CHANGING WHAT'S POSSIBLE

ULTRAFAST—Unlocking Lasting Transformative Resiliency Advances by Faster Actualization of power Semiconductor Technologies

PROJECT DESCRIPTIONS

Sandia National Laboratories – Albuquerque, NM

E1-Arrester for Improved EMP Protection - $2,560,000

Sandia National Laboratories will develop a solid-state surge arrester device that would protect the grid from very fast electromagnetic pulses that threaten the grid's reliability and performance. Sandia's arresters take advantage of the properties of granular metals—a composition of metal nanoparticles within an insulating matrix—to divert sudden and short-lived high-voltage and high-current surges of energy safely away from the grid. The proposed arrester responds on a nano-second timescale, which is faster than existing lightning surge arresters currently on the grid.

RTX Technologies Research Center – East Hartford, CT

TRIGER: Timed RF Integrated Gating for Energy Regulation - $2,500,000

RTX Technologies Research Center is developing semiconductor switching modules that are triggered using rectified 5G radio frequency rather than low frequency gate drive signals, thereby reducing losses and improving control of power electronics converters for aerospace systems as well as for the grid. These modules will permit the power devices they drive to perform at much higher frequencies than conventional devices, resulting in minimal size, weight, power, and cost while increasing the reliability and efficiency of future power systems. If successful, the devices will achieve switching at rates 10 times faster than state-of-the-art while controlling double the power.

University of Pennsylvania – Philadelphia, PA

All-Optical Control of Isolated High Voltage Power Systems Using Integrated Electronic, Photonic, and Microfabricated Sensing and Breaker Technology - $2,240,309

The University of Pennsylvania is developing an integrated module featuring wide-bandgap power devices to improve electric grid control, resilience, and reliability. The proposed co-packaged module integrates high-speed gate driving, optical power delivery, signal isolation, remote sensing, and protection. The module will non-invasively monitor the voltage and current of wide-bandgap devices and would have higher noise immunity than state-of-the-art.

Texas Tech University – Lubbock, TX

Ultrawide-Bandgap Semiconductors for Extrinsic Photoconductive Switching Devices - $3,070,735

Texas Tech University is developing a photoconductive semiconductor switching device from ultrawide-bandgap materials that would enable improved control of the grid. The ultrawide-bandgap semiconductors used in the device—hexagonal boron nitride and aluminum nitride—support higher voltage and current than legacy semiconductor materials. Texas Tech's device seeks to enable efficient high-power and high-speed power electronics converters for a smarter grid.

Lawrence Livermore National Laboratory – Livermore, CA

Diamond Optically Gated Junction Field Effect Transistor - $3,000,000

Lawrence Livermore National Laboratory is developing a semiconductor transistor device to enable future grid control systems to accommodate higher voltage and current than conventional devices. The team seeks to build a high-power diamond optoelectronic device that has the inherent advantages of diamond's superior properties relative to other wide- and ultrawide-bandgap semiconductor materials. Three of the proposed devices in series would be able to support more than 6 kilovolts, almost double that of existing wide-bandgap commercial options.

University of Arkansas – Fayetteville, AR

Heterogeneously Integrated Power Modules - $2,931,177

The University of Arkansas is developing a heterogeneously integrated power module for applications in the electric power grid and electrified transportation. The module will integrate capacitors, sensors, and integrated circuits, enabling next generation, more reliable power electronics. University of Arkansas' proposed technology could open the door for up to a 10-fold improvement in switching performance compared with the state of the art.

University of California, Santa Barbara – Santa Barbara, CA

Optically Controlled 20 kV Gallium Oxide Power Switches for Grid Resiliency - $3,122,356

The University of California, Santa Barbara (UCSB) is developing ultrawide-bandgap switching devices that would achieve a five times higher voltage than the state-of-the-art, enabling more sophisticated control methods for the grid. The proposed switching devices take advantage of beta-gallium oxide, an ultrawide-bandgap material that possess inherently superior properties compared with legacy silicon switching devices. UCSB's switching device will be optically powered and controlled to limit the effects of electromagnetic interference.

University of Wisconsin-Madison – Madison, WI

Optically Triggered Ultrawide-Bandgap (UWBG) Power Electronics - $2,990,321

The University of Wisconsin-Madison is developing an optically triggered semiconductor switching device to reduce power losses up to 50% compared with current technologies. The team seeks to monolithically integrate optically triggered phototransistors and power transistors onto the same chip—which are typically incompatible because of material dissimilarities—by using ultrawide-bandgap materials. The proposed technology could increase switching frequency without raising switching losses and serve as a critical building block for grid modernization.

