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Executive Summary

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Consumer Adoption and Grid Impact Models for Plug- in Hybrid Electric Vehicles in Dane County, Wisconsin Part A: Consumer Adoption Models

Prepared by:

**Jessica Y. Guo, Giri Venkataramanan, Bernie Lesieutre, Anthony
Smick, Megan Mallette, Chris Getter**

University of Wisconsin-Madison

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EXECUTIVE SUMMARY

This study focuses on assessing the demand for plug-in hybrid electric vehicles (PHEV) in Dane County, Wisconsin, and provides near term recommendations to manage its impacts on the electric grid.

This study has two main objectives:

- Enhance the understanding of consumers' perception of and demand for PHEVs, thereby informing policy development for wider PHEV deployment.
- Assess the market potential of PHEVs in Wisconsin and estimate the associated vehicle charging patterns, electricity consumption, and infrastructure needs.

Our analyses were limited to the Greater Madison area due to the time frame for the study. As such, the project serves as a demonstration of research methodology as well as a preliminary study for future expansion to analyzing the PHEV impacts to the entire state of Wisconsin.

The study objectives have been accomplished through three major research components: (i) infrastructure readiness assessment, (ii) consumer preference analysis and (iii) grid impact studies. This executive summary and the accompany report document the methodologies and findings relating to Part A of the study that focus on research components (i) and (ii).

Infrastructure Readiness Assessment

A PHEV readiness analysis at the community level using parcel level has been completed using Tax Assessment data for the City of Madison, WI. Nearly 70% of all residential parcels in Madison are found to be PHEV ready. That is, these parcels are occupied by single detached homes with either attached or detached garages. Based on results on the readiness analysis, a scenario analysis of electrical grid impact due to varying levels of PHEV adoption is also described. Compared to past studies of PHEV readiness that typically utilize aggregate data provided for census geographies, our parcel-level analysis provides much higher spatial accuracy regarding where the PHEV-ready households are. Both analyses serve to demonstrate the benefits and the need for parcel-level analysis to support utility planning and PHEV market promotion at a refined geographic scale. The methods allow electrical utilities to analyze their distribution network under scenarios of maximum near-term PHEV load.

However, recharging capability (at home or elsewhere) being a necessary but not a sufficient condition for early PHEV adoption, the likelihood of a household becoming an early adopter depends on a suite of factors ranging from infrastructure availability, charging methods, vehicle and fueling costs, vehicle performance characteristics, to household's income, life style, and attitudes towards environmental issues. Future studies are needed to better understand the relationship between PHEV preference and PHEV readiness, between the true market and the potential market pool.

In the long run, the possibility for recharging PHEV at commercial sites or public stations will not only change market behavior but also load distribution across the utility network. This aspect of PHEV is not covered herein, but to do so in the future would require an analysis of commercial/industrial geographic areas where such opportunities are more likely to be installed. It is hoped that our work presented here would assist with those expanded efforts.

Additionally, agencies that wish to adopt policies encouraging denser built environments with goals of fewer road miles may reveal a contradiction with PHEV home charging. If single unit personal garages remain the universal primary charging locations, the inclusion of those garages will use more land. Further, residents who choose to live in denser urban environments may be served well by PHEV if they must own personal vehicles, yet may not have adequate access to PHEV charging opportunities. It is anticipated that our geospatial approach would be extended to assist in these future assessments.

Consumer Preference Analysis

An in-depth consumer survey was conducted among consumers in the Madison area using a specifically designed survey instrument to study the impact of consumer preference on PHEV adoption.

Out of the 61% respondents that are interested in purchasing a vehicle in the next five years, 80.59% are willing to consider purchasing an alternative vehicle. This equates to 49% of the sample being willing to consider purchasing an alternative vehicle in the next five years. Applying this proportion to the population gives an estimated 70,000 households as the PHEV willing households in the Madison area in the five-year timeframe.

However, when one considers the expected price of PHEVs in the range of \$30,000 and upwards including subsidies, this translates into an *upper bound* of about 21,000 households that are able *and* willing to purchase PHEVs in the next five years. This would represent an annual increase of about 4.3% of the residential electrical utility customer base of the Madison Gas and Electric. The present level of survey data does not definitively develop the geospatial locations of the households where this growth would occur, particularly in light of the inability in sharing confidential consumer information of the survey respondents for correlation with Madison Gas Electric's customer information database. Thus any extrapolation on the resulting specific grid impact of the near term PHEV adoption by households connected to the distribution grid becomes highly speculative. On the other hand, infrastructure readiness analysis and worst-case transformer loading study results indicates that critical aspects of PHEV adoption that lead to circuit overloading tends to occur in rare occasions at rare locations. Therefore, in light of such uncertainties, it would rather be effective to focus on creative solutions that avert such rare events as opposed to developing guidelines or roadmaps for additional infrastructure investments in the distribution network. Preliminary investigations indicate that existing demand side management approaches may be effectively tailored for this purpose.