Disruptive Transportation Technologies

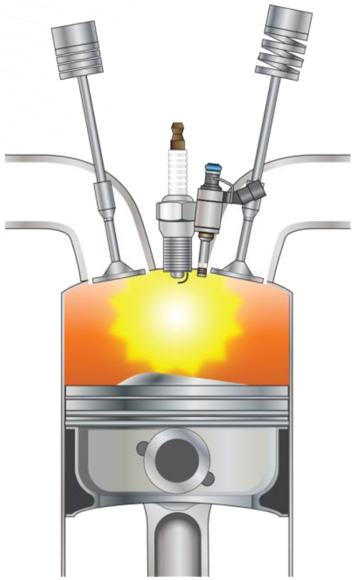
Rich Davies

Deputy Director

Sustainable Transportation Program

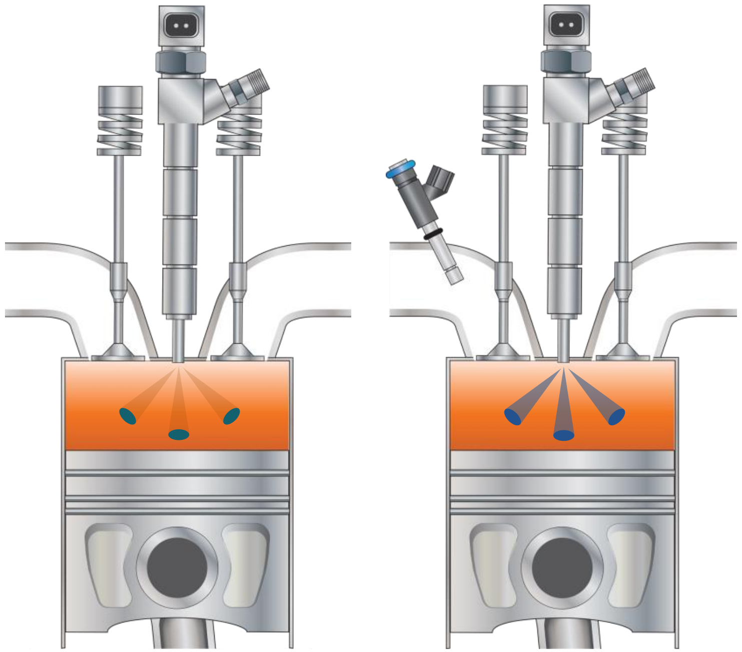
Internal Combustion Engines
Options no longer limited to conventional combustion

Spark Ignition



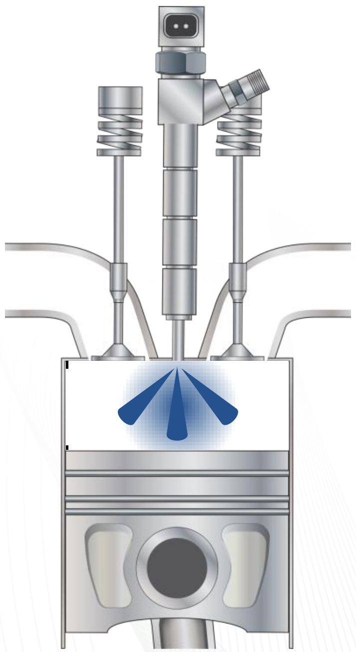
Low Reactivity Fuel

Advanced Compression Ignition



Range of Fuel Properties TBD
(depends on combustion mode)

Mixing Controlled CI



High Reactivity Fuel

Opportunities with co-optimization of fuel and engine technologies

Multi-laboratory Co-Optima initiative addresses three core questions for the light-duty, medium-duty, and heavy-duty sectors:

1. What **fuel properties** maximize engine performance?
2. How do **engine parameters** affect efficiency?
3. What **fuel and engine combinations** are sustainable, affordable, and scalable?

"Researching engines and fuels as a system offers the opportunity to improve the affordability and efficiency of future gasoline engines for American families and businesses."

- EERE Principal Deputy Assistant Secretary Daniel Simmons, February 2018

Current Trend for Battery Electric Vehicles

Current Status:

- 350 - 420 V
- 20- 30 kWh battery packs
- 50 kW PHEVs
- 100 kW BEVs

Chevy Bolt

Future :

- 800V+ light/heavy duty power electronics and electric motors
- 720- 800 V
- 100-250 kWh battery packs
- 350kW at 800V electric drive

GM Autonomy Concept

Charging times

- 6-8 hrs
- 2-3 hrs
- 1-2 hrs
- 20-30 mins
- 20-30 mins
- 10 mins
- <10 mins

Power levels

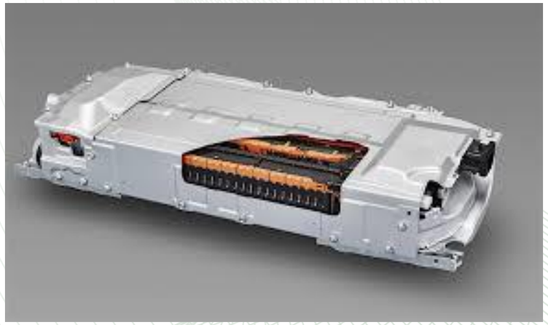
- 3.3 kW
- 7 kW
- 10 kW
- 22 kW
- 43 kW
- 50 kW
- 120 kW
- 150 kW- 350 kW

