NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Connectivity Enhanced Energy Management and Control for EREVs

Cooperative Research and Development Final Report

CRADA Number: CRD-11-457

NREL Technical Contact: Jeff Gonder

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

CRADA Report
NREL/TP-5400-62487
August 2014

Contract No. DE-AC36-08GO28308

NOTICE

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Available electronically at http://www.osti.gov/scitech

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: mailto:reports@adonis.osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/help/ordermethods.aspx

Cover Photos: (left to right) photo by Pat Corkery, NREL 16416, photo from SunEdison, NREL 17423, photo by Pat Corkery, NREL 16560, photo by Dennis Schroeder, NREL 17613, photo by Dean Armstrong, NREL 17436, photo by Pat Corkery, NREL 17721.

Cooperative Research and Development Final Report

In accordance with Requirements set forth in Article XI.A(3) of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

CRADA Number: CRD-11-457

CRADA Title: Connectivity Enhanced Energy Management and Control for EREVs.

Parties to the Agreement: General Motors, LLC

Joint Work Statement Funding Table Showing DOE Commitment:

Estimated Costs	NREL Shared Resources
Year 1	$ 175,000.00
TOTALS	$ 175,000.00

Abstract of CRADA Work:

The projected trend in personal mobility is the use of range extended electric vehicles (REEVs) and plug in hybrid electric vehicles (PHEVs). Although batteries with high power density and compact high power electric machines provide appreciable "all electric" range, there still exists the need for an onboard range extender. The use of connectivity information such as route, elevation/curvature, traffic etc. enables substantial real world improvement in system efficiency and fuel economy of REEVs and plug-in hybrids through efficient use of stored electrical energy.

The main goal of this project will thus be to utilize an advanced vehicle platform to develop/refine and evaluate techniques for reducing vehicle fuel/energy consumption through use of intelligent transportation system (ITS) technologies. A Chevrolet Volt will be used as the test platform for the study. Accurate models of the vehicle will be used to develop an energy management system that uses connectivity information available pre-trip to switch between various operating modes of the vehicle at specified trip markers to improve real world fuel economy. An algorithm to identify the fastest green route and the shortest green route will also be developed.

Summary of Research Results:

The National Renewable Energy Laboratory (NREL) and General Motors evaluated connectivity-enabled efficiency enhancements for the Chevrolet Volt. A high-level model was developed to predict vehicle fuel and electricity consumption based on driving characteristics and vehicle state inputs. These techniques were leveraged to optimize energy efficiency via green routing and intelligent control mode scheduling, which were evaluated using prospective driving routes between tens of thousands of real-world origin/destination pairs. The overall energy savings potential of green routing and intelligent mode scheduling was estimated at 5% and 3% respectively. These represent substantial opportunities considering that they only require software adjustments to implement.

Subject Inventions Listing:

Provisional Application No. 61/886,960, entitled, "Connectivity-Enhanced Route Selection and Adaptive Control Methods ", filed October 4, 2013, covering the three Records of Invention below:

- ROI-13-00069 "Predicting Drive Cycle Metrics Over Potential Travel Routes"
- ROI-13-00070 "Predicting Vehicle-Specific Energy Use from Representative Drive Cycle Metrics"
- ROI-13-00071 "Route-Connected Optimal Control Mode Scheduling for Plug-In Hybrid or Extended Range Electric Vehicles"

Report Date:

June 12, 2014

Responsible Technical Contact at Alliance/NREL:

Jeff Gonder

This document contains NO confidential, protectable, or proprietary information.