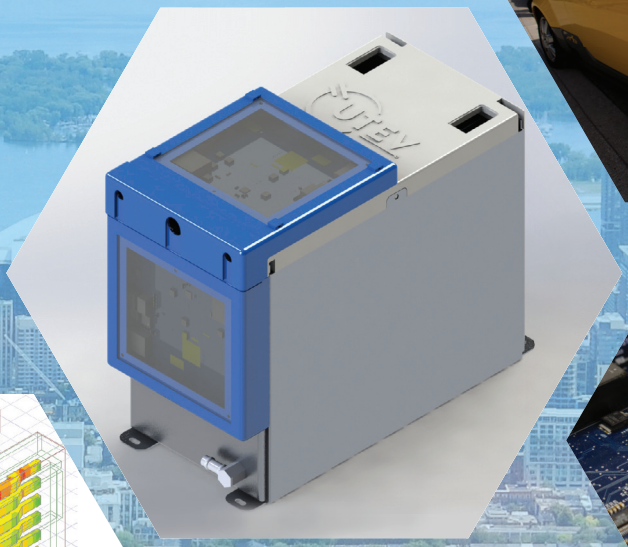
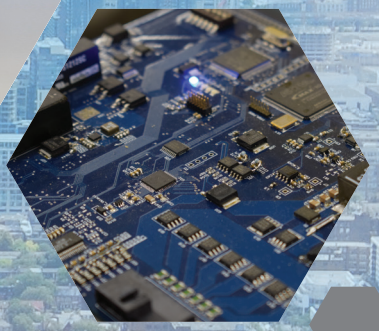
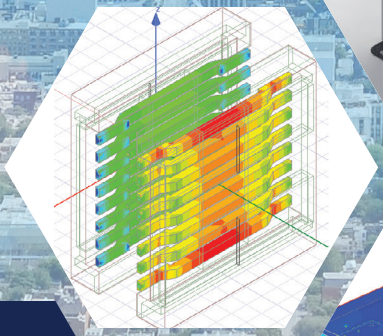
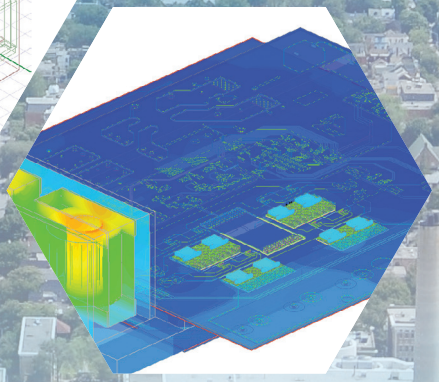








UTEV Research Centre

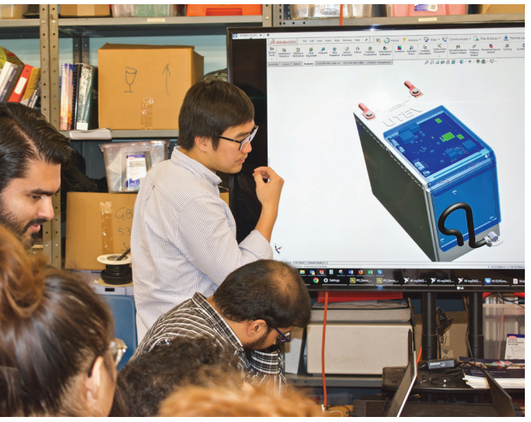
UTEV

UNIVERSITY OF TORONTO | Engineering

Research Focus

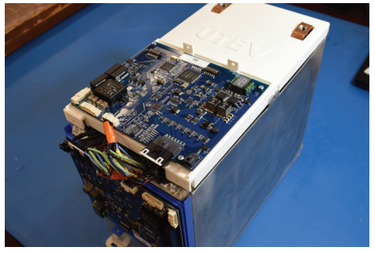
The University of Toronto Electric Vehicle (UTEV) Research Centre is a game-changing university-industry partnership, focused on next generation of EV technologies. Our research is focused in a state-of-the-art battery and power electronics lab at the University of Toronto's Edward S. Rogers Department of Electrical & Computer Engineering (ECE), with multi-disciplinary collaborations alongside leading professors from the Department of Mechanical and Industrial Engineering (MIE) and the UofT Institute for Aerospace Studies (UTIAS).

