MARQUETTE UNIVERSITY

ULTRA-FAST RESONANT DC BREAKER

PROJECT TERM: 6/2/2019–6/2/2021	**AWARD:** $500,000
WEBSITE: marquette.edu	**LOCATION:** Milwaukee, WI
TECH AREA: Electrical efficiency	**PROGRAM:** BREAKERS

CRITICAL NEED

Today's power grid relies primarily on alternating-current (AC) electricity. Direct-current (DC) benefits over AC include lower distribution losses, higher power carrying capacity, and reduced conductor materials. DC is well suited to industrial applications, transportation, and energy production. However, the risk associated with electrical faults, such as short circuits, and system overloads, continues to hinder the growth of DC markets. Inherently, AC electricity periodically alternates direction, providing a brief "zero crossing," where no current flows. This characteristic allows electrical faults to be interrupted by conventional electro-mechanical breakers. DC networks deliver power without zero crossings, which make conventional circuit breakers ineffectual in fault scenarios. To promote medium voltage (MV) DC usage, fast, highly reliable, scalable breakers must be developed for commercial deployment.

PROJECT INNOVATION + ADVANTAGES

Marquette University will leverage the technology gap presented by the lack of DC breaker technology. The project objective is to create an industry standard DC breaker that is compact, efficient, ultra-fast, lightweight, resilient, and scalable. The proposed solution will use a novel current source to force a zero current in the main current conduction path, providing a soft transition when turning on the DC breaker. A state-of-the-art actuator that can produce significantly more force than current solutions will be used. The approach represents a transformational DC breaker scalable across voltage and current in medium voltage DC applications, such as power distribution, solar, wind, and electric vehicles.

POTENTIAL IMPACT

The proposed breaker is installed close to loads to rapidly detect and react to the short-circuit fault. Thus, it could enable an increased number of electronic loads that operate using DC, such as ultra-fast electric vehicle charging stations and utility scale energy storage battery units, to connect to the MV distribution grid. This would improve overall power delivery efficiency.

- ECONOMY: Proliferation of MVDC systems protected by more effective DC circuit breakers could drive higher energy efficiency, lower equipment costs, and bolster grid resiliency.
- SECURITY: DC circuit breakers respond significantly faster than their AC counterparts, enabling prompt isolation and protection of assets from electrical faults. MVDC circuit breakers and grids enable greater resiliency to cyber and other attacks through targeted isolation of affected nodes.
- ENVIRONMENT: MVDC breaker-enabled microgrids could facilitate greater deployment and adoption of distributed renewable resources, greatly reducing power sector emissions. Electrification of transportation (ships, aviation) with DC systems would also reduce emissions.

CONTACTS

ARPA-E Program Director:	Project Contact:	Partner Organizations:
Dr. Isik Kizilyalli ARPA-E-Comms@hq.doe.gov	Dr. Nathan Weise nathan.weise@marquette.edu	University of Kentucky