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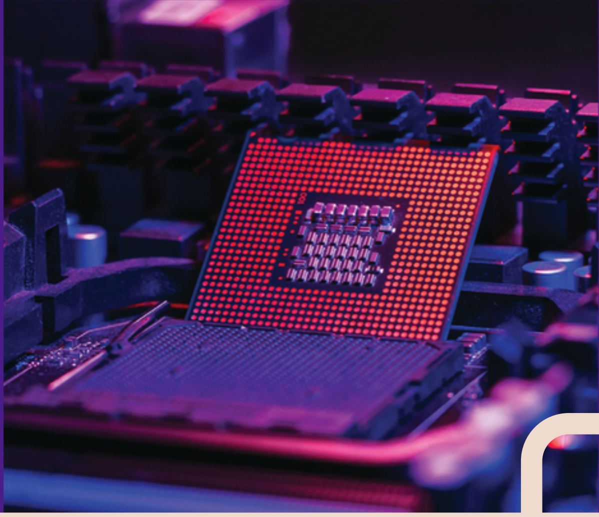

Power Electronics: A Cleantech Success Story (in Progress)

Power electronics are an essential, albeit hidden, component of the clean energy economy that will ultimately avoid gigatons of greenhouse gas emissions.[1] Power electronics make LED lightbulbs, solar panel inverters, electric vehicles, and many other technologies work. They rely on semiconductors made of materials like silicon carbide and gallium nitride that have a wider bandgap (a key property for electronics that determines how effective a conductive material is) than the crystalline silicon used in conventional electronics.

RD&D investments from multiple DOE and other federal programs helped turn the concept of wide bandgap semiconductors into a growing array of useful products. As an example, government support enabled the commercialization of silicon carbide as a wide bandgap semiconductor. The technology was first invented at General Electric, refined at North Carolina State University (NC State) with support from the Office of Naval Research, and commercialized by Cree (now known as Wolfspeed), a company founded in 1987 by former NC State students. The Department of Defense and National Institutes of Standards and Technology were key supporters in its early years.[2, 3, 4] Cree found success selling chips for LED lightbulbs, but was stymied by technical barriers in other applications.

Picking up the baton, ARPA-E's SWITCHES (begun in 2013) and CIRCUITS (2017) programs supported public-private research partnerships seeking to break through these barriers.[5, 6] In parallel, the PowerAmerica Manufacturing Innovation Institute, a DOE-sponsored consortium of industry, universities, and national labs founded in 2015 and based at NC State, sought to cut production costs, demonstrate benefits, and build the industry's ecosystem.[7] The consortium's flagship project is X-FAB, the world's first silicon carbide chip foundry, which enables many U.S.- based chip designers to manufacture domestically. DOE's vehicle and manufacturing technology offices have also invested in this technology.[8, 9]

Some $2 billion worth of wide bandgap semiconductors were sold in 2024, and sales are expected to triple in the next decade as these products reach cost parity in an ever-growing array of applications. [10] The five major players in this market are all are based in the United States, Europe, or Japan and have substantial U.S. operations. However, early signs suggest China may be catching up: researchers there produced more than twice as many high-quality research outputs regarding wide and ultrawide bandgap semiconductors than the United States between 2019 and 2023.[11]

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11 Australian Strategic Policy Institute, "ASPI's Two-Decade Critical Technology Tracker: The Rewards of Long-Term Research Investment," August 2024, p. 42. https://ad-aspi.s3.ap-southeast-2.amazonaws.com/2024-08/ASPIs%20two-decade%20Critical%20Technology%20Tracker_1.pdf