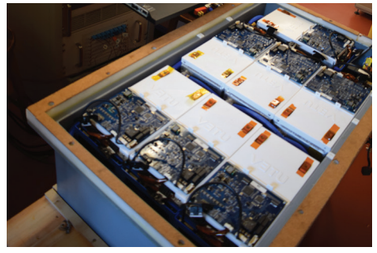
Enhanced Energy Management



Durability is an essential aspect of vehicles, which can be achieved through accurate modelling of the vehicle's sub-systems, combined with an in-depth understanding of the application. In this respect, advanced modelling and monitoring of electric vehicle sub-systems, particularly the battery, is of utmost significance to maximize performance. UTEV research focuses on modelling, monitoring, and controlling the battery to enable accurate assessment of its capacity and lifetime, which in turn enhances the range and utility of the battery.

- **Advanced battery management technologies: active cell balancing and embedded state-of-health determination to monitor degradation and extend the lifetime of the battery.**
- **Fault-tolerant battery management system through redundancy and intelligent control.**
- **Innovative liquid-cooled systems to minimize the temperature gradient across the cells and the physical footprint of the battery.**

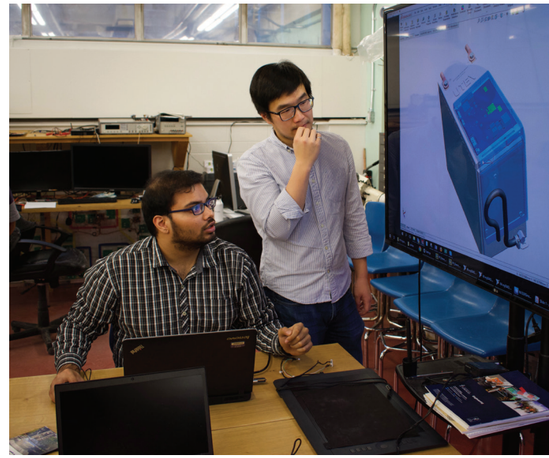


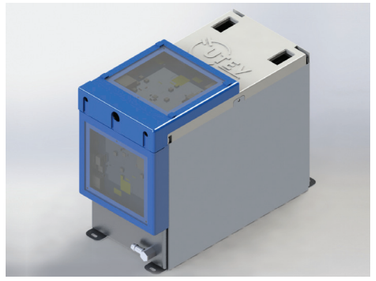


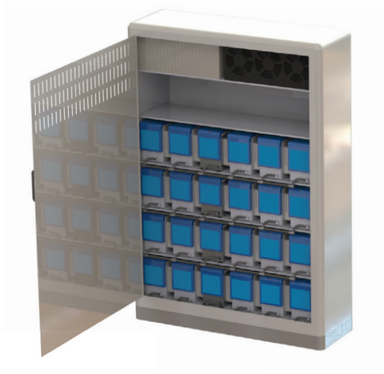
Energy Storage

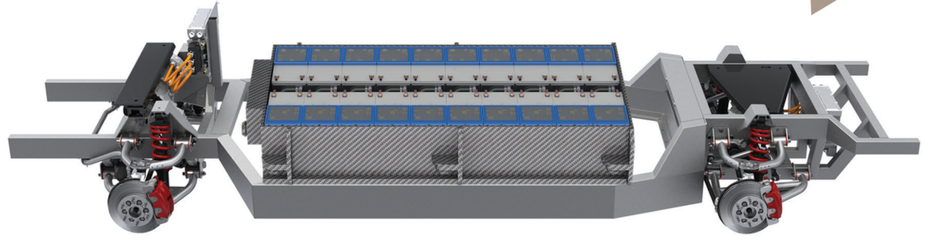
UTEV is developing a holistic approach for transitioning batteries from EVs to stationary second-life applications. The utility of the battery surpasses that of its life in an EV. UTEV's philosophy is to comprehensively deploy EV energy storage throughout the lifecycle of the battery. Once its primary role as an energy source in an EV is fulfilled, the battery can be utilized for secondary applications such as (i) backup energy source in microgrids, (ii) provide support services to the power grid, and (iii) mitigate output power fluctuations of renewable resources like solar and wind.

