Research Center for
Electric Vehicle Charging and Thermal Management (EVeCTherM)

We are proud to announce the establishment of a Research Center for Electric Vehicle Charging and Thermal Management (**EVeCTherM**) in the School of Mechanical Engineering at Purdue University. Issam Mudawar, Purdue's Betty Ruth and Milton B. Hollander Family Professor of Mechanical Engineering, will serve as Director for the Center.

History

For the past 37 years, Mudawar has served as Director of both the Purdue University Boiling and Two-Phase Flow Laboratory (PU-BTPFL) and International Electronic Cooling Alliance (PU-IECA) where his team has addressed both the science and application of liquid-to-vapor phase change as a means for safely dissipating enormous amounts of heat from small surface areas. Application of this method have included supercomputers, computer data centers, x-ray medical devices, magnetohydrodynamic energy conversion, steam generator turbines, fusion reactors, particle accelerators, condensers, and evaporators.

His work also included thermal management of several aerospace and defense systems, including high Mach number turbine engines, avionics, satellites, laser and microwave electronics, and radar systems. In 2021, his efforts culminated in installation of the Flow Boiling and Condensation Experiment (FBCE), NASA's most complex facility for investigating liquid-vapor phase change phenomena in reduced gravity, phenomena that will play a vital role in future space missions, including thermal control of space vehicles for a wide range of gravitational environments. His most recent space research involves phase change phenomena in cryogenic fluids found in propellant production, storage, transfer, and usage for NASA's missions to the Moon and Mars.

Mudawar has shown how the liquid-to-vapor phase change phenomena that were successful in tackling thermal challenges in industrial, aerospace, and defense applications are equally effective in automotive applications, including power electronics in hybrid vehicles and hydrogen storage. More recently his team invented a charging station cable capable of fully charging certain electric vehicles (EVs) in under five minutes – about the same amount of time it taken to fill up a gas tank. To charge an EV faster, higher electrical current needs to travel through the charging cable. The higher the current, the greater amount of heat that must be removed to keep the charging cable operational. The most advanced chargers in the industry only deliver currents up to around 520 Amperes, and most chargers available to consumers support currents of less than 150 Amperes. Limited current means full charging of the EV will require in excess of 20 minutes; an obstacle cited by drivers as a key disadvantage to owning an EV. By supplying dielectric liquid within the cable, Purdue's technology capitalizes upon the tremendous cooling potential of liquid-to-vapor phase change, allowing the cable to deliver over 2400 Ampere of current and achieve a full charge at least 4 times faster – in less than five minutes – compared to the fastest commercial EV chargers on the market today. In effect, Purdue's technology has the potential to make electric vehicle and commercial fleet ownership more appealing and accessible. But the new cable technology is only one of the major bottlenecks to high-speed charging, and the system can only be implemented with advancements in other components of the charging system, especially the batteries.

The (i) clear requirement of more thermal management research to enhance the proliferation of EVs, (ii) our successes in tackling several thermal management challenges in automotive applications, including power electronics, hydrogen storage, and EV charging, and (iii) availability of several state-of-the-art thermal management facilities and technical know-how are key to the decision to establish **EVeCTherM**.

Center Goals

The overriding goal of **EVeCTherM** is to serve as an international resource for tackling all thermal management challenges of EVs, both external and internal, including, but limited to:

(1) charging station liquid coolant flow loop (reservoir/accumulator, pump, liquid to ambient heat exchanger, and flow controller)
(2) station to EV charging cable
(3) charging connector (plug)
(4) inlet/socket inlet
(5) coolant loop within EV
(6) inlet to batteries
(7) batteries
(8) power electronics
(9) motor
(10) cabin thermal control

Proposals to Engage with the Center (submit via email to Issam Mudawar, *mudawar@ecn.purdue.edu*)

Step 1: Virtual Kick-off

Meeting to introduce both capabilities at **EVeCTherM** and the sponsor's goals.

Step 2: Project Proposal

To expedite process of engaging **EVeCTherM**, companies are asked to provide a two-page proposal describing:

(1) key EV component/technology of interest (details can be providing by listing relevant URL(s)).
(2) list of goals/outcomes.
(3) list of deliverables
(4) performance schedule
(5) contact information for company representative

Step 3: Sponsored Research Agreement

An **EVeCTherM** representative will respond promptly to the sponsor's Project Proposal by negotiating technical objectives, methods, schedule, and cost of proposed work.

Step 4: Sponsored Research Agreement

If the Technical Agreement is mutually acceptable, Purdue's Sponsored Program Services (SPS) will negotiate the terms of the research engagement. The contract will include such terms as the (i) final Statement of Work (SOW), (ii) budget, (iii) intellectual property, and (iv) publications arising from the study and other terms and conditions customary with a university sponsored research engagement.

Every effort will be made to complete steps 1 to 4 in less than 8 weeks.