Electric or Hybrid-Electric Heavy Vehicle

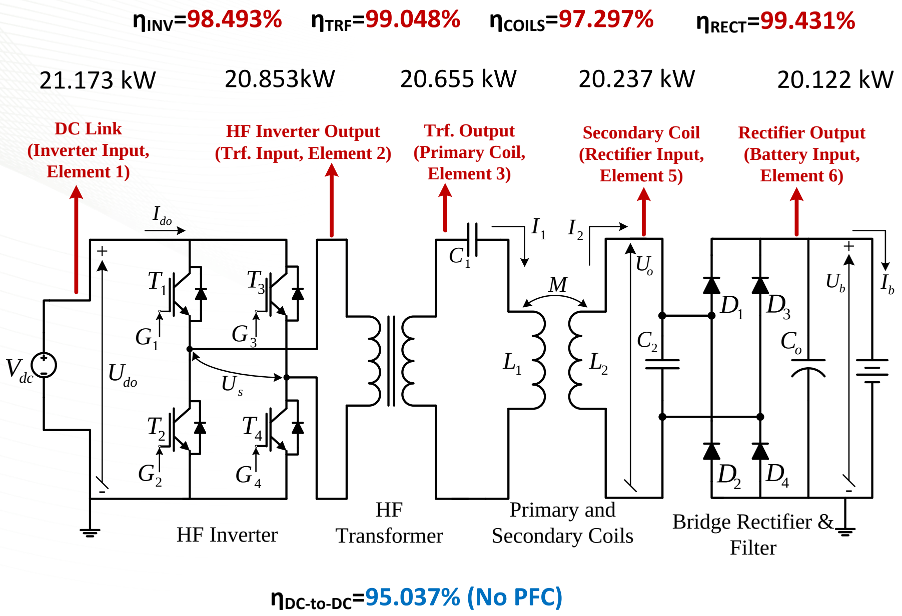
350 kW Wireless or Wired Power Transfer

800 V+ Light Duty Vehicles

100-250 kWh battery packs



Wireless Charging at ORNL



- Toyota RAV4 EV with ORNL Wireless Charging System: ~95%, 20kW, 162mm; Extended to 35kW
- Working on a bi-directional wireless charging system for a UPS Truck: 20kW to the battery, 6.6kW to the grid
- 100kW wireless charging demonstrated. Working towards the goal of 200kW+

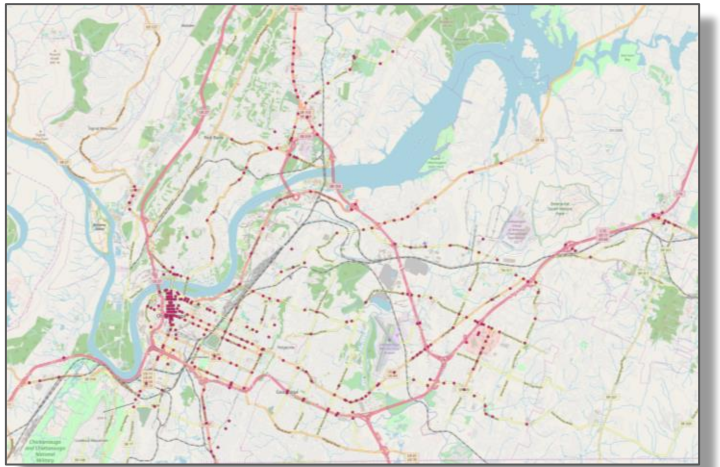
Oak Ridge National Laboratory

Real-Time Data and Simulation for Optimizing Regional Mobility using HPC

Jibonananda Sanyal, Hussain Aziz, Phil Nugent, Budhendra Bhaduri, and Rich Davies

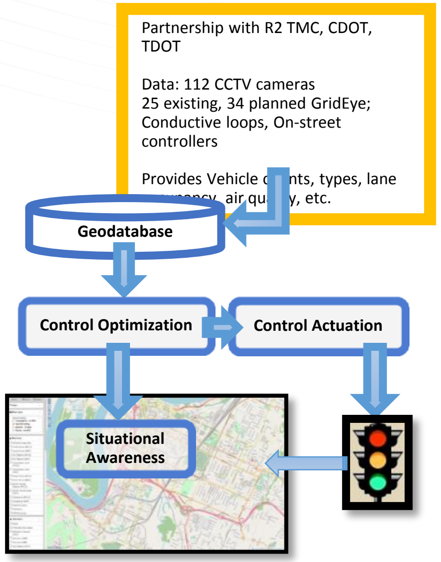
Oak Ridge National Laboratory, National Renewable Energy Laboratory,
Tennessee Department of Transportation, Chattanooga Department of Transportation

- Energy savings targeted through congestion management
- Use of HPC to create a ‘digital twin’ with real-time situational awareness of regional metropolitan highways,
- cyber physical control system with high-speed bidirectional communication and control of the highway infrastructure and connected vehicles
- Target achieving a 20% energy savings in a region
- Replicated region-by-region to commercialize the approach across the entire U.S.
- Over the next 10 years, reduce overall mobility-related energy consumption by 20% and recover $100 Billion of lost productivity in congestion.



Map of Chattanooga with data from CDOT illustrating the locations of the traffic signals.

The CBD area traffic lights are distinguished and highlighted.



Overview of the real-time situational awareness and mobility optimization system

Phased implementation plan

Phase 1 (Year 1)

Situational Awareness

- Visualize real-time data
- Quantify baseline energy consumption
- Estimate energy savings for identified corridors

With the TDOT and CDOT partners

|- Identify how to bridge to operations
|- Run the paperwork
|- Identify/address security risks

Phase 2 (Year 2)

Simulation-based signal control

- Develop signal control optimization
- Simulation driven
- Machine Learning driven

Demonstrate feasibility

Demonstrate on city infrastructure

|- Understand infrastructure needs
|- Understand control logic
|- Understand & degrade gracefully

Out years

Phase 3
Scale-up to other areas
Connected freight

Phase 4
Light duty commercial;
WAZES partnership;
Transport “App”

Phase 5
Autonomous Vehicles;
Advanced powertrain