- **Holistic approach for transitioning batteries from electric vehicles to stationary second-life applications**
- **Planning for optimized battery architectures and controls for both applications from the initial design**
- **Second-life stationary storage for grid support and battery-assisted fast charging**
- **Multi-use, fully exploits battery systems**

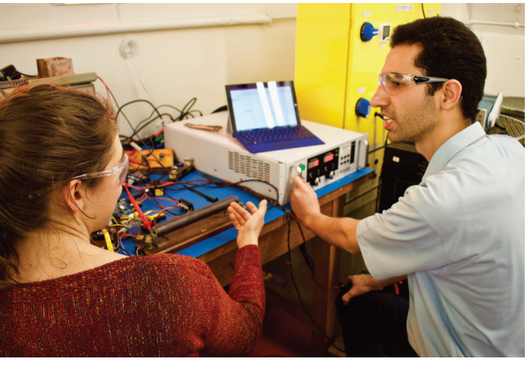




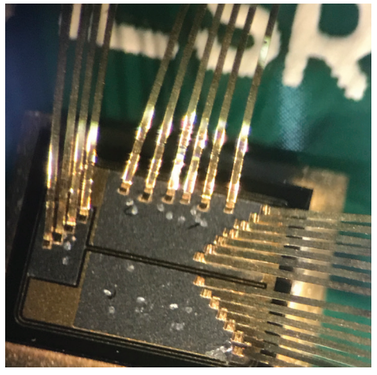




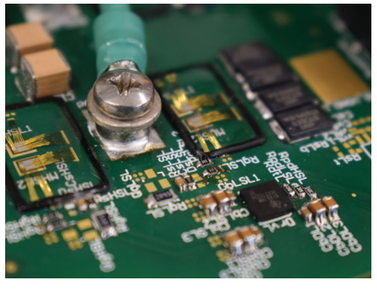
Advanced Power Modules and Integrated Circuits

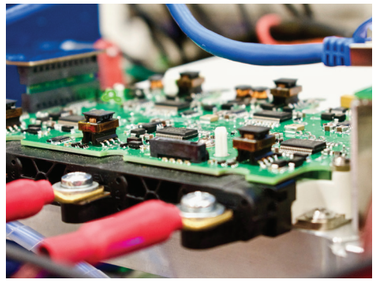


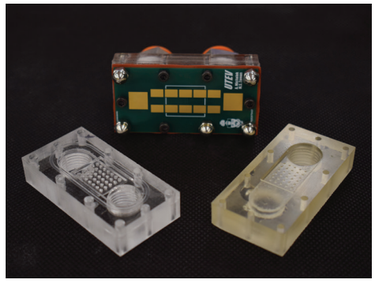
The popularity of EVs has created stringent new demands on the performance and reliability of power electronic converters based on consumer demands and regulatory requirements. UTEV offers a variety of architectures, packaging materials and control strategies to optimize the performance of converter systems. The multiphysics nature of these systems necessitates a co-design approach that harmonizes its competing electrical and mechanical constraints. UTEV is developing integrated power-conversion solutions that leverage cutting-edge multidisciplinary research in electrical and mechanical domains to achieve optimal performance, volume and cost.



