

**NAME OF APPLICANT: Iowa State University;**  
**PRINCIPAL INVESTIGATOR: James McCalley**  
**PROJECT TITLE: HVDC-Learn: Modular Education & Workforce Training in  
High Voltage Direct Current Electric Transmission**

The objective of this project is to develop & use educational modules to elevate the electric power community's awareness/understanding of the high-voltage direct current (HVDC) domain to increase HVDC deployment as an offshore & onshore transmission solution. A 7-university team is developing 36 modules containing 128 hours of deliverable content for education and workforce training in deploying HVDC transmission to facilitate the growth of zero-carbon electric power resources, with particular emphasis on offshore wind. These modules cover 12 areas of HVDC transmission: introductory and overview coverage, station components, converters, HVDC control, HVDC protection, HVDC line and cable technologies, point-to-point HVDC configurations, multiterminal HVDC networks, planning and design, HVDC system simulation and analysis, regulatory and permitting processes and procedures, and energy equity and environmental justice. Each module has a lead developer coupled with multiple co-authors from the faculty team, from the project board, and possibly from outside the project. The project board is comprised of representatives from 33 organizations: 17 US industry organizations, 3 European companies, 1 international organization, 4 US community colleges, 1 US university, 1 US vocational school, 4 European universities, 1 environmental justice advocacy group, and 1 energy equity expert.

Each module is divided into two sections. An initial section summarizes the particular HVDC topic for onshore applications, with varying depth depending on the topic, and appropriate references to point readers to other sources useful for follow-up. A second section addresses in-depth the same HVDC topic but for offshore applications. This approach enables students to compare and contrast onshore and offshore applications, starting with the more mature onshore area but fully addressing the complexities of deploying HVDC in offshore settings.

These modules target courses for students in vocational schools, community colleges, undergraduate and graduate-level engineering programs, and technicians and engineers in the workforce. Modules emphasize state-of-the-art concepts and information presented using textbook-quality writing coupled with high-quality, topic-relevant photos, animations, and videos, facilitated via versatile internet-based Jupyter products for creating, sharing, and interactively developing computational documents, code, and data.

Each module undergoes extensive review by the project board and other experts, together with classroom-based "course-testing" and modification based on student feedback. Modules are made available to the community via an easy-to-use searchable public website. These modules are deployed in over 40 existing courses at the seven different universities and project board community colleges; at least five of these institutions package courses to support certificate programs utilizing the modules. Additionally, we offer an industry outreach program through which we deploy modules via a series of short courses. We collaborate with the Global Power System Consortium and the Power Systems Engineering Research Center to develop ways post-project to maintain existing modules and create new ones.

We measure the effectiveness of our approach via module reviews together with assessment of the influence modules have on individuals and the extent to which modules are used by people involved in HVDC-related projects. These measurements help to maintain focus on module quality as well as the ultimate influence these modules have on HVDC deployment.

We implement a community benefits plan (CBP) to engage with the city of Bridgeport, CT., identified as a disadvantaged community. We work with city constituents to assist in identifying locally attractive options for reducing energy cost and environmental impact, focusing on energy equity. In another CBP feature, we address diversity and workforce issues via multi-school design projects where students at East Coast universities and community colleges collaborate to design HVDC offshore transmission systems.