U.S. Department of Energy
Advanced Research Projects Agency – Energy

Announcement of Teaming Partner List for Upcoming Funding Opportunity Announcement: Unlocking Lasting Transformative Resiliency Advances by Faster Actuation of power Semiconductor Technologies (ULTRAFAST)

The Advanced Research Projects Agency Energy (ARPA-E) intends to issue a Funding Opportunity Announcement (FOA) entitled Unlocking Lasting Transformative Resiliency Advances by Faster Actuation of power Semiconductor Technologies (ULTRAFAST), targeting development and demonstration of semiconductor material, device and/or power module technologies to create more capable power electronics building blocks for the future grid. More specifically, ARPA-E is looking for semiconductor material, device and/or power module level advances to enable faster switching and/or triggering at higher current and voltage levels for improved control and protection of the grid.

Separate categories targeting faster switching semiconductor devices or power modules for higher-bandwidth control, and/or higher current and voltage slew rates for triggering and protection, both at higher voltage and current ratings, are envisioned to allow for the broadest range of approaches, although technology developments that can simultaneously address both necessary functions are preferred.

ARPA-E held a workshop on this topic in October 2022; Information on this workshop can be found at https://arpa-e.energy.gov/events/ultra-fast-triggered-devices-workshop.

Individual semiconductor devices and/or modules operating at high voltages and current ratings are desired to reduce the number of stacked devices in power modules, stacked modules in power cells (half-bridge, full-bridge, flying capacitor, etc.), and stacked cells in multi-level converters for medium- and high-voltage applications. Reducing the required number of devices and modules will be necessary to improve overall system reliability, complexity, and (eventually) cost. Increasing the switching speed is desired to continue the trend of reducing passives' volume and increasing overall converter power density. Furthermore, decreasing the switching times (increasing slew-rates) leads to a reduction in switching losses thus relaxing the critical thermal management requirements but worsening the electromagnetic interference (EMI) which directly impacts the converter reliability. One way to minimize these issues is to wirelessly trigger semiconductor devices and modules (some examples are Photoconductive Semiconductor Switch (PCSS) and Light-Triggered Thyristor (LTT) that utilize optical energy for switching, but there may be other wireless means to do so). Hence, ARPA-E desires solutions which mitigate EMI issues while simultaneously providing semiconductor devices and/or modules capable of operating at high switching frequencies, and featuring high slew-rates, current and voltage levels.

Of interest is also wirelessly powered gate driver, associated voltage and current sensors, as well as wireless transfer of control signals and data, all of which can significantly mitigate EMI problems.

Similarly, ARPA-E is interested in new device concepts that promise performance at the required levels. Novel device concepts that span across categories are encouraged, as are ideas that allow incorporation of protection functions within a device or module.

Program category one seeks device and/or module technologies targeting protection functions at high current and voltage levels. As such, ARPA-E desires functionality that enables, very fast by-pass, shunt, or interrupt capability at as low level of integration as possible with nanosecond-level reaction time (and corresponding slew rates). Depending on the type of operation, there are different requirements on the efficiency and reliability. For example, protection device/module operating in-line (normally-on) is expected to function with higher efficiencies to minimize conduction loss and consequent thermal management requirements. For protection devices that are shunt-connected (normally-off), voltage withstand capability, very low leakage current, and extremely fast turn-on are essential attributes. For both types of protection device reliability of fault handling will be demonstrated through the number of operating (on-off) cycles. Because advances in category one target protection functions, their temporal performance is characterized by how quickly they can reach their final state, that is by the current and voltage slew rates, rather than by switching speed. Temporal and efficiency requirements of this program point to an all-solid-state solution, although other innovations are possible.

Category two addresses the need for high switching frequency devices and/or modules which enables high-power, high-speed power electronics converters for future grid. High efficiency is paramount, while reliability will be assessed through a device/module lifetime (hours of continuous operation). Category two devices or modules can additionally feature some or all protection functions from category one, offering a switch with unparalleled performance specifications.

Demonstration of device and/or module technologies developed under category one and two is expected. This can encompass verification of performance at the next level of system integration, such as a circuit, for example a buck, boost, half/full-bridge or other, relevant, converter structure. Teams should have a demonstration plan and justification in light of a potential technology application.

Category three targets supporting technologies for category one and category two, such as wireless sensing of device voltage and current, high-density packaging of multi-die power modules with the integration of wireless actuators and device/module-level protection, power cell-level capacitors and inductors, thermal management strategies, etc. While category three is distinct, it is expected that capabilities developed therein will be demonstrated in a system context corresponding to the next level of integration, such as devices/modules developed in categories one and two, or via suitable alternatives and overall demonstration strategy. Thus,

performance targets for category three encompass and support those for categories one and two.

Due to a complex cross-disciplinary nature of the intended program, ARPA-E strongly encourages outstanding scientists and engineers from different organizations, scientific disciplines, and technology sectors with expertise in power electronics, optoelectronics, photonics, and other related fields, to form new project teams. Interdisciplinary and cross-sector collaboration spanning organizational boundaries enables and accelerates the achievement of scientific and technological outcomes that were previously viewed as extremely difficult, if not impossible.

The Teaming Partner List is being compiled to facilitate the formation of new project teams. The Teaming Partner List will be available on ARPA-E eXCHANGE (http://arpa-e-foa.energy.gov), ARPA-E's online application portal, starting December 2022. The Teaming Partner List will be updated periodically, until the close of the Full Application period, to reflect new Teaming Partners who have provided their information.

Any organization that would like to be included on this list should complete all required fields in the following link: https://arpa-e-foa.energy.gov/Applicantprofile.aspx. Required information includes: Organization Name, Contact Name, Contact Address, Contact Email, Contact Phone, Organization Type, Area of Technical Expertise, and Brief Description of Capabilities.

By submitting a response to this Notice, respondents consent to the publication of the above-referenced information. **By facilitating and publishing this Teaming Partner List, ARPA-E is not endorsing, sponsoring, or otherwise evaluating the qualifications of the individuals and organizations that are self-identifying themselves for placement on this Teaming Partner List. ARPA-E reserves the right to remove any inappropriate responses to this Announcement (including lack of sufficient relevance to, or experience with, the technical topic of the Announcement).** ARPA-E will not pay for the provision of any information, nor will it compensate any respondents for the development of such information. Responses submitted to other email addresses or by other means will not be considered.

This Notice does not constitute a Funding Opportunity Announcement (FOA). No FOA exists at this time. Applicants must refer to the final FOA, expected to be issued in early 2023, for instructions on submitting an application, the desired technical metrics, and for the terms and conditions of funding.