- **Ultra-compact charging solutions with integrated heat exchangers**
- **Co-designed liquid-cooled thermal management system for optimized volume and cost**
- **Integrated fault-tolerant mixed-signal control circuitry for improved performance and robustness**
- **Wide-bandgap Semiconductors (SiC and GaN) for high-power density**
- **Advanced jet impingement cooling with miniature 3D-printed heat sinks**

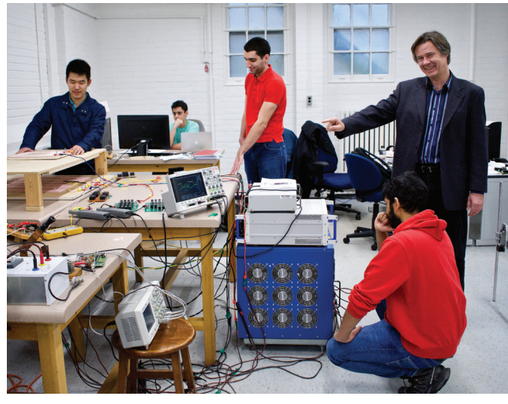




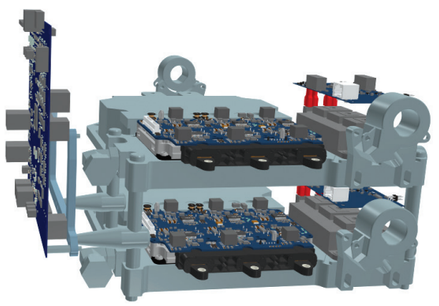


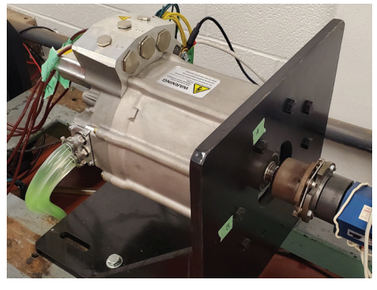
NEXT-Generation Powertrain

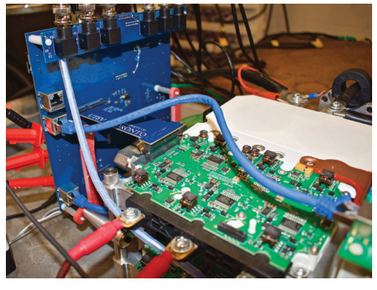
The core of electric vehicles lies within the powertrain. State-of-the-art electric vehicles employ a battery directly connected to a standard two-level voltage source converter. This limits powertrain developments to incremental optimization of the system to increase the range of the vehicle. Research at UTEV focuses on identifying new system topologies to substantially increase efficiency and safety of electric vehicle powertrains.

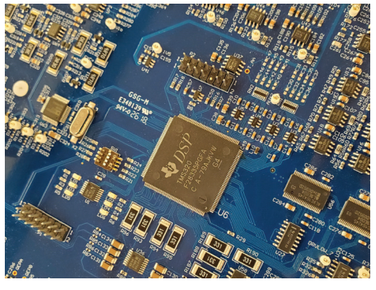


- **Identifying new EV powertrain topologies to unlock additional benefits in terms of driving efficiency and EV range**
- **Integrated driving and charging topologies which minimize power electronic converters required in an EV**
- **Reduced charging time, increased charging efficiency, and reduced system cost**
- **Opportunity to charge directly from renewable energy sources**
- **Advanced electrical and thermal modeling for maximum efficiency and power-density**