Georgia Institute of Technology – Atlanta, GA

Scalable Wide-Bandgap III-Nitride Switch (SWiNS) - $2,700,000

Georgia Institute of Technology is developing a semiconductor switching device from wide-bandgap III-Nitride material to improve grid control, resilience, and reliability. Georgia Tech's switching device seeks to achieve remarkable current and power capabilities by utilizing carrier control phenomena which transport current through the entirety of the semiconductor volume, a capability distinct from conventional power transistor designs which channel current through narrow constrictions. If successful, the device would enable switching on nearly any transmission line using a single device, greatly reducing cost and complexity of building the future smart grid.

Opcondys – Manteca, CA

Ultrafast, Autonomous Grid Protection Using Linear Photonic Switching - $3,178,977

Opcondys is developing a light-controlled grid protection device to suppress destructive sudden and short-lived surges in energy on the grid caused by lightning and electromagnetic pulses. The proposed protection module improves upon current slower surge protection devices by using high-voltage photoconductive power electronics with nanosecond response times. If successful, any sudden and short-lived disruption through utility lines will auto-trigger the module, halting a disruption from traveling any further and protecting grid-connected equipment.

Great Lakes Crystal Technologies – East Lansing, MI

High Power Diamond Transistors with Electrical and Optical Gate Control - $2,301,538

Great Lakes Crystal Technologies is developing a diamond semiconductor transistor to support the control infrastructure needed for an energy grid with more distributed generation sources and more variable loads. The proposed transistor takes advantage of the properties of diamond, an ultrawide-bandgap semiconductor material with better thermal management, lower power loss, and higher operating voltage than conventional materials. The device switches can be controlled by light source and electrical means, improving electromagnetic interference immunity.

NextWatt – Hoffman Estates, IL

UWBG Device with Rapid Switching and Minimal Optical Power Requirement - $2,268,750

NextWatt is developing an ultrawide-bandgap optical triggered device that addresses the need for fast protection for solid-state transformers (SST), a promising technology for revolutionizing substations and renewable energy systems. NextWatt seeks to build an ultrafast optical switching device using a low-cost beta-gallium oxide semiconductor triggered with a readily available mid-wavelength optical beam. If successful, the device would enable solid-state-circuit breakers for protection of SSTs and other power and energy applications.

University of Tennessee, Knoxville – Knoxville, TN

A UNIVERSAL (Ultrafast, Noise-Immune, Versatile, Efficient, Reliable, Scalable, and Accurate Light-Controlled) Switch Module - $2,759,821

The University of Tennessee, Knoxville will develop scalable light-triggered semiconductor switch modules for the protection of grid and aviation power systems. The proposed switch module seeks to achieve cost savings, fast switching speeds, and built-in redundancy by using sub-modules featuring lower-voltage and lower-current silicon carbide devices for desired higher application voltage and current levels. The University of Tennessee's switch modules are controlled by light instead of electrical signals to minimize the electromagnetic interference and to simplify electrical isolation design.

University of Illinois at Urbana-Champaign – Urbana, IL

Diamond PCSS: DIAMOND PhotoConductive Semiconductor Switches - $2,982,311

The University of Illinois at Urbana-Champaign is developing diamond semiconductor switching devices to enable revolutionary breakthroughs in electricity grid protection. The proposed device is composed of light-triggered ultrawide-bandgap materials and overcomes the voltage and current limitations of conventional photoconductive devices. If successful, the device will be a critical component in higher-temperature, more efficient, and reliable power electronics.

GaNify – State College, PA

Medium-Voltage Optoelectronic Power IC Building Block - $3,060,000

GaNify is developing a power integrated circuit building block that would enable an enhanced control of power electronics converters for a more efficient and reliable grid. GaNify's medium-voltage gallium nitride light-controlled integrated circuit takes advantage of low cost, manufacturable, and scalable components to design and build an integrated wide-bandgap semiconductor module for grid-level power electronics. If successful, the module would feature high noise immunity, enhanced protection, and five-fold lower power loss than legacy silicon-based technology.

University of Buffalo – Buffalo, NY

Optically Cascoded Ultrahigh Voltage Gallium Oxide Devices for Modular Multi-Converter - $2,847,754

The University of Buffalo is developing an optically controlled high voltage power switching device for enhanced resiliency, reliability, and control of power flow in grid applications. The proposed switches would be made of the ultrawide-bandgap material beta-gallium oxide, which offers benefits including high breakdown strength, scalable melt-grown substrates, and ease of material processing. The University of Buffalo would use an optical cascode architecture to achieve high slew rate operation and noise immunity for the devices.