As power demands have increased and new generation sources are added to the electric grid system, fault current mitigation has become a growing concern for utilities. Fortunately, Applied Materials Inc.’s superconducting fault current limiter (SCFCL) technology presents a new, viable solution to address this issue for electric utilities around the world.

“Applied Materials has developed a superconducting fault current limiter that can be seamlessly integrated into an existing distribution and transmission grid to absorb fault current before a disruption occurs,” says Paul Murphy, general manager of the Applied Materials Power System Group. “It provides critical impedance on demand capability, introducing impedance only when the system needs it to protect the grid and improve reliability.”

Murphy and a team of engineers, including Director of Technology Kasegn Tekletsadik, began developing the SCFCL in 2009 to target the problems utilities were having with fault currents. By leveraging the company’s expertise across a range of competencies that include high voltage, magnetics, superconductivity, power electronics and systems design engi-
neering, the team was able to quickly develop a new advanced SCFCL solution, Murphy says.

The company, which primarily manufactures equipment for the semiconductor, display and solar markets, recently provided an Applied SCFCL system for Central Hudson Gas & Electric Corp.’s Knapps Corner substation in Poughkeepsie, N.Y. The system is designed to reduce the first peak of fault currents on power lines, to limit damage to power equipment and improve system reliability.

**Project Inception**

The opportunity to install a SCFCL at the Knapps Corner facility came after Applied demonstrated the SCFCL to Central Hudson Gas & Electric Corp.’s Knapps Corner substation in Poughkeepsie, N.Y. The program, NYSERDA Senior Project Manager John Love explains, awards funding for research and engineering studies, product development and projects that improve the performance of electric power delivery in New York State. “Smart grids are an important element in Governor Andrew M. Cuomo’s agenda to make New York State’s energy systems cleaner, more reliable, more resilient and more affordable.”

Central Hudson Vice President of Engineering and System Operations Paul Haering said that the project is a good opportunity to test and evaluate the technology. “The large current experienced during a fault – up to 200 times the nominal current level – exerts excessive forces on power grid components and connections,” he said in a statement. “By adding fault current limiters in lieu of conventional current limiting reactors, our goal is to lengthen the service life of equipment and lower system losses, ultimately lowering costs for our electricity customers.”

**Excellence in Execution**

The installation of the SCFCL at Central Hudson Gas & Electric Corp.’s substation in Poughkeepsie went smoothly, thanks to strong coordination between the team members. Murphy says this installation was accomplished without disturbing regular grid operations and that collaborative efforts of all the parties paid off when the SCFCL installation was completed ahead of schedule and under budget.

Overall, Love says, the project went smoothly thanks to strong coordination between the team members. “The only delay was weather related, due to the extremely cold and snowy winter in Poughkeepsie. The weather delayed construction of the foundations for the SCFCL and associated support equipment.”

Haering adds that the project team ensured it would not compromise the reliability of the equipment or service quality to its customers. “A primary advantage of the application is that it defaults to a failsafe mode from an electric system standpoint.”

The project team also worked closely together to overcome the challenge of integrating a new technology into an existing substation. According to
Transmission & Distribution

Applied Materials – Building a Better Future

Based in Santa Clara, Calif., Applied Materials started operations in 1967 and has since grown to have a global reach, with 84 locations in 18 countries throughout Europe, India and the rest of Asia. It is the largest manufacturer of equipment for the semiconductor, display and solar industries.

The industries Applied works in are dynamic and always changing, says Om Nalamasu, senior vice president and CTO. To address these industries’ critical inflections, he maintains that Applied constantly innovates and develops new solutions to what were once intractable problems.

Applied adheres to the philosophy that understanding and solving its customers’ toughest challenges as quickly as possible is key to creating a better future. “At the core of enabling major advances across the semiconductor, display and solar industries is Applied’s expertise in precision materials engineering (PME),” Nalamasu says.

“Also critical to the company’s growth strategy and success is our ability to identify critical global inflections in multiple new industries and to utilize our core strengths in PME to develop time and cost effective solutions.”

New Markets

Applied invests more than $1 billion annually in research and development. Part of the funding is targeted for new markets where it can apply its diverse technical expertise.

“The fault current limiter [FCL] is a good example of how we use our engineering prowess to develop robust, highly reliable systems to address fault currents of the electric grid,” Nalamasu says. He believes that Applied’s SCFCL solution represents an important opportunity to address the utility industry’s critical need while creating a potential new market for the company.

Nalamasu believes in a strong future for Applied, which will continue investing in growth and finding ways to solve its customers’ toughest challenges in the markets it serves today as well as the needs of new markets.