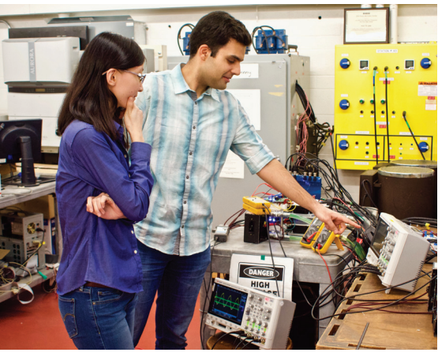


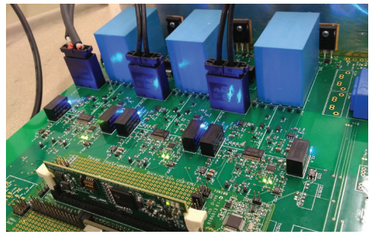


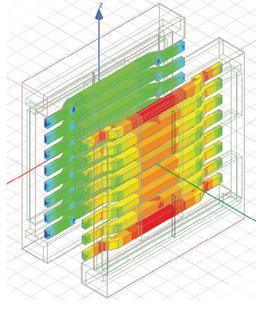


UTEV RESEARCH CENTRE

Ubiquitous Charging

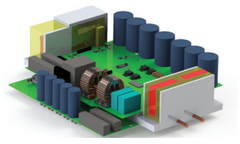


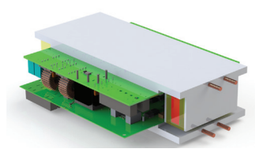




Despite the rapid proliferation of EVs, range anxiety and slow charging rates remain the most significant obstacles to the global adoption of EVs. To overcome these obstacles, UTEV is developing fast and smart charging solutions that enable shorter charging times and widespread charging infrastructure. A primary focus of UTEV is to facilitate a ubiquitous charging network that is comprised of on-board, off-board, wireless, and battery-assisted stationary chargers that can quickly and conveniently alleviate range anxiety of EV owners cost-effectively.

- **On-board, fast, and wireless charging capability to reduce range anxiety**
- **Innovations across the full spectrum: from power ICs to system-software, to facilitate the development of a universal charging network**
- **Intelligent charging to lower infrastructure costs**
- **Significantly reduced charge times with high-power chargers**
- **Wireless charging coil designs with high efficiency for large receiver misalignments**
- **High-efficiency converters for wireless charging**
- **Optimization of compensation capacitors for high power factor operation across a wide range of receiver misalignments**
- **Design of magnetic containment structures with finite element analysis software to ensure SAE specifications for leakage flux density**

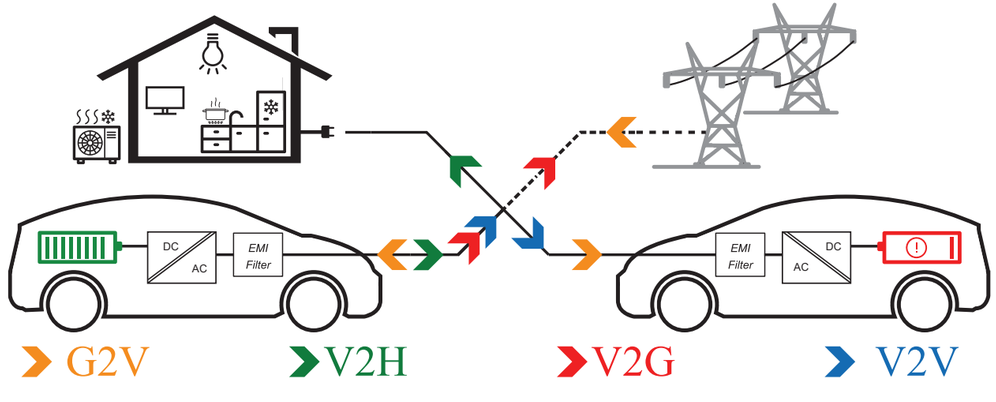


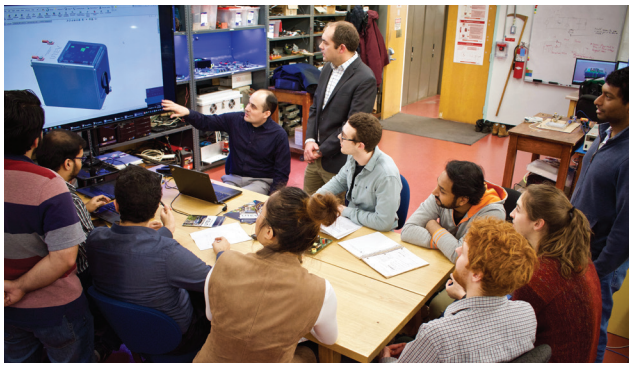


Electric Vehicle Opportunities

The electrification of cars is a modernization of vehicles, which presents an opportunity to expand their utility. The electric vehicle has become a platform that researchers at UTEV are leveraging to introduce a plethora of new uses for vehicles, including using on-board or stationary chargers to provide power from the electric vehicle battery to the grid to provide grid support functions or power homes.

