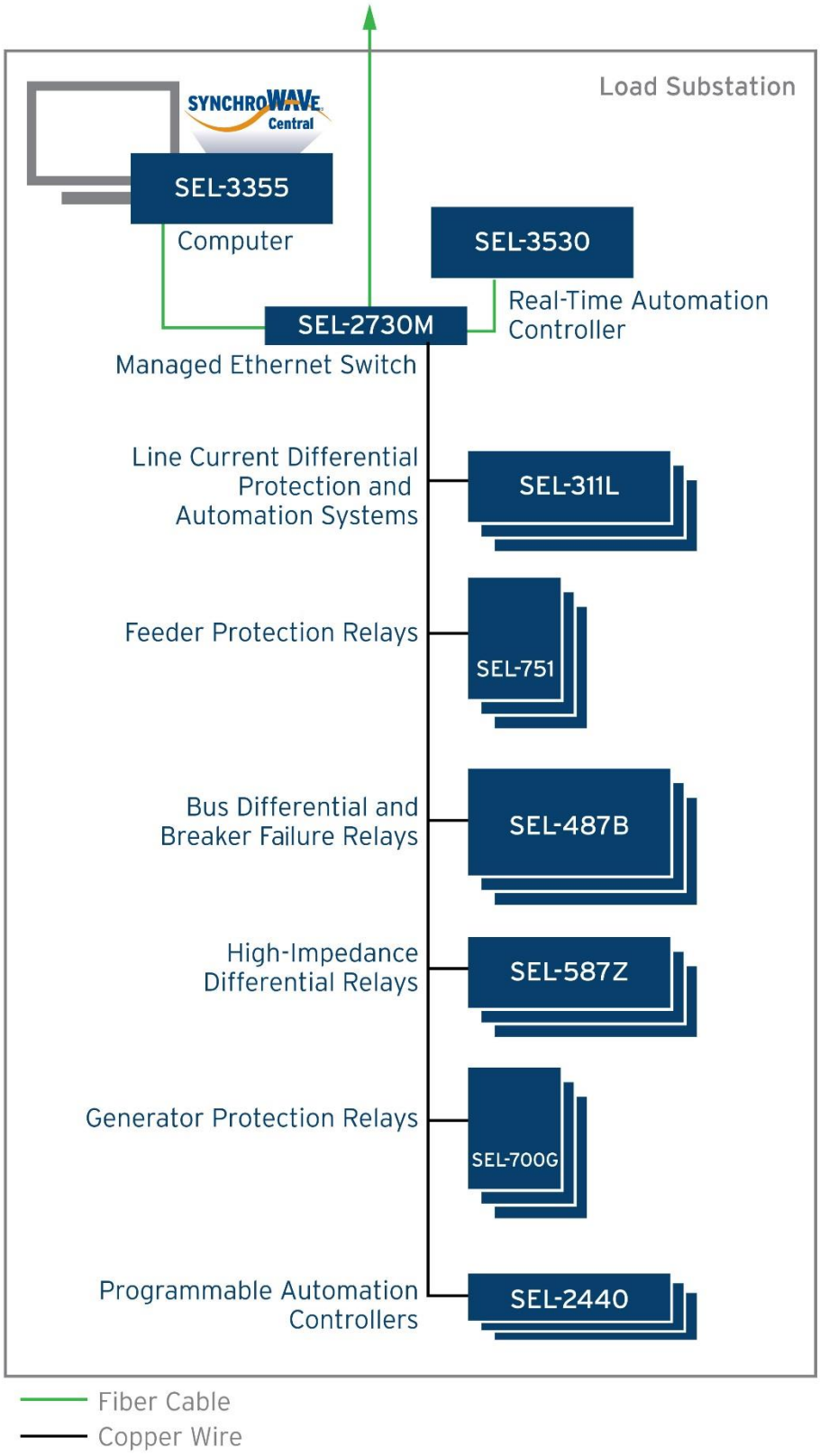

Figure 3—A UC San Diego load substation protected by SEL relays.

During the FAT, SEL hosted representatives from UC San Diego, including Associate Director of Energy and Utilities John Dilliott, for a week at the Pullman, Washington, headquarters so they could watch their solution in action. SEL duplicated the university's microgrid power system using RTDS technology, staging all the panels and equipment. SEL put the POWERMAX solution through hundreds of closed-loop RTDS tests and contingencies. It passed each test, proving its effectiveness.

The UC San Diego POWERMAX control system was installed in the summer of 2015. Now, not only is their microgrid able to detect unstable power in the main grid and quickly island itself, it is also able to shed noncritical load so that critical areas, like the Health System and Scripps, can maintain reliable operation. In addition, the campus is able to operate reliably at its maximum capacity and potentially save millions per year in energy costs. Partnering with UC San Diego allowed SEL to provide a solution that ensured the safe, reliable, and economical delivery of electric power to the university's critical infrastructure.

Figure 4—Pullman, Washington. This picture shows the team involved in the FAT for UC San Diego's customized POWERMAX solution. This solution passed hundreds of closed-loop RTDS tests.

About UC San Diego

The University of California, San Diego is a student-centered, research-focused, service-oriented public institution that provides opportunity for all. Recognized as one of the top 15 research universities worldwide, a culture of collaboration sparks discoveries that advance society and drive economic impact.

About SEL

SEL serves the power industry worldwide through the design, manufacture, supply, and support of products and services for power system protection, monitoring, control, automation, communications, and metering. For more than 30 years, SEL has provided industry-leading performance in products and services, local technical support, a 10-year worldwide warranty, and a commitment to making electric power safer, more reliable, and more economical.

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