Murphy, the company had extensively tested the system and proactively worked up front to make sure the install went smoothly. “The SCFCL was new for the team members of Central Hudson, but their professionalism and openness to the project ensured its success,” he adds.

The SCFCL system has performed well, Love adds. “The device has detected multiple fault currents since commissioning, and the SCFCL system activated and reduced the faults as predicted,” he says, adding it is “collecting valuable operating data that will be useful for other utilities in determining how they will address their current fault issues.”

Central Hudson is also proud of the system, Haering adds. “We think the project demonstrates the benefit of working collaboratively with innovative third parties in deploying technologies that can be readily applied to address common issues that face the electric system,” he says.

Proud Partners

The SCFCL project marks the first time Applied has worked with NYSERDA and Central Hudson. “We found them to be great partners, and very open and helpful. We learned a great deal from the experience and hope to continue collaborating with them in the future,” Murphy says.

Love agrees. “Central Hudson is a very progressive utility, eager to try advanced technologies, and it has the added benefit of being small enough to make quick decisions and execute on those decisions in a timely manner. Applied’s engineering team did a great job of keeping everyone informed of progress and maintained a fairly aggressive schedule from build to pre-test to install and operate.”

Murphy hopes to work again with Central Hudson and NYSERDA on other programs. He says it is Applied’s goal to develop a program to install a FCL at transmission. He explains in addition to distribution, the SCFCL has been developed to work at transmission levels, where it could be of further benefit to the utilities.

NYSERDA also has plans for the SCFCL. “Through the current project, we hope to demonstrate the benefits of the SCFCL product to other utilities, so that they may adopt the technology on their systems without the need for NYSERDA funding,” Love states.

Central Hudson is currently in discussions with Applied on other potential applications. “Also, we have two projects underway with NYSERDA, related to smart grid, system modeling and increased integration of distributed resources on the system,” Haering says.
Bringing Benefits

Applied Materials consulted with numerous power generation and transmission facilities worldwide prior to starting the SCFCL project, Director of Global Business Development for the FCL program John Ludlum says. This effort included examining a full range of value propositions the SCFCL may provide utilities.

The advantages that may accrue to Knapps Corner are considerable, Murphy says. Among them is increased safety. “Lower fault currents may make working in the live substation environment safer by diminishing the likelihood of arc ignition, plasma injury and system catastrophic failure,” he says.

Murphy asserts that the SCFCL also can reduce costs by decreasing the fault current rating on breakers and associated bus-bar works for future upgrades, as well as the need for a new substation.

The SCFCL may further provide Knapps Corner with more voltage stability. According to Murphy, conventional fault current reduction methods that use high impedance transformers and series current limiting reactors can lead to stability problems.

A SCFCL can minimize or eliminate voltage stability problems by minimizing or eliminating the need for high-reactance devices, he says. Low impedance transformers with no additional series of current limiting reactors, he adds, can be a common configuration with Applied’s system. “This new topology can minimize the shift in the phase angle of the source and load, improving voltage regulation and transient stability.”

According to Murphy, the SCFCL also can address the issue of voltage dips. He explains that when a fault current is present, the voltage magnitude will dip at different locations on the grid based on this occurrence. The rapid insertion of impedance enabled by the SCFCL can reduce these voltage dips helping the customers ride through the event.

The SCFCL system is also very useful to the overall durability and reliability of networks and substations, Murphy says. High fault currents heat up the underground cables, he says. Such thermal stress can degrade the dielectric strength of the cable insulation.

He continues to explain that high electromagnetic forces generated during high fault currents also can cause rupture failures. However, when the SCFCLs reduce the fault currents, they minimize or eliminate aging factors, thermal stress and mechanical fatigue.

With the wear and tear and faster aging electromagnetic forces and thermal stresses can cause, limiting fault currents is vital, Murphy says. He estimates a 50 percent current reduction, for example, reduces stresses by 75 percent, and the aging factor can almost be eliminated. SCFCLs also support adding more power transfer with existing systems without impacting the life of the system.

“The minimization of VAR compensation requirements in substations brings significant capital savings as well as potentially allowing for greater real power transfer and increases the overall efficiency and effectiveness of the transformers and circuits,” Murphy says. “The elimination of 10 percent to 25 percent impedance from the system bring significant savings for the utility as well as overall better potential network stability.”

SuperPower President Yusei Shirasaka (left to right) and Director of Research and Development Drew Hazelton stand with Applied Materials Corporate Vice President and General Manager Gary Rosen, Central Hudson Vice President of Engineering and System Operations Paul Haering, NYSERDA Senior Project Manager John Love and Three-C Electrical Vice President of Technical Business Development Scott Secrest at the project’s ribbon-cutting ceremony.