Wide Bandgap High Power Converters & Systems (WBG-HPCS)

Since its inception in 2011, this CPES mini-consortium program has provided a unique, open and collaborative forum for the power industry to explore, jointly with CPES researchers, new and emerging power conversion technologies to meet what are the ever-increasing energy demands of our modern society: WBG-HPCS looks at everything from power semiconductors, to gate drivers, to converters, all the way to the impact that they have on electrical power systems.

As a mini-consortium, WBG-HPCS allows CPES to pool various resources seeking to develop the above pre-competitive technology. CPES is then able to address common industry challenges, and effectively share research results among its members. The program is strongly leveraged by CPES's vast expertise in WBG-based power conversion and its in-depth knowledge of electronic power systems, which it has accrued over the past 30 years working closely with the transportation and IT industries. As a result, the WBG-HPCS mini-consortium has expanded its research scope decisively into high-power medium-voltage applications for grid, industrial, and transportation applications.

CPES has continued to support research activities within the WBG-HPCS mini-consortium by securing funding—at the basic research level—from several government agencies. The most prominent ones include the Office of Naval Research (ONR), the U.S. Department of Energy (DOE), DARPA, and ARPA-E. These agencies have been instrumental in developing key enabling technology presently used in WBG-based high power electronics applications, and as such represent ideal partners for CPES. Their collaboration over the past years has generated invaluable synergy within CPES aiding in the pursuit of the mini-consortium goals. From a funding standpoint, CPES has been able to effectively quadruple the research activity in this area thanks to their support, ultimately quadrupling too the results and technological advancement that are shared with its members.

The WBG-HPCS present research thrusts are the following:

High-Power WBG-Based Power Converters

- High-frequency control of modular multilevel converters in ac-dc and dc-dc mode.
- Design of SiC-based modular multilevel converters with 1.7 kV, 3.3 kV, and 10 kV devices (package, gate-drive, PEBB, converter, system).

WBG-Based Power Electronics Technology

- Characterization of MV SiC and LV GaN devices.
- Development of EMI containment and suppression strategies for power converters, modular converters, and electronic systems.
- Formulation of electric-field constrained design methodologies for medium-voltage components subject to high-frequency excitation and fast dv/dt transients.
- Development of enhanced gate drivers, auxiliary power supplies and sensors for harsh dv/dt and EMI environments with advanced control capabilities.
- Development of PCB-based medium-voltage ac and dc capacitor arrays for ultra high power density applications.

Renewable Energy Integration

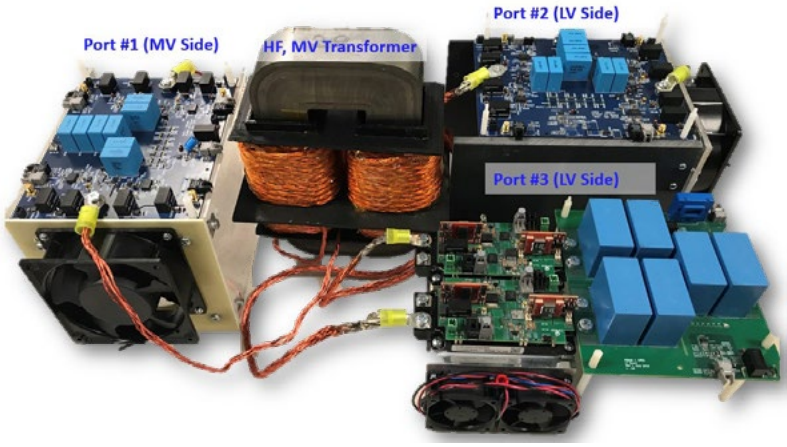
- Design of high-efficiency SiC-based grid-tied inverters for commercial PV applications.
- Design of high-efficiency GaN-based grid-tied inverters for residential PV applications.
- Static and dynamic impact of PV inverters in MV distribution systems.

Stability and Dynamic Interactions in Power Converter Systems

- Analysis of dynamic interactions between multiple STATCOM operating in proximity in HV transmission systems.
- Stability assessment and interactions of utility-scale PV inverters in medium-voltage distribution systems.
- Stability analysis in three-phase unbalanced systems and single-phase distribution systems.
- Grid-forming control schemes for grid-tied inverters.
- SiC-based impedance measurement unit (IMU) for ac and dc LV and MV distributions systems.

WORK SCOPE

- **High-power WBG-based power converters.**
- **WBG-based power electronics technology.**
- **Stability and dynamic interactions in a power converter systems.**
- **Renewable energy integration.**



Triple active bridge hardware setup.

PARTICIPANTS *January 2019 – January 2020*

WBG-HPCS MEMBERS

ABB Inc.
Delta Electronics
EnerSys
GE Grid Solutions
Huawei / Futurewei Technologies Co. Ltd.
Rockwell Automation
Siemens Corporate Technology
TMEIC Corporation

LEVERAGED WITH GIFTS FROM:

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