- **Using vehicle electrification as a platform for multi-disciplinary collaborations among electrical, computer, mechanical, industrial and aerospace engineering researchers**
- **Creating chargers that provide power from the EV battery to the grid, to homes, and to other electric vehicles**
- **Developing ground-penetrating radar to enhance vehicle self-localization in dense urban areas, improving autonomous performance and driver safety**



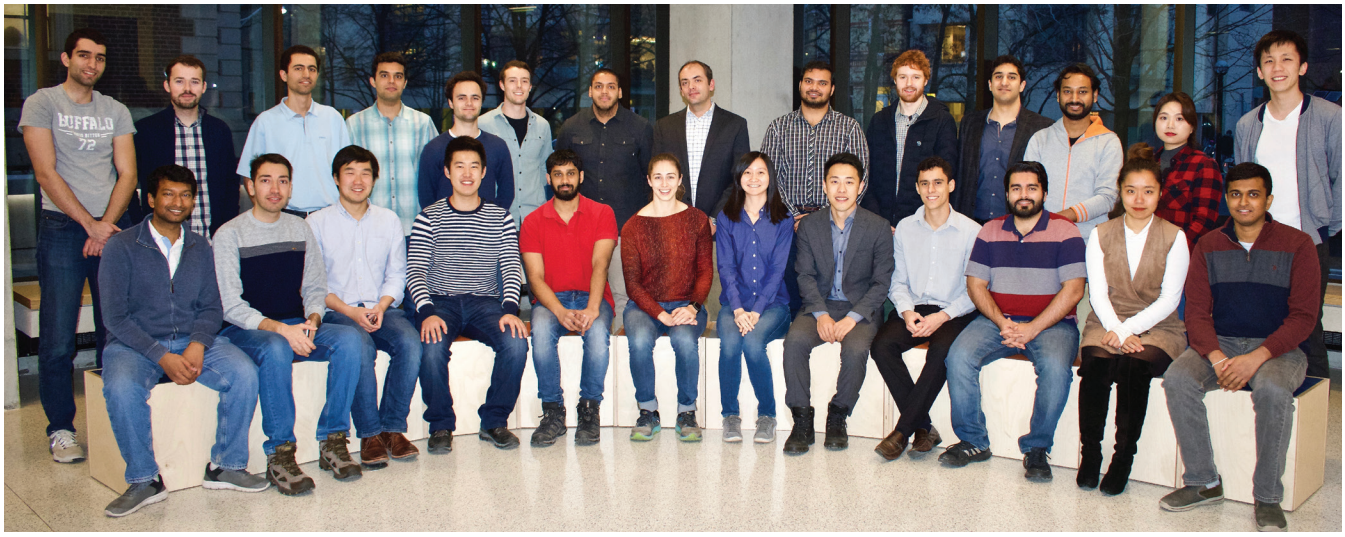


Multidisciplinary Team

UTEV researchers come from the entire spectrum of the Faculty of Applied Science & Engineering, including undergraduate and graduate students, postdoctoral fellows, research associates, and professors.

UTEV is positioned at the forefront of the regional EV ecosystem in Canada's top innovation hub, further encouraging the widespread adoption of EVs and providing many opportunities for Canada-grown EV experts.

UTEV offers a world-class environment ideal for large-scale deployments, testing, and development of battery, charging, and EV technology.



Partnering with UTEV Delivers

UTEV welcomes new partners to collaborate with our top researchers and students

Contact

Director: **Olivier Trescases**
ot@ece.utoronto.ca | (416) 978-2274
Office: SF 1020A

Associate Director: **Peter Lehn**
lehn@ece.utoronto.ca | (416) 946-5355
Office: SF 1021J

utev.utoronto.ca
University of Toronto Electric Vehicle Research Centre, 10 King's College Road, Toronto, ON M5S 3G8